CULTURAL STUDIES OF SCIENCE EDUCATION | 3

Deborah J. Tippins
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Editors

Cultural Studies and Environmentalism

The Confluence of EcoJustice, Place-based (Science) Education, and Indigenous Knowledge Systems

Springer

Cultural Studies of Science Education

Volume 3

Series Editors

The series is unique in focusing on the publication of scholarly works that employ social and cultural perspectives as foundations for research and other scholarly activities in the three fields implied in its title: science education, education, and social studies of science.

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ISBN 978-90-481-3928-6 e-ISBN 978-90-481-3929-3
DOI 10.1007/978-90-481-3929-3
Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2010933358

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Mission

To produce one of the most authoritative guides for ecojustice, place-based education, and indigenous knowledge in education.

Promotional Text

Ecojustice philosophy is a way of learning about how we frame the world around us and why that matters. Ecojustice is not social and environmental justice, but its priorities span the globe. Therefore, ecojustice recognizes the appropriateness and significance of learning from place-based experiences and indigenous knowledge systems rather than depending on some urgent “ecological crises” to advocate for school and societal change. The idea is that schooling is a small part of the larger educational domain in which we live and learn. Given these ideas, this book offers a conversation for developing homegrown talents, narratives, and knowledge; eco-region awareness; and global relationships. This book provides a nuanced lens for evaluating educational problems and community conditions while protecting and conserving the most threatened and vulnerable narratives. These narratives if lost, would affect us all in ways that should be discussed more fully, where children and their teachers share some of the responsibility for setting things right. With the diversity of voices coming together to initiate these conversations around the confluence of ecojustice, place-based (science) education, and indigenous knowledge systems, this book is an important starting point for educators in many facets of life itself. We anticipate this book brings into better focus a vital role for Earth’s ecosystems within ecosociocultural theory and participatory democracy which engenders a new era of peace.

Promotional Book Quote

Encompassing theoretical, empirical, and experiential standpoints concerning place-based knowledge systems, this unique book argues for a transformation of (science) education's intellectual tradition of thinking that emphasizes individual cognition. In its place, the book offers a wisdom tradition of thinking, living, and being that emphasizes community survival in harmony within itself and with Mother Earth. (Glen Aikenhead)

Foreword

Objectivity, experimental design, the scientific method – these have long been the chestnuts of science education. But this emphasis on scientific remove, on there being one right way to do things, belies the diversity of learners and cultures that fill our schools, in North America and around the world. *Cultural Studies and Environmentalism: The Confluence of EcoJustice, Place-based (Science) Education, and Indigenous Knowledge Systems* is the counterpoint to this constrained, single-minded view of science education. Instead of a one-size-fits-all mindset, it provides a tapestry of perspectives on culturally sensitive science education. It opens our minds to the reality that teaching science in rural Quebec, in agricultural Malawi, in inner city Detroit is in some ways alike, but is in many ways crucially different. If we do not attend to the differences, we lose the learners and the vital potential for students shaping the communities they live in.

Browse through this collection of thought-provoking essays as if you are shopping at your local farmer's market in search of the distinct terroire of regional cheeses, lost varieties of heirloom vegetables, unusual combinations of herbs and spices. Terroire is a French term that describes the unique aspects of a place that influence and shape the wine made there. But the term has spread from wine and other beverages to refer to the unique flavor of locally grown and prepared foods. So, if you're attentive, you can tell the difference between the terroire of New York Black Diamond cheddar and Vermont Grafton Farms cheddar because the local grasses and bacteria that shape the culture of the milk are different in each location. Similarly, when science and environmental education emerge out of real people, issues, and places, it is fresh and uniquely flavored. It can open students' eyes to the life outside the door and it can reinvigorate local cultural traditions. The science educators writing in this book, from Arizona to Australia, are bringing science education alive through infusing it with the terroire of local people and places. They are creating hope through providing opportunities for students to learn science through making their lived-in communities better places.

Science education, in the later part of the twentieth century was about homogenization and standardization, about making sure that every student got fed the same piece of denatured information in the same way on the same day. But this assumed that all our students were the same color, from the same cultural traditions, had the same opportunity for socioeconomic success. In the twenty-first century, science education instead needs to speciate, to adapt itself to the vast array of unique students, problems, and opportunities that present themselves. Many new teachers confront a sea of faces diverse in color, culture, and language ability. How can these new teachers instill the wonder of the biosphere in all of their students, especially those who are marginalized? How will they teach Eduardo, for instance, who just went through a harrowing experience illegally immigrating into the USA, about the Periodic Table of the Elements? And, more importantly, why is that important? Do Eduardo, and Monique, and Abdul really care about the periodic table, or would it be more appropriate to lure them into science by measuring air quality in front of the school when the school buses are idling, or through looking at how traditional methods of agriculture preserve the integrity of the soil? These approaches might actually eventually get them intrigued with understanding what that periodic table is all about.

While you are browsing for unique flavors at that farmers market, you also wind up in a wide variety of intriguing conversations. Your fellow shoppers are talking about genetic engineering, sustainable agriculture, the rivers that run through their lives, the many uses of coconuts. "*I didn't realize there were so many innovative wonderful thinkers working in my community*," you muse to yourself. The ideas are so refreshing, so unique, and so important that you feel tickled to be included. The editors and authors of this book make you feel the same way. They stray from the mainstream of annual yearly performance and "teaching to the test" discourse and instead pick up the side conversations, the ones outside the box, that view science education through the widest possible lens. One great achievement here is that the book offers not only new theory but also what-do-I- do-on-Monday ideas so educators can spice up their curriculum and pique their students' interests. These methods will help students find their own voice, make meaningful connections with their abiotic and biotic environments, and share their narratives with each other and the global commons. These passionate writers view science not as fast-food curriculum, but as a global banquet grown out of deep cultural traditions.

Cultural Studies and Environmentalism is organized into three sections: Ecojustice, Place-based Education, and Indigenous Knowledge Systems – each posing incisive questions about the state of education today. In the first section, one of the authors asks: "*Why teach mathematics and science in schools if what students learn is not used or unusable in the everyday life?*" Instead of teaching denatured water chemistry out of the textbook, this author engages British Columbian students in a place-based study of well-water degradation in their region that unfairly impacts low-income residents. The students become active participants in their education and what starts as math and science curriculum evolves into civic activism. Science becomes relevant to righting social wrongs while also teaching good chemistry. This curriculum teaches students how to become democratic citizens participating in community service through the vehicle of making strong connections to the local landscape. They do not just earn a grade on a piece of paper; they can physically see the outcome of their work and feel good about helping their neighbors.

The second section explores the intersections between place-based education, indigenous knowledge, and ecojustice education asking questions such as: "*What* *is the role of culture in science learning?*" and "*How does a science teacher become an effective instructor of underrepresented, low-achieving, racially marginalized students?*" In one article, David, a Hawaiian science educator, reveals how articulating his own cultural heritage helps him connect with indigenous students. David brings ethnic and social relevance to his curriculum through place- and culture-based science education. David does not just teach about Hawaii through the standardized curriculum. Instead, he and his students cruise the island viewing its flora and fauna through David's native perspective fused with indigenous art forms such as Hula. This unique vantage point helps all students, but especially engages "at risk" students, who are given perhaps their first opportunity to bond with and take ownership of their own lands. These students learn how to be successful in school and beyond.

The final section of the book ponders how educators can infuse science education with indigenous knowledge systems using the local to help the global. Indigenous people around the world are fighting to keep their lands and natural resources from the capital corporate enterprises looking to earn their fortunes. (Sounds a lot like mining unobtainium on Pandora, does it not?) Many of these contested places are hotspots in science education research. One question asked in this section is: "*How can these communities work together to achieve cultural sustainability for the indigenous people, community survival for the residents of the town and ecological integrity of the natural settings?*" Place-based education is introduced as a viable tool that can help indigenous people navigate the power structures that wage war for their lands. Place-based education, along with participatory research, are portrayed as tools that help indigenous people work with their land sustainably thereby fostering vibrant communities who live symbiotically with their natural environment. These beautiful narratives consider indigenous groups from around the world.

Let us bring science and environmental education back to the here and now, out of the textbook and into the farmers market, with it tendrils stretching out into worm-turned soil, subsurface aquifers, and many generations of traditional knowledge. The world is being gobbled up, faster than a teenager inhaling a bag of chips. But it is these special places around us that provide real nourishment. In these places we quiet our minds, our breath is taken away in amazement, we have fun and sweat, we talk to our God, and we sink our toes into the earth that provides the sweet corn we cherish. Science and environmental education gets cut off from its roots when it denies the nearby. Comenius, a seventeenth-century educator, said: "*Knowledge of the nearest things should be acquired first, then that of those farther and farther off.*" Through starting with the nearest things, the places we can walk to, the local watershed, the animal shelter, the Registry of Deeds, the community garden, we root the curriculum in things we can touch, and be touched by. Once we are touched, we want to know, and the wanting to know becomes the quest for knowledge. Science, rooted in place, becomes a way for students to set right the world.

Paige Jackins
David Sobel

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Author Biographies

Jennifer D. Adams is an assistant professor of science education at Brooklyn College. Her research draws on sociocultural frameworks to illuminate science teaching and learning in informal contexts. In particular, she studies teacher education in partnership with museums and community-based/contextualized science learning interactions.

Jennifer Lance Atkinson is a secondary science teacher at Washington-Wilkes Comprehensive High School, where she teachers biology, human anatomy, and physiology. She is also a doctoral candidate in the Department of Mathematics and Science Education at the University of Georgia. Her research interests include multicultural education, cultural relevant pedagogy, sociocultural science education, rural education, and ecojustice education.

Michael L. Bentley is retired from the science education faculty of the University of Tennessee. He has taught at the elementary, middle-school, and high-school levels and has also worked in science museum education, school administration, and state-level curriculum supervision. He is a founder of the Community High School in Roanoke, Virginia. His latest book is *Teaching Constructivist Science, K–8: Nurturing Natural Investigators in the Standards-Based Classroom*.

Elizabeth A. Brandt is a professor of anthropology and linguistics at Arizona State University. Her research includes indigenous knowledge systems and the social constraints on knowledge structure and dissemination, traditional ecological knowledge, patterns of land use, land claims, and gender. She does collaborative community-based research on issues of traditional cultural properties and protection of culturally significant places. She also works on issues of culture, language, and education.

Stacey Britton is a doctoral candidate in the Department of Mathematics and Science Education at the University of Georgia. Her experiences teaching science in village Alaska helped to foster a passion for indigenous science education and culturally relevant pedagogy. Her dissertation work focuses on the use of citizen science as a framework in secondary science teacher preparation.

Cory Buxton is an associate professor in the middle grades education program at the University of Georgia. His research explores the teaching and learning of science in multilingual and multicultural contexts. His current work focuses on how to create discursive spaces for students, parents, and teachers to learn together in ways that support both academic rigor and cultural accommodation.

Jamie Calkin is an adjunct professor who teaches science education courses for elementary teachers at the University of Georgia. He is also an accomplished artist. Formerly a high-school science teacher, Jamie began his art career while in graduate school; his dissertation was an arts-based narrative inquiry into co-teaching science using the visual arts.

Lyn Carter currently lectures in science and technology education to undergraduate primary and secondary teacher education students at the Australian Catholic University in Melbourne. She also lectures in postgraduate education particularly in the areas of research methodologies and contemporary issues in curriculum. Her current research focuses on the broader influences on science education, and the use of cultural theory as a way of expanding research within science education. She has published extensively in prominent international science education journals.

Philemon Chigeza is a science and mathematics educator. He has worked with indigenous students for many years teaching high-school science and mathematics on two continents. His dissertation research investigated the development of frameworks and strategies for mobilizing Australian indigenous students' cultural resources in ways which support learning science. His work explores the notion of agency and indigenous students' negotiation of language and culture in science and mathematics classrooms.

Pauline W.U. Chinn is a professor of science education at the University of Hawaii at Manoa. Her work is grounded in her experiences in place and culture-based science education, both as a secondary science teacher and teacher educator. Her cross-cultural, transdisciplinary research focuses on understanding the ways educating teachers in community-based, inquiry- and issues-oriented communities of practice supports the development of social networks, environmental ethics, place-based expertise, and teacher agency.

Amy Cox-Petersen is professor in the Department of Elementary and Bilingual Education at California State University, Fullerton. She teaches classes in science education and educational partnerships. Her expertise is in science teacher education and learning science outside the formal classroom. Her research interests include culturally relevant science teaching and learning in museum, field, and service-learning settings.

Xavier Fazio is an assistant professor at Brock University in St. Catharines, Ontario, where he teaches in the Department of Teacher Education. His current research interests include secondary school science teaching and learning, environmental education, citizen science, complexity theory, and literacy in science.

June George is a senior research fellow in science education at the School of Education at the University of the West Indies (UWI), Trinidad campus. Formally a high-school science teacher, she maintains a keen research interest in the interface between students' cultural backgrounds and school science, and has published several articles on this topic.

George Glasson is a professor of science education and coordinates the secondary science education program at Virginia Polytechnic Institute and State University in Blacksburg, Virginia. He has conducted research and developed curriculum on ecological sustainability and culture in Malawi since 2003. His research is framed within the context of place-based education, ecojustice, and indigenous science. His most recent curriculum project was designed to connect indigenous farmers with primary school teachers using mobile phone technology.

As a science teacher at Kawananakoa Middle School David D. Maika'i Hana'ike has coordinated more than 50 field trips designed to incorporate indigenous Hawaiian culture into place-based instruction. His work with colleagues supports greater understanding of culturally diverse and "at-risk" students from Pacific Rim countries. David has tracked his family's DNA to the Amis tribe of Taiwan where he has worked with educators on instruction relevant to Taiwan's aboriginal people.

Denise K. Henning is the president and vice-chancellor of the University College of the North and a committed educator who has become a leader in administration in higher education. A Cherokee/Choctaw originating from Creek County in Oklahoma, she has a deep passion for equity and inclusion in higher education. Her research includes Aboriginal graduate student persistence and completion, Aboriginal women's issues, and reducing the disparity of mathematics, science, and literacy attainment of Aboriginal students.

Sheliza Ibrahim is a doctoral candidate in science education at York University, Toronto. Her academic interests include community and youth activism, citizen science, critical place-based education, and visual imagery. Her current research focuses on the uses of visual imagery to connect science with community among urban youth.

Paige P. Jackins is a doctoral candidate in environmental studies at Antioch, New England where her work is focused on environmental literacy, multicultural education, and critical pedagogy of place. A former secondary environmental science teacher and mentor, she is currently a member of the education faculty at the University of Phoenix, where she teaches pre- and inservice teachers with an interest in English language learning.

Douglas D. Karrow is an assistant professor at Brock University, faculty of education, Ontario. He teaches preservice and graduate courses in the Department of Teacher Education and the graduate/undergraduate department. His teaching responsibilities span the broadly construed fields of elementary science, environmental education, and research methodology. His research interests include the relationship between place, metaphysics and technology, citizen science, care and environmental awareness, masculinity and ecological identity.

Miyoun Lim is an assistant professor in science education at Georgia State University. Her research focuses on issues of equity and social justice in education, place-based education with an emphasis on the urban context, and connected science education. Drawing on ethnographic and participatory methodologies, she works collaboratively with urban students, educators, and schools to promote connected science teaching and learning and environmental sustainability.

Kurt A. Love is an assistant professor of education at Central Connecticut State University. He focuses on ecojustice, feminist, queer, and critical pedagogies in science education and education in general. His research includes examining hegemonic pressures that prevent new teachers and student teachers from implementing transformative and emancipatory pedagogies.

Johnny Lupinacci is a high-school mathematics and science teacher in Dearborn, Michigan, and an instructor of social foundations of education at Eastern Michigan University. He is a founder and production editor of *The EcoJustice Review* and codirector of the Center for EcoJustice Education. He is committed to educational reform that uses ecojustice theory and pedagogy.

Bal Chandra Luitel is a doctoral student at the Science and Mathematics Education Centre (SMEC), Curtin University of Technology, Australia. He has been working in Nepal as a teacher educator for about a decade. Guided by multiple paradigms of postmodernism, integralism, and criticalism, Bal's research aims at developing a transformative philosophy of mathematics education in Nepal.

Curry Malott is a professor of education at D'Youville College in Buffalo, New York. He has served as an educational consultant for Menominee Tribal School and Menominee High School on the Menominee Indian Reservation in Wisconsin. His most recent books include *Teaching Native America Across the Curriculum: A Critical Inquiry* with Chairwoman Lisa Waukau and Lauren Waukau-Villagomez; *Policy and Research in Education: A Critical Pedagogy for Educational Leadership*; *Critical Pedagogy in the 21st Century: A New Generation of Scholars* coedited with Bradley Porfilio; and *Critical Pedagogy and Cognition: An Introduction to Postformal Psychology*.

Sonya Martin is assistant professor of science education in the Goodwin College of Professional Studies at Drexel University. Her research focuses on urban science teacher education and teacher preparation. In particular, she examines cogenerative dialogues and video analysis as tools for engaging classroom science teachers and their students in research to improve science teaching and learning in urban classrooms.

Rebecca Martusewicz has been a teacher educator at Eastern Michigan University for 21 years. She is director of the Southeast Michigan Stewardship Coalition, developing community-based-learning framed by the theory and practice of ecojustice with regional schools. She is coauthor of *EcoJustice Education: Teaching for Diversity, Democracy, and Sustainability* with Jeff Edmundson and Johnny Lupinacci.

Maria S. Rivera Maulucci is an assistant professor of education at Barnard College, Columbia University. Her research focuses on how teachers learn to teach for social justice and explores identity, agency|passivity, emotions, and the social context of teacher learning. Her work explores how teachers strategically activate material, cultural, social, and symbolic resources to resist the marginalization of science and emotions preservice teachers navigate as they engage in the process of becoming social justice educators.

Teddie Phillipson Mower is the director of the Center for Environmental Education and program coordinator for environmental education at the University of Louisville. Her research interests include intellectual and ethical development as it relates to navigating controversial issues, multiple worldviews, and the natural world. Her work with formal and nonformal teachers and teacher candidates emphasizes critical thinking skills, science for all learners, local relevancy, and issues of justice.

Michael P. Mueller is an environmental philosopher and science education professor at the University of Georgia. His philosophy focuses on how privileged cultural thinking patterns frame our relations with others including nonhuman species and physical environments. His research includes ecosociocultural theory, ecojustice, citizen science, nature schools, teacher preparation, and youth activism.

Tina Williams Pagan is a doctoral candidate in the Department of Mathematics and Science Education at the University of Georgia. Her interest in nature and local environmental issues prompted her studies, research, and outreach educational efforts in the field of water resources. Her dissertation research focuses on how science organizations can draw on local knowledges in addressing contemporary environmental issues.

Jennifer Ponder is an assistant professor in the Department of Elementary and Bilingual Education at California State University, Fullerton. She teaches social studies and science methods courses in the credential and graduate teacher education program. Her research interests include service learning, youth activism, democracy and education, ecojustice, and the infusion of fine arts into the curriculum. She is particularly interested in working with teachers and their students to examine social and environmental issues, and take action in their communities and beyond.

Eugene F. Provenzo, Jr. is a professor in social and cultural foundations at the University of Miami. The author of a wide range of books in cultural studies, literacy, technology, and educational history, he is particularly interested in the history of science and the development of scientific and historical thinking in children. With Cory Buxton, he has coauthored *Science Education for Elementary and Middle School Teachers: A Cognitive and Cultural Approach*, and has also recently completed with Buxton, *Place-Based Science Education*.

Wolff-Michael Roth is Lansdowne professor of applied cognitive science at the University of Victoria. His general interests include the study of knowing and learning across the entire life span, especially in the domains of science and mathematics. He engages in low carbon generating practices, grows all of his vegetables and many fruit and berries year-round, and has reduced garbage to one can per year. His recent publications include the edited volume *Science Education from People for People: Taking a Stand(Point)* and *Dialogism: A Bakhtinian Perspective on Science and Learning*.

Bradley D. Rowe is a doctoral student in the school of educational policy and leadership at Ohio State University. His areas of scholarship are in philosophy of education, environmental ethics, and educational policy.

Gary Schnakenberg has been a public high-school teacher for 23 years in southern New Hampshire. He teaches interdisciplinary courses, AP human geography, and has worked as an instructor in the geography department at Keene State College. He is currently pursuing a Ph.D. in geography at Michigan State University in the "nature and society" program, examining interactions between smallholder agriculture and economic globalization in Jamaica.

Steven Semken is an ethnogeologist and geoscience education professor at Arizona State University. His research centers on the significance of place, culture, and affect in Earth science teaching and learning, and is situated in the diverse communities of the Southwest USA. He also works in K-12 science teacher preparation on issues of diversity in geoscience. While teaching at the tribal college of the Navajo Nation he collaborated with indigenous scholars on place-based curricula.

Ajay Sharma is an assistant professor in the Department of Elementary and Social Studies Education at the University of Georgia, Athens. His scholarship focuses on studying classroom discourse in K-12 science classrooms and science teacher education programs from the perspectives of justice and equity. He is also interested in exploring implications of climate change and neoliberalism for science education and the democratic agenda of schooling.

Christina Siry is a postdoctoral researcher at the University of Luxembourg. Her research focuses on the intertwined areas of science learning and learning to teach science, particularly at the elementary and early childhood levels. At the foundation of her work are the importance and the complexity of working toward incorporating multiple voices and perspectives in teaching, research, and authorship.

David T. Sobel is the director of teacher certification programs in the education department and director of the Center for Place-based Education at Antioch University, New England. His published books include *Place-based Education: Connecting Classrooms and Communities* and *Childhood and Nature: Design Principles for Educators.* His writing examines the relationship between child development, authentic curriculum, and environmental education.

Arthur J. Stewart is a science education project manager for Oak Ridge Associated Universities. His experience includes research in limnology, stream ecology, and ecotoxicology at Oak Ridge National Laboratory, Tennessee. His science education focus is on "bridging the divide" between science and literature. He has authored several books of science-oriented poetry, and his poems and essays have been published in literary magazines.

Christopher Darius Stonebanks is an associate professor of education and is currently the chair of the research ethics board at Bishop's University, Canada. He teaches ethics and religious culture, social sciences, and curriculum development in the teacher education program and is also developing an experiential learning program in the rural regions of Malawi. Through a critical pedagogy lens, his research interests lie primarily in indigenous knowledge, counter-narratives and the manner in which the media influences schools in Canada and the USA.

Suzanne L. Stewart is a member of the Yellowknife Dene First Nation. She works as an assistant professor in the Department of Adult Education and Counseling Psychology at OISE/University of Toronto, where her teaching and research focuses on Indigenous healing in counseling and Indigenous pedagogy in higher education.

Dawn Sutherland is currently the Canada research chair in Indigenous science education and associate professor at the University of Winnipeg. Her research covers areas related to the influence of culture while learning science, self-efficacy of First Nations youth in science-related career development and educators' perceptions of culturally relevant science teaching. She has been actively working with First Nations communities to develop science education programming that incorporates Indigenous knowledge.

Peter Charles Taylor is associate professor of transformative education at the Science and Mathematics Education Centre, Curtin University of Technology. His research focuses on the contextualization of science and mathematics education with/in postcolonial societies, especially culture-sensitive ways of harnessing global forces of modernization. He is particularly interested in auto/ethnography, literary genres of narrative, fictive and impressionistic writing, nondual logics such as dialectics and poetics, and agentic standards of critical reflexivity and pedagogical thoughtfulness.

Norman Thomson is an associate professor in the Department of Mathematics and Science Education at the University of Georgia. His sojourn in Africa began in the Peace Corps in 1969 where he taught 'O' and 'A' level biology and chemistry. He spent 4 years in Uganda and 7 in Kenya where he developed biology syllabi, curriculum, and served as Chief Examiner for Biology. He has trained Peace Corps science teachers and codirects a Kenya study abroad program. His research is centered on developing hominid evolution curriculum for middle- and high-school students.

Deborah J. Tippins is a professor in the Department of Mathematics and Science Education at the University of Georgia. Her research draws on anthropological and sociocultural methods to invesigate questions of relevance and justice in elementary science teaching and learning and community contexts.

Michiel van Eijck is assistant professor of science education in the Eindhoven School of Education at the Eindhoven University of Technology. His research focuses on diversity and authenticity in science education. Driven by design research on harvesting the potential of diversity in science classrooms, he examines how the practices collectively shaped in science education relate to the practices of natural scientists. His latest book is *Authentic Science Revisited: In Praise of Diversity, Heterogeneity, Hybridity*, which he coauthored with Wolff-Michael Roth, Giuliano Reis, and Pei-Ling Hsu.

Peter D. Veronesi is an associate professor of science education at The College at Brockport in New York where he teaches courses on inclusive science education. He is particularly interested in sustainable and renewable energy use. He teaches courses on the construction of wind turbines for the Evergreen Institute: Center for Renewable Energy and Green Building.

Nicolas Walker has studied law at the University of Melbourne. He has a particular interest in Indigenous law and has worked with the Arabunna Aboriginal clans near Lake Eyre in Central Australia. He is fluent in several languages and is currently pursuing further law studies at the Université Panthéon-Assas Paris II.

Lauren Waukau-Villagomez is an education professor at D'Youville College in Buffalo, New York. She teaches classes in theories of learning and children's literature. Her research interests include multicultural/ Native American literature, the oral tradition and storytelling, hot cognition and learning, and Native American history. Her work with teachers emphasizes the use of subjugated knowledges in promoting learning for Native American children.

Hilary Louise Whitehouse teaches science education and environmental education and coordinates honors research in the School of Education, James Cook University in Cairns, Queensland, Australia. Her research interests include culturally appropriate science teaching and resilience thinking in sustainability education. She has developed early-years curriculum for the Wet Tropics Rainforest Explorer program and has developed community partnerships involving preservice teachers and local schools through Australian Government supported projects such as BirdNet, Science on the Oval, and the Cattana Wetlands project. She breeds wild, native tree frogs in the wet season to contribute to biodiversity restoration in urban Cairns and finds great happiness in being an accidental herpetologist.

David Zandvliet is an associate professor in the faculty of education at Simon Fraser University in Vancouver, Canada. His research interests lie in the areas of science and environmental education and learning environments. He has conducted studies in school-based locations in Australia, Canada, Malaysia, and Taiwan.

Dana L. Zeidler is a professor of science education at the University of South Florida. He currently serves as president of the National Association for Research in Science Teaching (2010-2011). His research program centers on theory development and pedagogical implementation of socioscientific issues in science education. His interests extend to the nature of science, epistemology, reflective judgment, and moral and cognitive reasoning. He is also a Sensei of Isshinryu Karate practicing the art for 27 years.

Prologue

Michael P. Mueller and Deborah J. Tippins

When Deborah first approached me about this book project, I was excited that we might have the opportunity to hinge together these three fitting discourses in environmental and science education. As many individuals know, the discourses of ecojustice, place-based education, and indigenous knowledge systems often remain marginalized within the national and international school environments across the USA and the world. There are definitely exceptions where common grounds are sought. Unfortunately, however, tensions remain about whether the environment should play a significant role in what students learn in schools, or whether science education should stick with the historical modes of inquiry. Deb and I both share a passion for the Earth and cultural diversity, so this project certainly builds on what we have developed a deeper love for. It is also exciting to work with Michiel and Jen who share our interests and bring even greater attention to these natural ecologies.

This book weaves together vibrant dialogues developed in ecojustice, place-based education, and indigenous knowledge systems' literatures for cultivating conversations about the significance of a more holistic way of thinking about people and the Earth in relation. We anticipate this conversation enlarges the spectrum of thinking within cultural studies and environmentalism. It reminds us to pay more attention to those things that we take for granted in our lives. The chapters that follow are part of a forum of exchange, as those who are passionate tell their stories about ecojustice, place, and indigenous knowledge, and explain their challenges or elaborate ideals. Whenever possible, we asked the authors represented in the book to read generously and provide a caring and thought-provoking deliberation. We invited a wide range of researchers, pedagogues, scholars, teacher educators, and practitioners both in the school and policymaking arenas. This book will hopefully further develop many fruitful departures for the authentic benefits of living in relation with others and the land.

The Complexity of Weaving Narratives

The guiding philosophy for this book is ecojustice. It is informed by place-based (science) education theory and activities, and indigenous knowledge. Since ecojustice is the youngest and most theoretical doctrine, we begin with it and show how place-based education and indigenous knowledge provide complexity and clarity for ecojustice theory. Educating for ecojustice is a way of learning about how we frame the world around us and why that matters. Ecojustice comprises anthropological and sociological understandings of cultural groups (Bateson 1972). It also concomitantly comprises many millennia of traditional knowledges which concurrently developed with ecology. In this sense, the ecological sciences draw on a resource of collective ways of knowing about how to mediate worldviews that have adverse influences and impacts. At the beginning of the book we are met with the poetry of Arthur Stewart. In his writing about "ecologists," he notes:

> We studied sand-dunes and the tendency of fish to move
>
> with flow, the population dynamics of goldenrod,
> teasel, lupine, geckos, whip-tail lizards,
> scissors-tail flycatchers, foxes,
> those capable
> and incapable of flying,
> indeed an entire suite
> of wet, dry and wiggly things.
> Now suddenly it seems
> each day the sun rises a bleary slab
> of orange or pick under a smear of clouds. I think
> yes, we really should give homage.
> to Santa Rosalia: we really should
> bow and give thanks
> to Our Sacred Sister, the long-haired
> Sweet Lady of Perpetual Notion (2003, p. 83).

Stewart illuminates what it takes to protect and conserve the Earth and pays homage to the responsibility and humility of communion. He describes this wise idea as Perpetual Notion.

Perpetual Notion also affects participatory democracy. Joshua Blu Buhs (2009) brilliantly writes about the impossibility of separating ecology from democracy by using an example of environmental history of eradicating Fire Ants:

> The job of the scientist was not to battle nature, but to elucidate natural processes and find ways to accommodate human life to the rhythms of nature. This view of the relationship between science and nature was seen to serve democracy in several different ways. Some saw the protection of nature as the promotion of spiritual values above economic ones, and thus a means for creating a better citizenry. Some felt that wildlife was one of the nation's most important natural resources and thus its conservation was a way of maintaining the country's strength. Others felt that living in accord with nature proved the vitality of democratic institutions. If insecticides, say, were used without regulation, killing wildlife, that meant that agricultural agencies had gained too much power and warped the political process, silencing those who voiced a concern for wildlife. A rich, varied natural world was evidence of a strong democracy, in which policies were set to appease competing factions. The USDA's favoring of agriculture over wildlife in the fire ant wars represented a threat to American democracy. (p. 354)

Correspondingly, Gregory Bateson (1972) envisioned Perpetual Notion would be essential to larger ecological policy choices and that we ought to evaluate knowledge based on the degree in which diversity is represented within the policymaking process. He suggested that adversarial ideas should not be abandoned, but rather limited (or restrained) with regards to how affective they are. For example, Bateson suggested that if we were to restrain technological progress, population increase, or the impact of human "hubris over nature," we would be better off as a species living with finite resources. Despite Nature's way, we make decisions to limit how we deal with the unpredictability of unforeseen uncertainty in Nature. In other words, we ought to adapt to Earth's evolving preeminence and this Perpetual Notion takes more than science to understand, which is why we invited many diverse voices to participate in this conversation.

Diverse cultural assumptions are complex and might even be considered multi-faceted when evaluated for associated influences. By analyzing endorsed world-views and how they influence actions, we can pay closer attention to what might be invisible otherwise. In essence, analyzing assumptions makes the "invisible more visible," which in turn reminds us of the now explicit behaviors that we endorse. Considering these behaviors, for example, we might restrain ourselves from relying on the worldwide Internet for finding new sources of knowledge and learning cultural skills. Rather we might turn to our community for these knowledges and skills. We might increase the time we spend talking with our neighbors or travel to the local farmer's market to purchase groceries. Analyzing cultural assumptions through cultural studies and other forms of educational research can rejuvenate our love for one another.

A brief point on ecojustice, for clarity. Note that ecojustice is not social and environmental justice – its priorities span the globe. On the one hand, environmental justice does not do justice to ecojustice. It seldom explores beyond ideas regarding adverse social problems limited to the ways in which humans live with particular environment conditions and ills. On the other hand, social justice has been too focused on unclear social and environmental concerns for people. While there are many problems facing humankind, social justice has actually exacerbated, say, the ways in which natural resources are used and also thereby increased anthropogenic environmental disruptions. This anthropocentrism can be seen unfolding and attributed to the way people in countries such as India and China are after the same sorts of justice or "standards of living" that have been afforded to people in North America for many years. Why should people living in these countries be denied the opportunities to justly live a quality of life granted to a few? It seems counterintuitive to deny others the same lifestyle lived by those who are in more economically advantaged countries. Questions that emerge are complex and have to do with the ways in which humans are thought of as this way or that way, or "what counts," in relation with the ways people value values in economically advantaged nations (middle-class norms). The questions go beyond what can be analyzed with forms of social justice that are still reaching for larger participatory democracy.

This book initiates the conversation around many facets of ecojustice broadly, and gives new directions for approaching these difficult topics proactively. Most educational questions span the globe; issues of justice can be derived from almost every neighborhood, city, forest, stream, or mountainside. We learn by engaging in physical geographies in different ways, not always generalizable yet definitely educational.

Thus, education is the goal of ecojustice philosophy. Ecojustice recognizes the appropriateness and significance of learning from dynamic place-based (science) experiences and indigenous knowledge systems rather than depending on less affective ethical imperatives for the much needed impetus for environmentalism (Mueller 2009). When schooling is acknowledged as a small part of the larger educational domain in which we live and learn, then we turn to the knowledge, activity, and practice embedded within communities. The larger educational domain provides all that we need to show personal and shared agency, environmentalism, and sustainability. There is no need to indoctrinate individuals into a "green agenda." Rather, we strive to learn from the education of community people, those who possess a differentiated status of knowledge and skills. These traditional knowledge and skills will take many different forms, and thus, can be found in every place that has a "local" worldwide. Educating for justice needs educators who are willing to engage with questions of how to live in relation with others and Earth's others in perpetuity.

We anticipate and hope this book will further develop interesting conversations around which we might travel as science educators.

Given these ideas, this book offers some generative Perpetual Notion for furthering the conversation and developing homegrown talent, narratives, and ecologically influenced knowledge, skills, and events. Ecojustice provides a platform to champion regional places and global relationships around coffee, literacy, materials, schools, and so forth. There are a plethora of other examples that this book will charge, and we would use this book as a nuanced lens for evaluating ideas.

If nothing else, let the debacle begin! There is plenty of room for absurdity, humor, irrationality, irony, and scrutiny for interested scholars. How do we become more aware of, say, what it takes to be on this big blue Orb? Stewart (2003, p. 36):

if I let my hair grow tangling

and cast off this coat and step
out of these shining shoes
could I become that wild
green man in autumn barefoot,
eating locusts, tasting the rich
lather of fermenting honey—
could I feel the hard storm coming and see
more clearly than I see now?

Then it is the charge that this book provides a space for cultural studies and environmentalism not marginalized within the dominant literature. In some cases, this book plugs an alarm clock for individuals who are complicit with sleeping in while the Earth's environment "heats up!" (i.e., changes). This book provides a nuanced lens for evaluating and resolving a few complicated educational problems and community conditions, while protecting and conserving the most threatened narratives.

These narratives if lost, would affect us in ways that will be discussed more fully in the third section on indigenous knowledge, where children and their teachers share some of the responsibility for setting things right through place-based work. (Please note that the terms "Aboriginal," "Indigenous," "Native," and "Elder" are capitalized depending on the use by the author within each of the individual chapters and rejoinder.) The second section on place highlights these practices associated with schooling and provides important experiential understandings needed to argue for education centered largely on justice when integrated holistically. With a diversity of voices coming together to initiate these conversations around the confluence of ecojustice, place-based (science) education, and indigenous knowledge systems, this book is an important starting point for educators in many facets of life. Throughout the book, the weaving has been done conspicuously and we anticipate this book brings into better focus a vibrant role for the Earth's ecosystems, within ecosociocultural theory and participatory democracy, which engenders a new era of peace.

Please join in this conversation for justice, place, and wisdom.

Breaking Free

We are bound
to this Earth, our island home,
by the logic of our domination: by leafy
shades of green and gray, by walls
built up, torn down, rebuilt,
made permeable
(oh, if we work hard connecting
youth with age, mysteries
with fact) – yes! – made permeable
by living well between place and being,
centering where locale arises, where thought
originates – pause there
a moment before flying
across lands, rivers, streams,
the dry and stony ground
of one place giving rise
to forests, and dark forests
giving rise beneath you to hills, and thoseat last! To rough-shouldered mountains
juxtaposed, multifaceted, teeming with wild

beliefs, concerns, the Earth
turns slowly,
blue orb in black space; it remains
gracious: it feeds us,
pities us, stirs us, holds up
the mirror of what we do.
Learn by doing and teach
through the heart:
science, our great construct, is not
value neutral. Lean forward and taste it:
oil, spark, salt and cinnamon; hear it,
a hundred thousand voices; speak it
in your own tongue, negotiate
each new idea, a bright coin.
Arthur J. Stewart

Acknowledgments The editors wish to thank Kenneth Tobin, Kate Scantlebury, and Springer Publishing (Bernadette Ohmer), who have promoted a forum centered on topics such as indigenous knowledge and sociocultural frameworks in science education for several years now. We want to encourage the representation of many voices for years to come.

References

Bateson, G. (1972). *Steps to an ecology of mind*. Chicago/London: University of Chicago Press.
Blu, J. B. (2009). The fire ant wars: Nature and science in the pesticide controversies of the late twentieth century. In P. Sutter & C. Manganiello (Eds.), *Environmental history and the American South: A reader* (pp. 345–371). Athens: University of Georgia Press.
Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.
Stewart, A. J. (2003). *Rough ascension and other poems of science*. Knoxville: Celtic Cat.

Chapter 1
The Need for Confluence: Why a "River" Runs Through It

Deborah J. Tippins and Michael P. Mueller

In the recently released *The World of Science Education: Handbook of Research in North America* (Roth and Tobin 2009), Regina Smardon (2009) provides a brief history of sociocultural and cultural-historical frameworks for science education. Smardon's key point is to bring together sociocultural and cultural-historical activity theories in science education to analyze the complexity of cultural staying power, change, and individual and collective agency. This book builds on sociocultural theory by enlarging the conversation around the ecosociocultural confluence of eco-justice, indigenous knowledge systems, and a sense of place, and demonstrates how they also lead to a greater participatory democracy. Creating participatory democracy through cultural studies and environmentalism is in line with this mission of confluence, situations where we participate and advocate through actions.

Considering Confluence

Our lives are filled with many examples of confluence. Science-fiction writers and readers gather annually at their confluence convention to share new visions and ways of expressing their literary ideas. At the Biannual Confluence Conference sponsored by the Chesapeake Bay Foundation participants discuss the significance of resource conservation. Confluence is a theme central to the annual meetings of the Surface Design Association. And recent developments and innovations in communications technology have led to the creation of Confluence, a social networking platform. It is no coincidence that the notion of confluence, defined in the classical geological sense as "the flowing together of two or more streams," has inspired

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_1,

creativity across diverse aspects of society. In the same way that streams and tributaries flow together to create a mightier current, we draw on our understanding of confluence to bring together three powerful currents – ecojustice, place-based education, and indigenous knowledge systems. Scientists often acknowledge gravity as the instigator of processes that draw moving water and runoff materials downhill, forming streams, tributaries, and rivers that shape the surface of the Earth. Near the source of rivers, water may flow out at a moderate rate. But as more runoff and tributaries are drawn into rivers, a confluence is created and the rate of flow increases until the water eventually slows and forms a floodplain where it empties into a lake or ocean. The journey of a river mirrors the way we envision the intersection of ideas in this book. By examining the confluence of ecojustice, place-based education, and indigenous knowledge systems, we hope to invoke new insights, create fresh patterns, etch out new channels, and forge a deeper flow of ideas. It is the intermingling of these currents that will allow ideas to merge and make visible assumptions and relationships previously hidden. Through the intersection of experience represented in this book, we hope to foster unique questions and invite further inquiries.

The Need for Confluence

In terms of the educational literature around ecojustice, place-based education, and indigenous knowledge systems, there are currently few articles and books written about them in an integrative way. A significant problem for these ideas is that although they play a major part in what we do as science educators, they remain in the margins of science education and environmental literatures. However, there is an increasing interest in these topics within cultural studies and environmental literature.

Historically, science education research has not always recognized and captured the diverse ways in which all science educators are teaching within the larger educational domain. In the attempt to isolate and analyze educational phenomena, we have not always been educated to think in terms of confluence or uncertainty. With great trepidation, we may now be forced to consider the world as a web of multidimensional and interrelated phenomena that require us to recognize and deal with the possibilities of uncertainty.

Our educational quest for certainty has influenced efforts to produce generalized science understandings which can be applied to any location. However, solutions to some of today's complex educational, environmental, and sociological issues are elusive, formulated outside the wider concerns of justice, place, and indigenousness. Test-driven curricula, for example, are rooted in a fragmented worldview with little concern for the affective, emotive, and intuitive science understandings essential to solving pressing problems of the world. In one sense, this book questions accepted narratives, exploring ways to renew our sense of injustice and reconnect ourselves with nature.

The Relevance of EcoJustice in Science and Environmental Education

Worldwide, dominant educational models in recent years have linked economic development to educational practices through an emphasis on standards that marginalize cultural and environmental ways of knowing. Yet, there has been a trend to preserve cultures that has persisted in the attempt to ensure that memories survive the legacies of colonialism and genocide. A delicate balance exists with some indigenous cultures vulnerable in terms of their very survival and others actively reaffirming the vitality and usefulness of their traditional ecological knowledge in seeking solutions to contemporary societal issues. At the same time, with the emerging green movement, there is a trend to protect the environment as individuals and groups wrestle with such complex issues as agricultural sustainability, biodiversity conservation, environmental management, and intellectual property rights. A newer trend, one which aims to protect culture and environment together, is emerging with the interest in ecojustice in science and environmental education. The relevance of ecojustice in science education is inextricably linked to the recognition that ethics and morals have been and should always be a part of the choices made about science education research decisions and reform agendas, both locally and throughout the world.

In contrast to western science and its quest for universal relevance, ecojustice, when woven together with a sense of place and indigenous environmental knowledge systems, is local and highly contextualized. In both an ideological and material sense, the confluence of these three currents provides a different way of reading the world – one that acknowledges the responsibility humans have to nature as well as to each other. In bringing together these three currents of thought, we are deeply aware of the need to avoid some form of hyperconfluence leading to only one frame of reference. It is, in fact, the diversity of ideas and the variation in research contexts that each author in this book has to offer that makes the idea of an emerging ecosociocultural theory infinitely more powerful and relevant.

The Promise of Ecosociocultural Theory

Interestingly, the opening of a book that many people have read and seeing it with a new light is exactly what happens when we read the promise of an emerging idea such as ecosociocultural. This theory is premised on the presupposition that we cannot separate ourselves from the larger ecosociocultural world, and we should not try to separate schooling from the larger ecology. However, the larger ecological world has messages writ large for us, not only interpreted but reinterpreted from our perspectives, and interpreted from seeing them in a new light. The idea is that as we learn more about ourselves in relation to other human beings and the larger animal–plant–physical world, we begin to see things again and should revisit our prior ideals.

Sociocultural is no longer applicable when we hold that human beings are not separate from what influences and impacts lives, namely, the environmental conditions that largely determine us. We are only part of the ideologies of knowing and relating that we call epistemology and ontology; surely Earth will have its way. Indigenous knowledge reminds us that nature will always correct for ways of knowing out of sync with the natural world.

This book does not theorize ecosociocultural; however, the term is used throughout as a way to foster the reopening of our book.

If we remain open to the confluence, then there are sure to be controversies, which will lead to new research questions, ways of impacting our local communities, and educating others. However, when we think we have it all figured out, disruptions create aggregations not yet foreseen. So controversies are good. They are a part of living in relation to others who hold diverse perspectives and see things that we see in a different light, while together we see it in a much greater light and so forth. It is with this challenge that ecosociocultural brings out a new light to make the visible invisible and invisible more visible, to have new conversations about what we see in the place near us (the way we make sense of place is as much a book as a book). In seeing ourselves in a new light, we sense the place diversely. But difference is good, that is when we begin to see confluence. Ecosociocultural gives us a new lens to open our old books and find new ideas, inquiries, differences, theories, and scholarship. Are you ready to take your books off the shelf and dust them?

References

Roth, W. M., & Tobin, K. (Eds.). (2009). *The world of science education: Handbook of research in North America*. Rotterdam: Sense Publisher.

Smardon, R. (2009). Sociocultural and cultural-historical frameworks for science education. In W. M. Roth & K. Tobin (Eds.), *The world of science education: Handbook of research in North America*. Rotterdam: Sense Publisher.

Part I
EcoJustice

Chapter 2
Nurturing Morally Defensible Environmentalism

Michael P. Mueller and Deborah J. Tippins

We begin this section on ecojustice by acknowledging that schooling is a very small part of the larger educational domain. As students sit at their desks or at lab benches learning about science and how to do science, they get merely a glimpse of the world at large. This world is the setting for a "science" inseparable from the lives of men and women in every cultural, ethnic, racial, and national milieu. Moreover, it is a science inseparable from the lives of animal and plant species, embedded in the strata of robust geology. Children are pure witnesses to this Nature breathed in and breathed out, their hands in the muck, their minds and bodies affected by the minutiae of environmental toxins and nurturing chemicals. Our Nature is a world of ecologies in which we humans are situated, withstanding rationalities which create mindful tolerances of epistemic separation until Earth gives way to our abstractions.

These abstractions comprise subjects taught in schools. But education is what we do when what we learn in schools is used to make sense of our embodied and relational situations. Subjects are fodder for school but education is larger than life in school. Education begins in the womb of our mothers and before that in the soils of the Creation. It ends and begins with soils. What matters then is the regeneration of the soils in the Sacred, which is described in this book. Education that does not offer the regeneration of the soils, and by extension, the lives of people, does much less to contribute to the moral and spiritual formation developed when living more fully within the community and environment. At the heart of every school is a community regenerated and built of lives vis-à-vis "life"; a metaphor having very little to do with the larger stage of educational ecologies. The idea of educating children is not limited to the spheres in which schooling occurs. Rather education lives in relation to every other spherical geography in which young lives are nurtured the

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_2,

world over. When animals and plants and mountaintops become ecologically degraded, we too become degraded. This degradation of communities and environments reveals what humans are willing to accept and exchange for shared common cultural and environmental spaces. Consequently, ecological degradation can lead to injustices in schools in ways which contribute to more abstraction and death of Nature.

Ecojustice is a new term, used in this section to represent the holistic ways of knowing ourselves in relation to others (Thayer-Bacon 2003). It guides questions of how we should live in relation to, and nurture the Earth with, other people. In many ways, it is a theory of integrated relations, which is impossible to distance from humans and the more-than-human (Abram 1996). Ecojustice reminds us to seek schools where much of education happens in a way that is more fully realized through John Dewey's classical theory of participatory democracy (Dewey 1916/1966), yet not limited to a realm of sociocultural knowledge and scientific endeavor as *the* best method. Therefore, this section strives to reach out to notions of understanding and democratic education as food for thought and body. Ecojustice represents an interpretation of the condition of the sciences not separate from lives, where the school's community is enlarged and embodied within understandings of embeddedness. Relations within the community are necessary to question those ideas which make lives more threatened. In this way, ecojustice serves as a lens to understand cultural assumptions or patterns of thinking which influence the ways in which we frame ourselves in the world, such as behavior and action. Ecojustice is a holistic theory which dissolves dualisms between epistemology and ontology, or does not consider thinking and being as separate ways of encountering ourselves within Earth. It helps us to evaluate cultural assumptions and the ways we frame the world and why that matters.

Ecojustice also helps us to analyze educational experiences and the challenges and tensions between sociocultural abstractions and interpretations and the larger ecoeducational domain. Analyzing educational experiences and tensions can reduce some of the nervousness that many scholars have described as "the threat" to the world's ecologies associated with, for example, population pressures, which inadvertently perpetuate the control of women's bodies (Mueller 2009). When we de-emphasize the imperative of "crises" implicitly reinforced in the vast majority of environmental scholarship about social and environmental justice, it guides us to seek greater ethics. Ethics serve as the context of the third and greatest foci of ecojustice within ecoeducation theory. In brief, cultural assumptions, educational experiences, and ethics constitute ecojustice theory. These things live in relation to each other and cannot be separated, only reduced to descriptions, which helps us to understand the qualified parts of the whole ecojustice movement within schools.

Ecojustice draws on the communal activities within indigenous knowledge systems. Further, an essential aspect of ecojustice theory is the conservation of cultural and biological systems, in forms of *nurturance*, rather than construction, management, and validation with humanity. Cultural traditions should always be considered within the wider spectrum of ecorelations (in contrast to "correlations," which is a statistical deduction of Earth to the mathematical sciences). Whenever possible, the conservation of civil liberties, freedom, oral narratives, species and habitats, the arts, or conviviality, should not be limited by a politics of *conservative* and *liberal*. With few exceptions, both politics generate and regenerate forms of anthropocentric tendencies and consumerism as unquestioned platforms. Hence ecojustice does not represent a neoconservative or neoliberal position within philosophy. Ecojustice does not seek to renew a philosophical romanticism, which serves as a challenge for scholars who strive to highlight the vulnerabilities within the confluence of ecojustice, place-based (science) education, and indigenous knowledge systems.

For ecojustice educators, justice *is* fairness among humans, nonhumans, and the Earth. Ecojustice is different from "social justice" and "environmental justice," where only humans and animals have some defensible rights. Just because the soil is not easily defended, it does have the potential of defensible environmental rights, which may require advocates. In terms of ecojustice, responsibility for justice falls on those who live within particular communities, where justice is more fully defined by law and rights. Justice then applies to becoming more informed, reading newspapers, articles and books, and granting the same status to learning from the literacies of those who may be considered illiterate and uneducated. Because humility is a significant part of this philosophy, we must acknowledge those things we may never know and learn, and we must be willing to protect cultural and communal differences and biodiversity, as a philosophical principle of "justice embedded within social ecologies." Dewey highlighted this transactional approach early in his work (1916/1966). He notes that subjects are learned and focused on evaluating the wider spectrum of societal problems in order to set things right. In order to do this, cultural traditions and habits are endorsed through intergenerational relations. These things help teachers and their students to evaluate the curriculum of the larger society and environment. Teachers and students share some of the responsibility for moving towards the common good, which can be interpreted as the basis for which degradation is mediated together. Justice is shared and mediated in common. When we say that we are mediated by just relations, it is to say that we ought to be compelled to do what is just. Although legal constraint is the most obvious aspect of justice in most societies there is also an underlying aspect of moral obligations. Thus, if we are not punished by the law, we are punished by the punitive opinion of other people, or the burden of bad conscience. In terms of ecojustice, there are few juries to enact judgment in the sense of moral reprisals against those who commit heinous acts of cultural and ecological violence.

Justice implies something that is right to do, and wrong not to do, but also something which can be defensibly claimed from us to have moral rights. We should not be held responsive to the generosity of others who have insufficiently claimed to have developed a moralist ecology. A question of what these ecologies should provide for humans is not exempt from moral theory. Hopefully, this section will open the mind to some possibilities for defending ecological rights in ecojustice theory, beyond some human acquired debts to natural systems for which Nature is due. The "acquired debt" stance within environmental philosophy is a taken-for-granted supposition that may need more conversation before these characteristics of ecojustice become convincing. Consider, for example, how "ruthless" Nature might be judged by those who survived the legacy of Katrina, or those who escape the many apparently destructive forces of Earth. The act of defending Nature's rights based on our obligations to Nature as embedded beings is a contradiction of reproductive and survival ethics. Ecojustice enlarges the conversation; however, there are many things that we grant charity, empathy, and generosity whereas do not extend rights to Earth's nonhuman entities and physical environments. Ecojustice requires that for Nature to have rights, the larger society must accept that Nature has rights that can be defended beyond the utility of humans. It is anticipated that ecojustice theory will eventually convince such that the claim will go from "Nature *ought* to have rights" to "the indispensability of Nature's necessity for rights and ecojustice." Ultimately this morally defensible environmentalism will be the consequence of our generosity, or the "violence" that the Earth will wage on humankind through climate, pestilence, and famine.

References

Abram, D. (1996). *The spell of the sensuous: Perception and language in a more-than-human world*. New York: Vintage Books.

Dewey, J. (1916/1966). *Democracy and education*. New York: Macmillan.

Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism, and sustainability. *Science & Education, 18*(8), 1031–1056.

Thayer-Bacon, B. J. (2003). *Relational (e)pistemologies*. New York: Peter Lang.

Chapter 3
EcoJustice Education for Science Educators*

Rebecca A. Martusewicz, John Lupinacci, and Gary Schnakenberg

We live in a world of immense power, beauty, and wisdom. Every living and nonliving entity that occupies this planet, including humans, participates in an infinitely complex set of shifting, communicating relationships that create everything, making life possible. And while humans may desire to understand it all, there is no possible way to ever fully uncover or control all the resulting mysteries that circulate here. This is the meaning of the sacred.

So why start here, with these thoughts about the sacred when this is a book about science education? We take this position, that humans cannot completely or finally understand or control these life processes, recognizing that it may ruffle some feathers in a book of this nature. While not applying to all scientists, science itself has a long history of engaging in the pursuit of knowledge grounded in this very assumption that we can know and thus control the forces that make life possible. We begin from the recognition that in order to know anything, humans must use language to represent it, or more broadly stated, a symbolic system, which immediately puts us at a distance from what it is we seek to know. Further, as we will describe in more detail later, all our "languaging" engages a process of differentiation that is actually very creative of something other than what we assume we are merely re-presenting. And yet sometimes, all too often in fact, we forget that. We get lost in our hubris as "creatures of reason." To believe that we are outside it and can thus unpack it all, or to believe we should even try, is a dangerous undertaking certain to fail, to cause much damage both within human communities and within the larger systems of life that we depend upon.

*Though we have life, it is beyond us.
Wendell Berry

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_3,

We offer a framework for thinking about science education that takes these problems seriously. How do we accept the sacred, what is fundamentally "unknowable," while we teach about the systems we care so deeply about? While the aims of scientific investigation – validity, replicability, predictability, measurability, for example – lead to important insights into specific phenomena, they are incomplete ways of knowing by virtue of being embedded in a specific cultural (and thus symbolic/language) system. These ways of knowing have a history linked to particular interests and power structures that may be unrecognized by those who take them for granted. They can thus take on a life of their own, and are clearly influencing what we define as a strong education. In this chapter, we introduce an analytic framework for considering the effects of some of these issues, especially for teachers entering the field of science education. Below, we introduce the major strands of an ecojustice framework and then move to provide examples of how K-12 teachers in a variety of settings are beginning to use this framework in their classrooms and communities.

Introduction to the EcoJustice Framework

The first important piece of this framework entails a definition of "ecology" that goes beyond the limited view established in the late nineteenth century that positioned "science" as the primary framework to be used in "protecting" and managing the environment as a separate object of study. This view or position disregards the etymology of the word ecology, which when traced back to the Greek "oikos," means home or household. Thus, rather than asserting a view that positions the environment as outside of or separate from human communities, we begin from the understanding that all human communities are nested and participate in complex communities of life – ecosystems – that we depend upon for our very lives. So, how is it that we come to think and behave in ways that disregard this essential embeddeness, and even interfere with this critical interdependence?

In this essay, we introduce three major goals of an ecojustice framework: (1) to engage an analysis of the linguistically rooted patterns of belief and behavior in western industrial cultures that have led to a logic of domination leading to social violence and ecological degradation; (2) to offer an alternative way of knowing that recognizes humans as just one part of a vast system of communication among all life forms that creates wisdom, beauty, and the sacred; and (3) to identify and revitalize the existing cultural and ecological "commons" that offer ways of living more sustainably in our own culture, as well as in diverse cultures across the world.

Emphasizing "ecology" to mean the complex network of diverse living relationships creating the community within which we live, ecojustice perspectives understand issues pertaining to social justice to be inseparable from and even embedded in questions regarding ecological well-being. This perspective also recognizes the essential relationship among biological, cultural, and linguistic diversity. As Daniel Nettle and Suzanne Romaine (2000) point out, there still exists across the planet at least 5,000 different languages that correspond to different cultural systems and also to specific bioregions where they originated. Thus, there is an important relationship among linguistic, cultural, and biological diversity that creates different maps or ways of seeing and behaving relative to the natural world as well as toward other humans. As English is spread worldwide as the dominant language of western economic systems, for example, diverse languages are being lost. As languages are lost, so too are important knowledges and practices of local bioregions, knowledge used for hundreds of years to cultivate the land and to protect watersheds and the diverse species within them. Utilized by the interests of powerful minorities, western science has had a role in this destructive process.

The Cultural Foundations of Ecological and Social Problems

For K-12 teachers, the first goal of this framework offers an analytic path for learning to identify and disentangle the ways language works to frame the ways we think. This approach entails a "cultural-ecological analysis" (Martusewicz and Edmundson 2005) that most science teachers are probably not used to using to think about their roles and responsibilities. This piece of the framework invites us to consider the ways that our beliefs about, and behaviors toward, both the natural world and each other are constructed within a complex and centuries-old sociolinguistic system.

Ecojustice scholar C. A. Bowers (1997) uses the concept "root metaphors" to get at the ways that language operates analogically to create foundational discourses such as ethnocentrism, individualism, mechanism, scientism, and anthropocentrism. The idea of "root" here is important because the metaphors at the heart of these discourses are old and deeply entrenched in our day-to-day lives; legitimated through what we have come to call the Enlightenment, they shape both the institutional structures and individual relationships and identities implicated in both social and ecological violence. At the most basic level, exchanged linguistic forms or discourses, handed down over many centuries, shape the ways we think at a deep unconscious or taken-for-granted level. For example, an instrumental view of knowledge as made up of discrete disciplines can be linked to "mechanism," the idea that nature is reducible to an object made of predictable parts and laws for our use.

This idea emerged during the Scientific Revolution to replace a more organic view of the world as a product of a divine creator. In 1605, for example, Johannes Kepler (1571–1630) wrote: "My aim is to show that the celestial machine is to be likened not to a divine organism, but to a clockwork" (Merchant 1980, p. 129). According to historian Carolyn Merchant, this rendering asserted rational control over nature, society, and the self, redefining reality itself through the new machine metaphor. "The removal of the animistic organic assumptions about the cosmos constituted the death of nature – the most far reaching effect of the Scientific Revolution" (p. 193).

Commenting on our contemporary inheritance of this way of thinking, Wendell Berry (2000) writes:

> The most radical influence of reductive science has been the virtually universal adoption of the idea that the world and its creatures are machines – that is, that there is no difference between creature and artifice, birth and manufacture, thought and computation. Our language, wherever it is used, is now almost invariably conditioned by the assumption that fleshly

> bodies are machines full of mechanisms, fully compatible with the mechanisms of medicine, industry, and commerce; and that minds are computers fully compatible with electronic technology. (p. 6)

Think for example of talking about a stream as a “drain,” or a farm as a “factory.” What gets hidden, overlooked, or rationalized when we consider a cow as a machine for milk commodities? Or, a flowing body of water a mechanism for moving liquefied manure “away” from the farm?

While all cultural systems use metaphor and are socio-symbolic systems, many non-western people use more organic or even familial/kinship metaphors to describe their relationship to the cosmos. These different worldviews create very different relationships to the living world. Thus, the Quechua people living in the Andes, for example, use the word “Pachamama” to name the Earth and the living cosmos. And, “chacra” means both a plot of cultivated land and nurturance as a central metaphor for the most essential relationships among community members (Apffel-Marglin 1998). The Ladakhis from northern India use the notion of “dependent origination,” a Buddhist concept describing the complex interdependencies that exist among all living things: nothing exists outside its relationship with other things (Norberg-Hodge 1991). The world, in these views, is not a machine, it is, rather an organic set of living relationships in which humans are nested and participate.

The important analysis put forward by this part of the ecojustice framework is that the ecological crisis is really a cultural crisis brought about by western industrial culture. To understand the processes leading to the devastation of the world’s diverse living systems or the impoverishment of communities, we must look at historically codified patterns of belief and behavior. These powerful discursive forms and practices result in social policies, economic decisions, and educational institutions that continue to reproduce unsustainable overconsumption of the resources we need to survive. Further, they produce subjective formations and collective psychological patterns that make certain relationships seem normal, natural, or universal. They even form the ways that we think about the ways we think! That is, they influence what scientists and philosophers say about who we are as “rational” self-reflective humans. The most obvious example of this is the way we have learned to think of ourselves as dominant species by virtue of our abilities to “reason.” Yet, we are the only species on the planet who has used this capacity to wage war, marginalize whole groups as inferior to other groups, or create and dump chemical toxins into our environment that are now bringing the life systems of the planet to the brink of disaster. The words we use on a day-to-day basis help to maintain and recreate “master narratives” that structure complex hierarchized systems of thought, identity, value, and material realities that create and recreate violent, destructive relationships and practices as if they are “normal” or “natural.”

Ecofeminists Val Plumwood, Karen Warren, Carolyn Merchant, and others offer further insights on this sociolinguistic analysis. Plumwood’s detailed analysis of what she calls “centrist” modes of thinking exposes the intertwined nature of age-old patterns of hierarchized belief leading to both social and ecological oppression. “A hegemonic centrism,” she writes, “is a primary-secondary pattern of attribution that sets up one term (the One) as primary or as centre and defines marginal others as secondary … as deficient in relation to the centre. Dominant western culture is androcentric, eurocentric and ethnocentric, as well as anthropocentric" (2002, p. 101).

In this mindset, "Reason" and associated terms such as "intelligence" and "mind," tend to be understood as exclusively human qualities, legitimating the "radical exclusion" of that which is not human and their positioning as objects of exploitation. Such an orientation to the world can be traced as far back as Plato, through the "age of reason" in the work of Rene Descartes and other Enlightenment thinkers, and into the modern world. Specifically, we have inherited and internalized a form of thinking that divides the world into a naturalized system of hierarchical oppositions – man/woman, reason/emotion, body/mind, culture/nature – where the first term in the pair not only has more value, but is given the "natural" right to define, control, and even exploit the other. There is no interdependence among these terms, only dependence of the second "weaker" term upon the first.

Ecofeminists recognize this ideological foundation as the basis for the oppression of women and other marginalized groups that are represented within western discourses as either part of nature or closest to it. Thus, we see close ideological ties among anthropocentrism, patriarchy, and ethnocentrism. All interweave via these dualistic assumptions mapped onto our consciousness through our daily conversations, and within our cultural institutions to form a deeply embedded set of assumptions that underlie and lead to both the ecological crises and social crises plaguing our communities.

It is important to note the role that science has played in these processes. For example, the historical deprivation and exploitation of enslaved African communities, or the genocidal actions taken against Native Americans was rationalized historically via analogic comparisons of non-white peoples to "savages," "beasts," or "farm animals." In the nineteenth and early twentieth centuries, scientific evidence was provided comparing the size of the skulls of different "races" of people in order to argue for the inferior capacity for reason of peoples of African descent. So powerful were these narratives that even those victimized by them were captured in their definitions. Slave narratives reveal, for example, a discursive double bind as they struggled to be considered "human" rather than mere animals (Haymes 2001), thus accepting the dominant logic of domination that defined animals as fundamentally inferior to humans, thus reproducing the structure of their own oppression.

Similarly, examination of the history of the Scientific Revolution in Enlightenment thought exposes the ways "Woman" as a cultural category is historically defined as the inferiorized opposite of "man" based on her "lack of reason and closeness with objectified nature … constituting a lower order of life" (Plumwood 2002, p. 102). Thus, she is the social and political analogue of radically excluded nature. And, here as in the above example, science was used as the rationalizing epistemological framework to assert such truths.

Today, as the ideas of western industrial culture are globalized in the name of "modernity," "development," and "civilization," diverse and centuries-old patterns and practices that acknowledged ecological limits and human interdependencies with natural systems are swept aside, defined as “primitive” or “undeveloped,” in favor of the “technological efficiency” of industrial methods. Monoculturalization and market-based relationships are replacing what were once rich relationships nurturing community along with biological and cultural diversity (Shiva 1993). We live in a culture that presents these problems as inevitable consequences of human “progress.” As C. A. Bowers (1999) points out, such a mindset is the result of deeply embedded and discursively reproduced ideological forms that represent modern industrial processes as the most “evolved” even while they are killing us: “A form of cultural intelligence that ignores how toxins introduced into the environment disrupt the reproductive patterns of different forms of life jeopardizes its immediate members as well as future generations” (p. 169). This is a system of short-term achievements that values, even argues for, individual profit over life. We are currently reeling from the myth that an “unfettered market” is the shortest route to “freedom.”

Of course, this definition of “freedom” is undergirded by the powerful assumption that humans are unavoidably self-interested, that the “individual” is the most basic unit of the human species (which is superior to all other species), and that the most successful societies will be those organized to effectively capture that individualist drive and make it productive. Indeed, that idea organizes the entire notion of equality of opportunity, and the myth of meritocracy as the basis of public schooling as well as the idea that the primary purpose of public schooling should be to prepare our children to compete in the workforce and to “make our economy the most powerful in the world.” Reports beginning in the early 1980s such as *A Nation at Risk* claimed that the USA was falling behind our economic competitors worldwide, and it was primarily the fault of inferior math and science education. Since then, a standards-based accountability movement valorizing math and science as the most important domains of knowledge has dominated public school politics. This is no accident as these knowledge areas are defined as the most important for industrial development.

Our culture is so steeped in metaphors that valorize competition, “progress,” and “unlimited growth” as the way to satisfy individual profit motive as a core human trait, that we accept as inevitable the attending exploitation of human and nonhuman life to get what we are told we “need.” “Hey, that’s Progress!” The drive to consume our forests and fisheries, to put McMansions all over once fertile farmland, and impoverish our rural and urban communities as we manufacture more and more “stuff” in outsourced international labor markets in the process is “just the way it is.” We look the other way as animal torture is practiced in the name of science, justified in layers of anthropocentric “progress.” The same can be said for perversions of ethics in medicinal research in which drugs are used experimentally on patients who exercise a so-called free will but, because of their economic positions in relation to an industrial military complex, in reality have no choice.

These damaging economic practices are put in place and rationalized via deep cultural meanings that are internalized and passed down over many generations, so that we don’t even notice the ways they operate in our daily conversations. While they may be shifted as they are exchanged and applied over time, in general, they frame and normalize the ways we think and they show up in our everyday words and texts, as well as in our relationships, and this includes those exchanged and reproduced in schools.

A Different View of Knowledge, Wisdom, and the Sacred

In the above section, we were interested in uncovering the ways our modernist language systems shape a dualized system of centric thinking, creating our beliefs and behaviors toward each other and the natural world. This system assumes that we are separate from or "outside" the natural world that we depend upon. But are we?

The late Gregory Bateson (1904–1980), zoologist, anthropologist, psychologist, and some say the "epistemologist of the twentieth century" (Berman 1981) dedicated his life to demonstrating the ways that "intelligence" or Mind is much more than a human characteristic. Disrupting the dualistic structure that positions "reasoning man" as outside of and superior to all other species, Bateson's work challenges what Val Plumwood (2002) calls the "illusion of disembeddedness" characteristic of western ways of knowing. His general argument is that humans participate in a complex system of communication with all other living creatures. The meanings that we make of the world, our understandings, are necessarily influenced by what bits of information or differences that our senses pick up from the living and nonliving world. These bits of information interact with other bits of information in the form of "differences that make a difference." Bateson argues that these differences circulate within complex loops of communication throughout all life systems, making all creative processes possible. "Wisdom" in this sense does not emanate from human experience alone, but is only possible in the interactive and interdependent relationships within the whole complex system of life. The world around us sends us all kinds of messages that we use to negotiate our way.

For example, when the wind comes up we may see the leaves of the trees nearby show their silvery undersides. That bit of information may soon be followed by drops of rain, or a storm. If we are exposed to these messages among others who have also experienced them, we may learn to interpret those leaves as warning that we should seek shelter. We may observe birds and other animals scurrying to take cover. We may feel the wind on our faces more sharply. Using different interpretive systems, humans and other creatures receive this information, and in turn send out other messages as we respond that also get "read." Thus, according to Bateson, we create patterns of information that connect to other patterns – meta-patterns, or patterns of patterns (Bateson 1972). For Bateson, this complex process constitutes an "ecology of mind" (2000) and is the source of all wisdom. To become aware of its complexity is to become aware of what is sacred in the interrelatedness of all life. It is also to become aware of our limitations as humans to control it. Indeed, to deem oneself outside or superior to it, according to Bateson, is a fatal mistake.

As we explained in the section above, humans use complex language systems to mediate the information sent by the world (the wind, for example) and to interpret what it means. In this sense, we "map" the world with our words, concepts, stories, or "data" just as paper maps present a "picture" of the territory represented. But, it is impossible to get everything on the map, and the map, as Bateson says, is not the territory. There is always a gap between the world itself and what we can say about it, leaving all sorts of opportunity for errors of judgment, as well as an infinite number of other possible interpretations depending on the metaphors employed to make those "maps" or tell those stories. We tend to forget that what we think we "know" is fraught with these interpretive gaps made by language. Moreover, our words and our interpretations have a history, and so become interpretations of interpretations of interpretations.

For example, in order to understand some phenomenon better, researchers often make observations and record data (which is another type of symbolic representation), and then use these to create a model to show how that phenomenon works. This model can then be used to produce more data, which then sometimes get incorporated into the development of yet another new model. Leaving aside the possibility that any errors in the original data gathering are replicated in this process, scientific models (by design and necessity) simplify all the possible variables and complexity in observed phenomena. So the model based on data from the original model becomes a simplification of a simplification. And, because of these abstractions, we are actually further and further from the world itself, though we take very seriously what we believe we "know."

To be clear, all human cultures use language to make sense of the world, to "know it," but there are very diverse systems of metaphor and structures of thought within diverse cultures. As we pointed out earlier, there are at least 5,000 different languages still in existence across the planet, and each of these has been developed over many centuries in relation to very diverse ecosystems that have influenced what the peoples living within them can say, and how they say it. Some cultures have within their systems of thought and collective psychology a much clearer sense of the sacred among all life, and a perception of themselves as living within those interdependencies.

Identifying and Revitalizing the Cultural and Environmental Commons

The recognition that diverse cultures across the world live within very different cosmologies that have very different effects on the natural world is an important aspect of this work. An ecojustice framework emphasizes the ways that various communities and cultures around the world actively protect and revitalize their cultural and environmental commons (the social practices, traditions, and languages, as well as relationships with the land necessary to the sustainability of their communities). This includes listening carefully to the voices of North American indigenous peoples, for example, as they teach us about their ancient belief systems and practices as models of more sustainable ways of living (Longboat et al. 2009). It means that we introduce our students to a way of thinking about economics beyond the usual liberal ideologies and systems that dominate modernist cultural ways of knowing. Students learn to analyze the ecological consequences of different economic approaches, identifying ancient and existing economic ideologies and relationships that are operationalized by the specific needs of communities first, as opposed to those market liberal systems where the accumulative demands of the market rationalizes production and frames social life.

Further, and perhaps most important of all, ecojustice insists on reconnecting students and teachers to their own local communities: to the shared relationships and assets within neighborhoods, landscapes, and with the more than human creatures that often go unnoticed as primary sources of knowledge and life-sustaining support. In the analysis that follows, we use the "cultural and ecological commons" as concepts that can help us pay attention to the nonmonetized relationships and practices that diverse groups of people in our communities and across the world use to survive and take care of one another on a day-to-day basis. The "commons" is a concept that allows us to recognize both the interactions between cultural and ecological systems, and the ways that certain practices, beliefs, and relationships are oriented toward the future security of both. These include nonmoney-based economic and social exchanges including work-for-work, strong communitarian beliefs/practices/relationships, alternative forms and spaces of education, democratic decision-making, and efforts to create more sustainable, ecologically sound relationships with natural systems. Aimed at protecting the ability of both human communities and natural systems to live well together into the future, these are the sorts of day-to-day relationships and practices that function to nurture the larger communicative system of intelligence – or Mind – to which Bateson refers as essential to life.

Two points are key to defining the commons: (1) They are not owned. They belong to everyone; and thus, (2) they do not require money to be accessed. Ecojustice scholars and teachers are interested in the ways the cultural and environmental commons intersect, and in this case, in the traditions, beliefs, and practices that are aimed at protecting the larger life systems (Martusewicz 2009). This includes an acknowledgment of the vital nature of each – human cultural practices and natural systems – as well as their mutual dependencies, and represents our attention to security, and to social and ecological well-being. The purpose of education within this context is thus systemic wisdom, where learning is oriented toward understanding of and acknowledging the ways in which we interact with, depend upon, and impact a larger system of intelligence.

The environmental commons are often easier to identify since they are designated by our shared relationships to land, water, and air that we share in order to live. The cultural commons may include food cultivation and preparation, medicinal practices, language and literacy practices, arts and aesthetic practices, games and entertainment, craft and building knowledge, decision-making practices, and so on. A particular practice, skill, or tradition has value in our estimation to the degree that it helps to maintain a healthy community of life, and thus has a smaller ecological footprint. For example, farmers who use manure to fertilize their fields instead of buying commercially produced chemical fertilizers are using an ancient, commons-based agricultural practice that is both a good way to dispose of animal waste, and helps to produce strong plants needed for good food. Or, in urban settings, the decision by some residents to use rain barrels to collect water used in gardens and yards instead of running sprinklers from the tap demonstrates the knowledge that water is a sacred resource to be conserved and protected.

The question before us here is how might science teachers, aware of the rich practices and knowledges – the assets – in local communities, involve their students in work that is focused on protecting interdependent relationships that are part of intricate living systems. What aspects of the local commons support living systems, and which aspects work to undermine living systems? What needs to be sustained? What needs to be limited or recognized as harmful and thus abolished? Here we want to emphasize that not all nonmonetized, commons-based activities or beliefs are beneficial. This should be clear from our discussion of the ways modern western culture is built upon taken-for-granted value hierarchies and hegemonic centric thinking that lead to all sorts of domination. Racist, sexist, or anthropocentric beliefs or practices may be shared without monetary exchange and thus form part of the cultural commons, but they do not protect life. Learning to discern the difference in the effects or consequences of commonly shared practices is what it means to become ethically engaged in the local.

Of course, while practices and relationships that make up the commons continually emerge and develop, most of the practices that we identify as having a smaller ecological footprint are generally very old. In our western culture, they date back to times when our economy was more community-based. For example, the practice of barter is ancient – but how we barter, and what we exchange, may be modern. For many of us in the West, these commons practices have been so eaten away by processes of commodification, that it may be difficult to identify them as still existing (Bowers 2006). The important point for science teachers is that communities comprise any number of strengths – assets – that can be brought to bear in solving all sorts of problems. Science ought to be approached as a way to both identify and address needs and problems in the community.

Enclosure

> [To] reduce life to the scope of our understanding (whatever "models" we use) is inevitably to enslave it, make property of it, and put it up for sale. (Berry 2000, 7)

Woven into the long history of the world's diverse ecological and cultural commons is the practice of enclosure. Enclosure privatizes and commodifies what was once freely shared, and cuts people off from the life-giving relationships offered by the commons. Founded upon deeply embedded cultural assumptions that define humans as in charge of and outside of all natural systems and some humans as more worthy than others of controlling those natural systems, enclosure practices claim everything and anything to be up for grabs for the market and private profit. When the commons are enclosed by processes of economic privatization, they are no longer available to people who need them to survive unless those people can pay. If the people cannot pay, they are generally blamed as deficient in any number of ways, and left to fend for themselves. Enclosure is thus a process of exclusion created and kept in place by economic practices, and a complex cultural mindset that presents hierarchical relationships of value as natural. The resulting exclusions benefit the few over the whole and thus contradict those essential collaborative interdependent relationships that create life itself.

Unfortunately, science has all too often been used by powerful agents in the process of enclosure, due to its enlistment in industrial processes (and thus, commodification), as well as in providing "data" to rationalize the hegemony of white males who control both what is considered acceptable knowledge and how it shall be used economically. The "market" as a mechanism of enclosure has become such a powerful force on its own, that it contributes to the positioning and rationalization of scientific knowledge as "high status."

A great example of science at work was the understanding and decoding of DNA. This scientific knowledge has since been applied by companies to develop patents for the genetic code of specific varieties of rice grown by peasant farmers in India. Once the genetic code of a particular rice variety is patented, farmers who may have been saving those seeds for centuries, using their locally situated knowledge to select for most desired traits, cannot legally save the seeds of that variety. They must purchase them from the company that owns the patent (Shiva 2000). Another thing that had been a long-standing part of a people's commons (and freely exchanged) has been turned into a commodity via the process and mindset of enclosure.

For science teachers, therefore, it is important to help students be aware of both the ways in which enclosure works and the ways in which science has been used to make the process seem "rational." Students introduced to a cultural ecological analysis, learn to identify how aspects of the commons that support life are threatened under problematic ways of knowing and acting in our local communities. Recognizing commons-based knowledges that support life (among our own families, neighbors, and elders, as well as across diverse cultures) while analyzing the ways in which science may function to enclose living systems opens the opportunity for the fundamental strengthening of communities. Further, a process referred to by Bowers and Martusewicz (2008) as "revitalizing the commons" offers educators the opportunity to engage students with local community members to learn skills that support local living systems while limiting or at least naming previously unacknowledged acts of enclosure that threaten life.

Despite the important limitations that we have been emphasizing, science education has much to offer within this framework given the background and theory explained above. The following section offers a glimpse into a few examples we have witnessed in two very different educational settings, one urban, and one suburban.

Science Education in an EcoJustice Framework

Science educators using an ecojustice framework are ethically committed to strong local-living communities using an approach to knowledge that can be described, using the framework shared above, as *situational*, *local*, and *supportive of living systems*. By situational we mean that we recognize that all creation works via relationships – everything comes into being because of its situated relationship to something else. Culturally speaking, all knowledge-making, all meaning is part of an interactive languaging process that is metaphorical, and these metaphors can either support life or treat living creatures as dead machines. Additionally, in the Batesonian sense, situational refers to the complex communicating relationships that make living systems possible. This also relates to what we mean by the local, since any local place is composed of specific situated relationships and meanings – soil and climatic type, geolithic base, topography, flora and fauna, human architecture and settlement patterns, customs and traditions, and so on – that come together within a particular space in a particular time that affect us in specific ways. The "local" is not independent from other diverse "locals" that interact with and are connected within other larger systems – social, political, hydrological, biological, historical, and so forth – that shape it. Remember that ecojustice scholars and teachers view the ecological as comprising both human and more than human communities together, and so recognizing how these interact at various levels is crucial.

The point is that students and teachers ought to be starting their studies from where they live while they identify and analyze relationships to other places/systems as part of a commitment to protect life. We acknowledge the important contributions made by "placed-based education" (Gruenewald and Smith 2008), while complicating that approach via the overarching cultural ecological analysis that ecojustice offers. Ecojustice-oriented science teachers ask how the processes studied or methods used support or threaten life? How meaningful and relevant is this to students' lives, and to the future of their children's lives? And what is the larger cultural context within which these processes are situated?

For example, we work with a group of teachers and community organizations in southwest Detroit. The K-8 charter school is located in a landscape comprising highly contaminated brownfields that is also a residential neighborhood where these students and their families live. Middle-school students study science through an inquiry model that poses critical and ethical questions to examine these highly relevant aspects of their surrounding neighborhood. What is the history of this landscape? What are these brownfields composed of? What makes them toxic? What sorts of decisions led to this outcome and who made them? Who was excluded? What is the meaning of community in this context? The teachers, in cooperation with local community organizations, work to frame their curriculum by the analysis and remediation of these sites. Focusing on this situated urban and industrialized context and working with other content area teachers, the science teacher approaches the teaching of state standard science objectives by involving her students in direct inquiry and action to resolve this critical local problem.

Students learn about chemical and biological properties of soil, as well as how toxins began to be a problem in our environment as science helped to introduce new plastics and other chemically based substances into our economic and consumer system. The students and teachers along with members of the community learn in and from the history of Detroit and the local landscape in ways that help them to critically assess the presence of violence, dangerous levels of pollution, and blight. One related project involved 8th grade students working with community-members in a cleanup of illegally dumped tires in the lots and fields in the neighborhood, while learning community–mapping skills, the process of a tire's creation, use, and "disposal," and a process for recycling them. Science is learned both as a means to understand why the brownfields exist, and what can be done to eradicate the pollution. In order for the students, teachers, and members of the community to tackle this difficult task responsibly, they are learning about a very specific situational context. And, they are learning about the value of working together with other members in their community. Science meets democratic practice!

In another setting where soil was the focus, high-school students in a former agricultural area of now-suburban New Hampshire investigated the biology, chemistry, and physics involved in the process of composting while cultivating organic gardens and studying the history and politics of food security. The science teacher for this class had groups of students dig samples from a compost pile begun earlier in the year (using kitchen scraps from the school's cooking class). Using a combination of secondary research and direct observation and testing, students developed presentations on the chemical analysis, temperature dynamics, and micro- and macro-organisms involved in "ideal" composting, in comparison to the compost they had started. The situational nature of this activity is reflected in several ways. First, students study composting in contrast to predominant forms of agricultural soil augmentation – the use of chemical fertilizers that arose after World War II. Using the ecojustice analysis of language and culture, they confront the ways these approaches were promoted as "miracles of modernity," advancements in technology necessary to maintain farmers' abilities to meet the world's increasing food production needs. Today these promotions frequently utilize the image of scientists and science, and come from companies that naturally have a significant profit motive involved. They capitalize on the cultural assumption of "progress" emphasizing the "high-status" character of science in our culture, and the accompanying belief that practices like composting are inefficient and backward. Many accept this idea without understanding the actual processes involved in how fertilizer works.

This course emphasized the local in the sense by helping students learn about the practices of their own community in the not-too-distant past. Two generations ago, many of the houses in which students live were located on former agricultural lands that employed composting from the community's founding (in its European incarnation, anyway) in the mid-1700s. What does this say about the long-term sustainability of their community? This composting activity is thus supportive of life in several ways: students learn quickly from hands-on experience that compared to petroleum-based fertilizers, compost is more soil-sustaining, and it reduces waste. Further, studied in the wider context of global economics, they come to understand that this localized, situational practice does not require the importation of oil from troubled areas of the world or support the violence often needed to keep it flowing.

In both cases, science educators play a vital role in guiding students' learning along paths of inquiry that support living systems, as well as identify and interrupt ways of thinking/acting that threaten them. Avoiding typical mechanized metaphors that objectify what is being studied, the teachers use language and engage both bodies and minds in ways that invite the students to recognize their relationships to soil as a complex living entity. As part of this process, students work to address ways in which aspects of science knowledge and methods can be used explicitly to protect life. At the same time, they also study how some of these same methods led to the creation of toxins used by industrial processes now contaminating the soil in their neighborhoods, or used as pesticides and fertilizers in commercial agriculture. The teachers introduce the students both to the history of the production of chemical toxins, and also to the use of the tools of science – scientific methods and concepts, and a soil testing kit, for example – to ask students to learn specific chemical or biological qualities of soil that is healthy.

Testing soil or reflecting on the benefits of local compost is not a unique pedagogical approach; these sorts of activities are going on in schools all over the country. However, in both of these schools, the students are engaged in their own unique situational context as these connect to larger social, political, and economic contexts. And, they are learning how to respond in ways that focus on protecting the sacredness of life. They learn to engage their senses and bodies in the process of knowing by putting their hands in the soil, smelling it, squeezing it in their hands, observing its qualities. In the process, they learn that they cannot possibly know everything about that handful of living. And they use diverse interdisciplinary sources to experience more fully the deep meaning of healthy soil cultivation. In New Hampshire, students talked with local elders who owned nearby farms belonging to original white settlers in the region. They read novels chronicling the struggle of farming communities, and wrote poetry about gardening, food, and the Earth. Students in Detroit talked with neighbors about life in Detroit when industry was at its height, and they used life-sized puppets to perform theatrical presentations about the land and marshes of southeastern Michigan as it existed before colonization or the onset of industrialization. Because there is the clear understanding that no one form of knowing exists that can finally give us the answers, science was studied in conjunction with art, history, geography, literature, politics, and economics. While we recognize that not all science teachers will have this opportunity – to teach within an interdisciplinary team – we want to endorse this approach, along with community-based learning projects, as the best way to engage the beneficial aspects of scientific approaches.

We have chosen these two examples deliberately. Soil is sacred. It is one of the essential foundations of life. Beginning here is a great way for science educators to deal with situatedness, with the local, and with the sacred nature of life itself. Water could also be used in a similar fashion as an entry point or focus. We work with several schools that are focusing on various rivers and watersheds in the southeastern Michigan region – the Rouge, the Huron, the River Raisin – as the focus of community-based learning projects designed to introduce ecojustice concepts, and develop eco-ethical consciousness and stewardship in the Great Lakes region. One group, for example, is examining the relationship between civil rights, suburbanization, and the demise of the Rouge River in Detroit. History, ethics, and biology teachers are working together with a nonprofit organization called Friends of the Rouge, which helps to introduce students to methods of water analysis, as well as zoological concepts related to local amphibian and fish populations. The River Raisin Institute has worked with science and social studies teachers to reintroduce wild rice in areas along the river where it once grew prolifically and was a main food staple for indigenous peoples in the area. Members of the Anishinabeg Ojibwe Nation worked with the students and teachers exploring the specific characteristics of the species being planted, Native American methods for processing the rice for consumption, and performing ceremonies to celebrate the planting and give thanks (see www.rriearth.org/wildrice.html; retrieved July 12, 2009). Longboat, Young, and Kulnieks (2009) argue that this sort of approach – corroborating traditional science findings with traditional indigenous knowledge – helps to dispel dualistic hierarchies that privilege western ways of knowing over other experiences and explanations. They advocate for a position that emphasizes our experience and relationship *in* nature rather than *to* nature. Whatever the point of departure – soil, water, air, forests, animals, and so on – students ought to learn to use science in ways that compliment other ways of knowing rather than marginalize or neglect them. And, they should *situate* a rigorous examination of the important issues in a relevant local context beginning with cultural ecological analysis of that context.

Summary

Science is one way of knowing, not *the* way of knowing. However, it often gets treated as if there is no other legitimate way of comprehending the world, so that those who have access to it are granted the privilege of superiority and thus control over others – human and more than human. The origins of modern science from the fifteenth century through the eighteenth century, known as the Age of Enlightenment, created deeply rooted discursive patterns – ways of thinking and acting in the world – that led to economic relations, structures, and policies that continue to frame our lives. The overall orientation assumes that with the application of the power of a reasoning mind, humans can finally and fully know the universe, and thus control it and mold it to our purposes. Because of its privileged position in the West, science has contributed to forms of enclosure – both ideological and economic – that cause significant harms to the complex systems supporting life.

We are not arguing that scientific ways of approaching knowledge be thrown out; however, we urge that science educators take initiative to recognize the impact they can have in empowering students and communities through engagement in revitalizing commons-based practices that support life. Culturally, so much value has been placed on modern science and technology that many expect that it will be only a matter of time until science solves all of the worlds' problems (hunger, poverty, disease, war, etc.). And yet, we can trace some of the world's most serious problems to modern science and technologies. We cannot fully understand the universe; we are born, live, and die like all living creatures and full control of the complexities of this situation is not possible. Work in science and thus science education, if it is to useful, needs to be rooted in local conditions and nested in a variety of systems of knowledge acknowledged for what they offer life, while understanding that we will never finally possess full knowledge of the universe.

Notes

We recognize the etymology of "drain" from Middle English as *draynen*, or from Old English *drēahnian* (see, e.g., Merriam Webster online: www.merriam-webster.com/dictionary/drain). The word in current usage has multiple meanings. On the one hand, it refers to the movement or flow of water over a landscape or in a watershed away from its source. It is also used to mean a device used to move waste away from where we live or work, as in a sewer pipe. When these two usages are convoluted as analogues for one another we see the ways the word "drain" functions within a mechanistic discourse or mindset. Specifically, when we begin to assume that a body of water like a stream which is a living system can or should function as a sewer, we are employing mechanism as a discourse to reduce nature to a machine. In this sense, mechanism is very detrimental because it fails to acknowledge living relationships in that which it defines as an inert machine.

References

Apffel-Marglin, F., with PRATEC. (1998). *Spirit of regeneration: Andean culture confronting western notions of development*. London/New York: Zed Books.

Bateson, G. (1972). *Steps to an ecology of mind*. Chicago: University of Chicago Press.

Berman, M. (1981). *The reenchantment of the world*. Ithaca: Cornell University Press.

Berry, W. (2000). *Life is a miracle: An essay in modern superstition*. Washington, DC: Counterpoint.

Bowers, C. A. (1997). *The culture of denial: Why the environmental movement needs a strategy for reforming universities and public schools*. Albany: State University of New York Press.

Bowers, C. A. (1999). Changing the dominant cultural perspective in education. In G. Smith & D. Willams (Eds.), *Ecological education in action: On weaving education, culture, and the environment* (pp. 161–178). Albany: State University of New York Press.

Bowers, C. A. (2006). *Revitalizing the commons: Cultural and educational sites of resistance and affirmation*. Mahwah: Lawrence Erlbaum.

Bowers, C. A. & Martusewicz, R. (2008). Eco-Justice pedagogy and the revitalization of the commons. In E. Provenzo Jr. (Ed.), *Encyclopedia of the social and cultural foundations of education* (Vol. 1, pp. 272–279). New York: Sage.

Gruenewald, D. A., & Smith, G. A. (2008). *Place-based education in the global age: Local diversity*. New York: Lawrence Erlbaum/Taylor & Francis.

Haymes, S. N. (2001). “Us ain’t hogs, us is human flesh”: Slave pedagogy and the problem of ontology in African American slave culture. *Educational Studies, 32*, 129–157.

Longboat, D. R., Kulnieks, A., & Young, K. (2009). Beyond dualism: Toward a transdisciplinary indigenous environmental studies model of environmental education curricula. *The Ecojustice Review, 5*. Retrieved September 15, 2009, from www.ecojusticeeducation.org

Martusewicz, R. (2009). Educating for “collaborative intelligence”: Revitalizing the cultural and ecological commons in Detroit. In M. McKenzie, H. Bai, P. Hart, & B. Jickling (Eds.), *Fields of green: Re-storying education* (pp. 253–270). Cresskill: Hampton Press.

Martusewicz, R., & Edmundson, J. (2005). Social foundations as pedagogies of responsibility and eco-ethical commitment. In D. W. Butin (Ed.), *Teaching social foundations of education: contexts, theories, and issues* (pp. 71–92). Mahwah: Lawrence Erlbaum.

Merchant, C. (1980). *The death of nature: Women, ecology, and the scientific revolution*. San Francisco: Harper Collins Publishers.

Nettle, D., & Romaine, S. (2000). *Vanishing voices: the extinction of the world’s languages*. Oxford/New York: Oxford University Press.

Norberg-Hodge, H. (1991). *Ancient futures: Learning from Ladakh*. San Francisco: Sierra Club Books.

Plumwood, V. (2002). *Environmental culture: The ecological crisis of reason*. London: Routlege.

Shiva, V. (1993). *Monocultures of the mind. Perspectives on biodiversity and biotechnology*. London: Zed Books.

Shiva, V. (2000). *Stolen harvest: The hijacking of the global food supply*. Cambridge: South End Press.

Chapter 4
Toward Awakening Consciousness: A Response to EcoJustice Education and Science Education*

Michael L. Bentley

Introduction

In "Ecojustice Education for Science Educators," Rebecca Martusewicz, John Lupinacci, and Gary Schnakenberg break new ground for the field of science education in relating long-known limits to our ability to understand the cosmos to those eternal mysteries they identify as the meaning of "sacred." Our fundamental unawareness was well-understood by the medical researcher and gifted science writer, Lewis Thomas, who wrote that, "[t]he only solid piece of scientific truth about which I feel totally confident is that we are profoundly ignorant of nature" (1974, p. 58). Beginning with the premise of our fundamental inability to ever fully know, Martusewicz, Lupinacci, and Schnakenberg argue that to achieve a sustainable society in proper relation to the ecosystem, science educators will have to rethink the curriculum and adopt a different approach to instruction.

They begin with the premise that "languaging" is a creative process that produces representations that diverge from the reality that intended to re-present it. In other words, as we reason through our language-culture filters, these filters influence our perspectives about reality, and those perspectives are necessarily flawed and limited. The authors note that humankind's 5,000 different languages are the bases of many different cultural systems. So, it is the old "Blind Men and the Elephant" wisdom story. Thus, as Michael Reiss (1993) has pointed out, every science is really an ethnoscience: "What is of significance for science education is that there can be no single, universal, acultural science" (p. 24). What's more, science has to be reported in a language (mathematics also being a language), and all languages are human constructions. So the scientific enterprise has "incomplete ways of knowing by

*Truth is One, but the sages speak of it by many names.

The Rig Veda

Compassion is the keen awareness of the interdependence of all things.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_4,

virtue of being embedded in a specific cultural (and thus symbolic/language) system." Note that the authors do not deny that science is the best process yet worked out by humankind for "knowing" – the authors only claim that we can never know everything via scientific processes. And I fully agree.

Taking this stance of epistemological pluralism, Martusewicz, Lupinacci, and Schnakenberg call on science educators to respect indigenous knowledges. Further, they recognize the great loss that occurs in the loss of a language or when a traditional society disappears. They also recognize that first-world science has played its part over the years in cultural imperialism and that, as a result, other species and cultural groups have suffered or gone extinct. Michael Mueller and I have written about these very matters (Mueller and Bentley 2009).

Martusewicz, Lupinacci, and Schnakenberg also base their argument on the premise that we all live embedded in ecosystems and are fully dependent on natural services for survival. Absolutely true, but regularly taken for granted. From these premises, the authors introduce three major goals of an ecojustice framework, goals which involve deconstructing the dominating beliefs and behaviors of the first world societies, advocating a new epistemic stance, and revitalizing the cultural and ecological commons as the basis for sustainable societies.

To address the education of science teachers, Martusewicz, Lupinacci, and Schnakenberg recommend that teachers think about their roles and responsibilities using a deconstruction approach they identify as a *cultural-ecological analysis*. In explaining this approach they draw on the work of Chet Bowers, a pioneer in identifying "root metaphors" that shape our thinking and behaviors. Through cultural–ecological analysis, teachers will come to understand how, "The words we use on a day-to-day basis help to maintain and recreate 'master narratives' that structure complex hierarchized systems of thought, identity, value, and material realities that create and recreate violent, destructive relationships and practices as if they are 'normal' or 'natural.'" Recognizing value in non-western sciences, and through this process of cultural–ecological analysis, students gain a deeper perspective: "[E]xploring traditional science enables us to step outside our own cultural belief systems and more freely examine our hidden, capricious, and sometimes troublesome assumptions" (Corsiglia and Snively 1995). Martusewicz, Lupinacci, and Schnakenberg go on to give examples of how this western way of thinking is connected to the human-damaged environment in which we find ourselves living.

Wisdom as a Goal of Schooling

The reference to Gregory Bateson's work in Martusewicz, Lupinacci, and Schnakenberg warmed my heart, as his work was formative for me when I discovered it in the late 1970s and, later, that of his colleagues, Humberto Maturana and Francisco Varela. Bateson extended the concept of intelligence-Mind to outside the human sphere and thus Martusewicz, Lupinacci, and Schnakenberg conclude that, "wisdom" emerges from what Bateson called, "the ecology of mind," that is, "in the interactive and interdependent relationships within the whole complex system of life." This notion inspired by Bateson means that every day we continually negotiate our way with the world via messages that we receive from our surroundings.

Martusewicz, Lupinacci, and Schnakenberg then address the teaching–action component of the ecojustice education framework, arguing that education should lead to activities that "protect and revitalize their cultural and environmental Commons." This key concept of the *Commons* is from Bowers and is taken to be "the social practices, traditions, and languages, as well as relationships with the land necessary to the sustainability of their communities." What should happen in the classroom is that students, in their analysis of an issue, put the needs of communities first and come to see the consequences of different economic and political approaches to policy. Students *think globally and act locally*: local communities become the most important focus for sustainability efforts (just the opposite of what is enacted with national content standards and assessments).

According to Martusewicz, Lupinacci, and Schnakenberg, the purpose of ecojustice education is the attainment of "systemic wisdom where learning is oriented toward understanding of and acknowledging the ways in which we interact with, depend upon, and impact a larger system of intelligence." The ecological is viewed as being both human and more-than-human communities together, communities that interact at various levels. And thus, for science teachers, who should be knowledgeable of the assets of their local communities, it comes down to a series of questions:

> (how to) involve their students in work that is focused on protecting interdependent relationships that are part of intricate living systems. What aspects of the local commons support living systems, and which aspects work to undermine living systems? What needs to be sustained? What needs to be limited or recognized as harmful and thus abolished?

Following these key questions, Martusewicz, Lupinacci, and Schnakenberg warn of the inevitable process of *enclosure*, a process also identified by Bowers. Enclosure is a process of exclusion that runs counter to collaborative interdependent relationships and helps create and maintain a status quo of hierarchies that protects elitist economic interests. Science, they note, has all too often contributed to cultural enclosures and several examples are cited, such as when "back in the day" science provided "data" to support white racial superiority. Teachers should help students to become aware of how enclosure works and how science has been used in the process.

Thus, to Martusewicz, Lupinacci, and Schnakenberg, science teaching from an ecojustice perspective should be "*situational*, *local*, and *supportive of living systems*." They provide examples of students who are engaged in their own situational contexts and how these connect to larger social, political, and economic contexts. These students are learning how to respond to problems in ways that sustain life. The authors also endorse an interdisciplinary approach to teaching in which science is studied in combination with history, geography, art, literature, economics, and sociology.

A Strong Foundation for EcoJustice Education

> Study without desire spoils the memory, and it retains nothing that it takes in. (Leonardo Da Vinci)

Martusewicz, Lupinacci, and Schnakenberg offer a compelling framework for ecojustice education based upon a sound epistemological foundation that should resonate with educators who are familiar with a constructivist epistemology (Bentley et al. 2007). I offer a concept map in Fig.1 of this proposed framework for ecojustice education. The graphic illustrates the foundations of epistemology on the one corner of the triangle and of our situated ecosystem context on the other, both focused on the apex, the teaching-action component, which is the outcome of a cultural–ecological analysis process.

I have labeled the bottom-left corner of the graphic, "The Sacred Unknowable," because Martusewicz, Lupinacci, and Schnakenberg emphasize such a space in their argument that scientific knowledge will be incomplete. This corner could just as well have been labeled, "The Nature of Science" (NOS). The NOS, properly understood, includes the proposition that scientific knowledge is ultimately limited. An excellent resource about a postmodern view of the NOS is McComas (1998).

Epistemological Support from Modern Science

Martusewicz, Lupinacci, and Schnakenberg do not draw upon science itself in their argument for the limits of science, but they well could have. In mathematics,

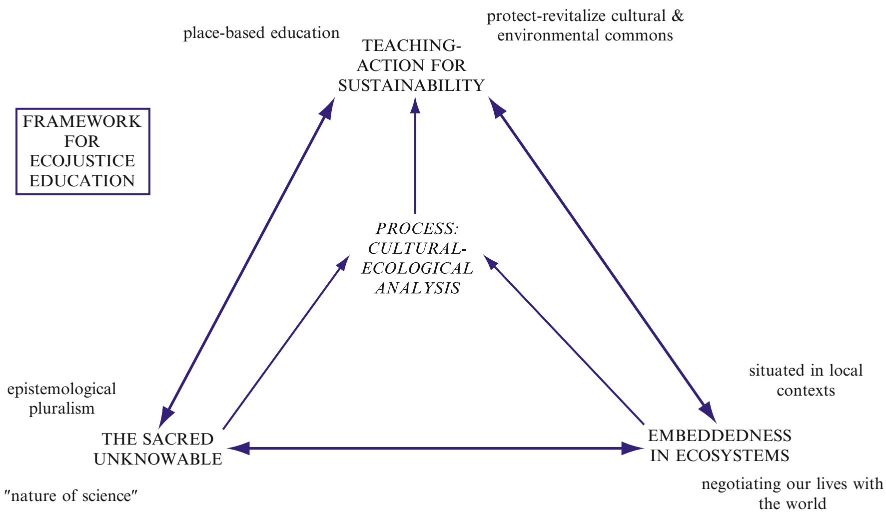

Fig. 1 A graphic representing the ecojustice education framework

they could have made reference to non-Euclidean geometry, which attests to multiple equally valid geometries, or they could have cited Kurt Godel's Incompleteness Theorem of the 1930s, which demonstrates that even mathematical proofs are not absolutely attainable. In physics they might have noted Quantum Theory, particularly, Werner Heisenberg's 1927 theory of indeterminacy, also called the Uncertainty Principle. They could also have referred to Nonlinear Dynamics and Complexity Theory, more popularly known as Chaos Theory. From the latter we now know that the most common systems in nature are nonlinear systems, that is, not in equilibrium. Such systems are inherently unstable and thus limit predictability.

The point is that scientists themselves have recognized since the last century that while western science may be foremost among ways to comprehend our universe, it is not the only way, it is not infallible, and it will always leave us with some uncertainty. This is important for students to know, since the impression that is conveyed by the massive science textbooks used in many schools is that science is a done deal and there is little left to be "discovered." These textbooks, by the way, typically treat the nature of science in the introductory chapter and usually promote the notion of a single "scientific method," which is not surprising since few scientists have studied the philosophy of science and the assumptions underlying their own research (Glasson and Bentley 2000).

Consistency with Other Trends in Science Education

For several decades now, much attention has been given in the field of science education to inductive teaching methods, usually called inquiry teaching. Inquiry teaching is not a new teaching method as inductivist approaches can be traced back to Dewey and even to even earlier object teaching. An inquiry approach is strongly promoted in the two major national science curriculum reform documents (National Research Council [NRC] 1996, and the American Association for the Advancement of Science [AAAS] 1993).

Likewise, for decades, science educators have been discussing methods of interdisciplinary teaching and the use of an "S–T–S" (science–technology–society) approach in teaching (Yager 1993). Ecojustice education is compatible with all of these movements.

Further, Martusewicz, Lupinacci, and Schnakenberg emphasize the importance of a curriculum that engages students in exploring their local environments and the complex ecosystems that they represent. In this regard, they give a nod to the more recent movement in science education called *place-based education*, a movement that also can be traced back to Dewey and even to Rousseau (Gruenewald and Smith 2007). One of the values of place-based education is that it tends to create a bond between the child and his/her environment (Sobel 2004). Place-based education can be called community-connected education that taps into local people, workplaces, and cultural institutions (Bell et al. 2009).

Ethics and Urgency

Martusewicz, Lupinacci, and Schnakenberg provide an underlying ethic in their foundation for ecojustice education based upon the sacredness of the complex ecosystem upon which all life depends. The provision for ethics as an aspect of content in the science curriculum also was a concern of Dewey and has a long history in science education. In 1937, Dewey said, "The formation of the attitude ... is the work and responsibility of the school more than of any other single institution" (1987, p. 254). This concern has particularly been a focus of feminist critiques (Zell 1998). Certainly science education includes both cognitive and affective dimensions and we need to be more concerned about developing students' attitudes and motivations. In the words of Stephen Jay Gould (1994), "we cannot win this battle to save species and environments without forging an emotional bond between ourselves and nature … for we will not fight to save what we do not love" (p. 4). An education that excludes an ethics foundation can lead to a self-centered, rudderless citizenry. According to the late Senator Gaylord Nelson (1997):

> Ironically, an issue at least of equal importance to population is rarely noted or mentioned anywhere. Yet it is the key to our environmental future. The absence of a pervasive, guiding conservation ethic in our culture is the issue and the problem. Society's answer must be to focus its attention and energies on nurturing a conservation generation imbued with a conservation ethic. Without such a guiding cultural ethic, society will not have the understanding, motivation, conviction or political will to persist in addressing the truly hard questions that will confront us in the decades to come. (pp. 38–39)

To develop an ethic of ecological sustainability science educators ought to become familiar with deep ecology, conservation biology, bioregionalism, ecofeminism, and socially critical analysis (Corcoran and Sievers 1994). This task is all the more critical in our time as distress signals from one ecosystem after another become harder and harder to ignore. Croplands, forests, and grasslands, systems that support the world economy, are under varying degrees of stress and degradation in almost all places including the USA (Worldwatch Institute 2009). NASA tells us that the ten warmest years on record all occur within the 12-year period 1997–2008 (Goddard 2009). I am not advocating that educators should teach from a crisis mode, but it is long past time to begin educating a generation of students on how to live in a world of ecological scarcity and to help them learn how to create a more sustainable society.

More Examples of EcoJustice Education in Practice

Martusewicz, Lupinacci, and Schnakenberg focus primarily on schooling, but learning is broader than schooling. Museums and other institutions of informal education could play a prominent role in ecojustice education, both for students and in professional development for teachers. Science learning in informal settings can complement classroom science goals and encourage connections with the local community (Bell et al. 2009).

My colleague Claudia Melear's work with graduate students and preservice science teachers on Ossabaw Island, Georgia's first Heritage Preserve, is an example of the kind of professional development that we need for teachers that facilitates a bonding with nature and the development of a conservation ethic. This work can be accessed at http://web.utk.edu/~ctmelear/ossabaw/.

As to public education, the Parkway High School for Peace and Social Justice in Philadelphia is an example of a public school that transformed itself into a place that develops socially responsible young adults (Self 2009). The school program emphasizes self-reflection "to enable students to build personal responsibility through exploring their own values and beliefs" and strives to provide students a critical understanding of local to global social justice issues. In their coursework, students analyze how media is used to influence viewers' perceptions and ideas. Projects are part of the program, as is community service.

In addition, I can speak of an example of appropriate K-12 schooling from my own experience as a parent. When we moved from Chicago to Virginia in 1996 we initially enrolled our daughter, a rising second-grader, into the local public schools. Sarah had previously been a student at the lab school attached to the university where I had taught. She had been accustomed to a personalized, Deweyan-type of schooling and came home from her new school crying every day for 2 weeks. As we learned, she was expected to sit at her desk for long periods of time and take notes from the chalkboard during the teacher's lectures. Our consultations with the school got nowhere and we soon realized that the school was primarily focused on drilling in content knowledge so that it could meet its goal of achieving the pass rate on the state's high-stakes tests. We moved Sarah to a private, not-for-profit school, founded in 1971 and known for a child-centered, experiential, hands-on instructional approach. At Community School (http://communityschool.net) Sarah's interest in learning began to thrive again. When our boys reached school age, they followed in Sarah's footsteps. Later I served on the board of the school and led several of its annual curriculum evaluations. Community School serves a diverse population of 140 students through middle school. Typically, over 40% of Community School students receive financial aid. The school campus is located adjacent to Hollins University with which it has a cooperative relationship. Community School is a "peaceable school" with a peer-mediation program. It has a strong outdoor education program with many options and weekly field studies for most students. It is a school with separate full-time staff for teaching, drama, music, and fine art. The school's annual arts festival in the spring is a fantastic public display of all the arts – a feature of the curriculum Jerome Bruner (1996) called *Oeuvres* (cultural works), and said we needed more of.

Off and on over its history Community School had a secondary curriculum, but it had been in mothballs for some time when, in 1999, the board formed a high-school committee to revive it. Our committee spent 2 years studying alternative schools and planned our new high school based upon a "museum school" model. The curriculum design built upon Community School's tradition of experiential education, characterized by:

- Learner-centeredness
- Community-connectedness

- Low student to teacher ratio
- Integration of social justice and environmental education in an interdisciplinary curriculum
- Infusion of the visual arts, drama, movement, and music into the curriculum.

In starting up, we focused foremost on faculty selection, recognizing that unique teaching capabilities would be required for enacting the ambitious curriculum. As it turned out, this was our best decision. The school's program has evolved from the collaboration of students, faculty, and educators working in the museum/cultural community. According to Takahisa and Chaluisan (1995), formerly of the New York City Museum School:

> The Museum School necessarily involves a paradigm shift: requiring new organizational structures, new role definitions for teachers and museum personnel. Faculty (must have) a willingness to move in new professional directions, an interest in interdisciplinary learning, a commitment to urban education, a sense of themselves as learners, an openness to team teaching and collaborative modes of curriculum development, and a sensitivity to the school's diverse community of students and their families." (p. 24)

Community High School (CHS) (http://www.communityhigh.net) opened in 2002 and now has 60 students. CHS is located in downtown Roanoke in the heart of the museum and cultural community and now represents a unique local expression of the "museum school" concept. Today, CHS offers a distinctive learning experience in an environment of free enquiry and respect for the individual. Its small student body is diverse and intellectually curious. While most students are college-bound, they nevertheless have a wide choice of challenging courses and can also pursue their own interests and can gain hands-on experience through museum and community internships. Since they are not locked into classes by age or level, students develop friendships throughout the student body and are able to work with others of various ages and both learn from and teach one another. The multiple curricular offerings and the nurturing environment of the school help students gain self-confidence and respect for themselves, one another, their teachers, and the environment.

Corporatocracy as the Obstacle to Better Schools

Education is not only about issues of work and economics – as important as these may be, but also about matters of justice, freedom, and the capacity for democratic agency, action, and change as well as the related issues of power, exclusion, and citizenship. Education at its best is about enabling students to take seriously questions about how they ought to live their lives, uphold the ideals of a just society, learn how to translate personal issues into public considerations, and act upon the promises of a strong democracy. (Henry Giroux 2009)

With our high dropout rates some might contend that the USA has a failed public education system when compared to other industrialized nations. Teachers are often the scapegoats for those who hold this view, but a much more significant factor is our public schools' long history of resource deprivation. The "No Child Left Behind" (NCLB) program of the Bush administration (a bipartisan project) has been an unfunded mandate, left to the states and localities to pay for and implement (Association of California School Administrators 2008).

In fact, there is little evidence NCLB has improved American education: scores on standardized tests in the USA have shown no discernible change in student achievement for the last 5 decades, despite it (Baines 2007, p. 100). With many accepting the view that "what can be measured matters," misconceptions are common about the status of US student achievement as well as about how they stand among the world's children (Bracey 2009).

Unfortunately, President Obama's new "Race to the Top" program is little more than an expansion on NCLB that would likely make matters worse, moving from state to national standards and linking teacher pay to the test performance of students. "Race to the Top" also compels state governments to shift funding from established public schools to charter schools.

The Obama "reform" adopts a corporatist ideology and identifies as its primary goal to create a more productive workforce. This perspective includes blaming the problems of public education on "bad" teachers. "Race to the Top" features a $4.3 billion "competition" among the states for federal grants that would be awarded to only a few states that implement these charter-school and merit-pay "innovations" ("Obama's Race" 2009). Schools whose students underperform on tests would have their principal and staff replaced or they would be turned into a charter school managed by a nonprofit agency and funded by parents and civic groups, possibly religious groups. "Race to the Top" will give money to states and school districts to "change the school culture" and encourage a punitive atmosphere in firing teachers and principals who fail to raise student test scores.

In the USA, public school funding remains primarily based on local property taxes and thus our system is segregated by affluence: children who live in the suburbs and areas of wealth have well-equipped schools and well-paid teachers, while those in the inner cities and in many rural areas go to underfunded schools. Yet, instead of a program to equalize resources, Obama's plan continues to shift funding away from the most needy schools and thus further entrenches our class-based education system.

Obama's Secretary of Education, Arne Duncan, comes to the cabinet position with a business approach to education, as a proponent of expanding charter schools and of the corporate model for reform. Rich Gibson and E. Wayne Ross (2009) make a good case for the connection between this model of change, classism, and the current wars on "terrorism" – what they call the "core issue" of our time: "the interaction of rising inequality and mass, class-conscious, resistance" (p. 41). "Obama's education plan," they write, "is based on the same rhetoric (fear mongering) and reasoning that produced the educationally disastrous NCLB. … Like his predecessors, Obama misrepresents public education performance as a scare tactic and to open the door for the privatization (of public education)" (pp. 39–40).

With a concentration of power that enables the elite to pursue a global empire, America's "corporatocracy" – a term coined by Perkins (2004) to describe the form now taken by our ruling oligarchy – represents the biggest obstacle to creating schools that will further the goal of a democratic and sustainable society: “Rooted in the primacy of property rights over human rights, corporatocracy protects the rights of corporations as well as wealthy individuals to determine how resources will be used, by whom, and to what ends” (Sleeter 2008, p. 139). Yet, given the recent collapse of the economy, replete with examples of unfettered greed and fraud, it would seem that the public might reject or at least question the business approach to education (Glickman 2008). But the corporatocracy seems undaunted in its project of remaking schools in the image of business. The simplistic “one-size-fits-all” mentality of NCLB suits the corporate model because children are seen as both raw materials and products.

With the elevation of the subjects of reading and math above all others in the K-12 curriculum, social studies and science have suffered, often sharing the same meager time slot at the end of the day (Brown and Bentley 2004). Children who do not read or do math at the prescribed level and within the time limit are labeled “at risk,” even if they might have other talents that would enable a future success in life. Once identified as “at risk” such children receive remedial instruction and may miss opportunities to develop other talents, such as in the arts. Worse, some children may see their own aspirations demeaned and lose their motivation to learn (Zhao 2009).

In contrast, like Martusewicz, Lupinacci, and Schnakenberg, Deborah Meier (2008) and others have argued for more attention to curriculum goals other than that of producing a better workforce. To Meier, the primary goal of schooling should be to promote civil society and democratic values. With NCLB, she points out, “(the) focus is still unremittingly on preparing students to ‘fit into’ the future rather than to shape it” (p. 510). She warns of the overemphasis on “content knowledge” that we find in NCLB: “The ‘genius’ of America, I would contend, has rested on its respect for playfulness, imagination, thinking outside the box, practical smarts, the taking apart and putting together of objects, exploring, and inventing” (p. 509).

Moreover, Larry Cuban (2008) has argued that Americans have always supported goals for their public schools that are not related to economic productivity, including goals related to citizenship, cultural unity, and improving social conditions. Obama’s program of national standards would only continue the narrowing of the curriculum that began with compulsory state standards, and further lead to the deskilling of teachers who already are singularly focused on “test prep.” Obama’s program is likely to lead to a loss of instructional continuity for students from more curriculum fragmentation and more interventions uncoordinated with regular classroom instruction.

Beyond Command and Control

For a school’s curriculum is not only about subjects. The chief subject matter of school, viewed culturally, is school itself. That is how most students experience it, and it determines what meaning they make of it. (Bruner 1996, p. 28)

We need to grow up and move beyond the command-and-control discourse that dominates government efforts to improve education. As a nation, we should have learned by now that command and control is a losing strategy in the chaotic system of the classroom. Trying to apply chaos and complexity theory to organizations like schools, Dee Hock (2000) has coined the term "chaordic," by which he means chaos and order existing at the same time. Hock argues that the harmonious interplay of both is necessary for all vital, adaptable systems. He distinguishes between control and order: control is imposed, an attempt to eliminate chaos. Control stifles creativity and self-motivation. In contrast, *order* should arise naturally out of a shared purpose that engages students deep down and calls forth their best efforts. In an open letter to the current Secretary of Education, Herbert Kohl (2009) reminds us that

> [i]t is possible to maintain high standards for all children, to help students learn how to speak thoughtfully, think through problems, and create imaginative representations of the world as it is and as it could be, without forcing them through a regime of high-stakes testing. Attention has to be paid to the richness of the curriculum itself and time has to be allocated to thoughtful exploration and experimentation. It is easy to ignore content when the sole focus is on test scores.

The Obama administration's educational program will be an obstacle rather than a segue to the implementation of Martusewicz, Lupinacci, and Schnakenberg's ecojustice education framework, but that does not mean that we science and social studies educators should fold our hands in resignation. There are those already-mentioned long-standing and respected movements in our field for us to draw upon – the "STS" (science–technology–society) approach, place-based education, experiential education. Even the National Science Education Standards make room for the goal of teaching "science in personal and social perspectives" and "the nature of science" (National Research Council 1996). If it turns out that compulsory national standards for science and social studies education are enacted and then accompanied by high-stakes tests, perhaps there will be some comfort in that these subject areas also will be assessed, even if by inappropriate and dubious means, so that they will still have a place in the curriculum.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy: Project 2061*. New York: Oxford University Press.

Baines, L. (2007). Learning from the world: Achieving more by doing less. *Phi Delta Kappan, 89*, 98–100.

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: National Academy of Sciences.

Bentley, M. L., Fleury, S. C., & Garrison, J. W. (2007). Critical constructivism for teaching and learning in a democratic society. *Journal of Thought, 42*, 9–22.

Bracey, G. W. (2009). *Education hell: Rhetoric vs. reality*. Alexandria: Educational Research Service.

Brown, C. L., & Bentley, M. L. (2004). ELLs: Children left behind in science class. *Academic Exchange Quarterly, 8*, 152–157.

Bruner, J. (1996). *The culture of education*. Cambridge: Harvard University Press.

Association of California School Administrators (2008, January 21). Ruling: NCLB an unfunded mandate. *EdCal*. Retrieved October 23, 2009, from http://www.acsa.org/FunctionalMenuCategories/Media/EdCalNewspaper/2008/January21/RulingNCLBanunfundedmandate.aspx

Corcoran, P. B., & Sievers, E. (1994). Reconceptualizing environmental education: Five possibilities. *Journal of Environmental Education, 25*, 4–8.

Corsiglia, J., & Snively, G. (1995). Global lessons from the traditional science of long-resident peoples. In G. Snively & A. MacKinnon (Eds.), *Thinking globally about mathematics and science education*. Vancouver: University of British Columbia, Research and Development Group.

Cuban, L. (2008). The perennial reform: Fixing school time. *Phi Delta Kappan, 90*, 240–250.

Dewey, J. (1987). Freedom. In J. Boydston (Ed.), *John Dewey: The later works, 1925–1953* (Vol. 11, pp. 247–255). Carbondale/Edwardsville: Southern Illinois University Press.

Gibson, R., & Wayne, E. (2009). The education agenda is a war agenda: Connecting reason to power and power to resistance. *Workplace, 16*, 31–52.

Giroux, H. A. (2009). The corporate stranglehold on education. *Sociologias*. Retrieved September 8, 2009, from http://sociologias-com.blogspot.com/2009/09/corporate-stranglehold-on-education.html

Glasson, G. E., & Bentley, M. L. (2000). Epistemological undercurrents in scientists' reporting of research to teachers. *Science Education, 84*, 469–485.

Glickman, C. (2008). Backtalk: Educators tell business how to stop ruining America. *Phi Delta Kappan, 90*, 392.

Goddard Institute for Space Studies. (2009). *GISS Surface Temperature Analysis: Global Temperature Trends: 2008 Annual Summation*. Retrieved September 19, 2009, from http://data.giss.nasa.gov/gistemp/2008/

Gruenewald, D. A., & Smith, G. A. (Eds.). (2007). *Place-based education in the global age*. New York: Lawrence Erlbaum.

Hock, D. (2000). *Birth of the Chaordic Age*. San Francisco: Berrett-Koehler Publishers.

Kohl, H. (2009). Good stuff: An open letter to Arne Duncan. *Rethinking Schools*, *23*. Retrieved August 29, 2009, from http://www.rethinkingschools.org/archive/23_04/good234.shtml

McComas, W. F. (Ed.). (1998). *The nature of science in science education: Rationales and strategies*. Dordrecht: Kluwer.

Meier, D. (2008). Schooling for democracy or for the workplace? *Phi Delta Kappan, 89*, 507–510.

Mueller, M. P., & Bentley, M. L. (2009). Environmental and science education in developing nations: A Ghanaian approach to renewing and revitalizing the local community and ecosystems. *The Journal of Environmental Education, 40*, 53–64.

National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

Nelson, G. (1997). Environment-population-sustainable development: Where do we go from here? *Focus, 7*, 36–39.

Obama's "Race to the Top". (2009, July 30). *Wall Street Journal*. Retrieved August 3, 2009, from http://online.wsj.com/article/SB10001424052970204886304574308442726348678.html

Perkins, J. (2004). *Confessions of an economic hit man*. San Francisco: Berrett Koehler Publishers.

Reiss, M. J. (1993). *Science education for a pluralist society*. Philadelphia: Open University Press.

Self, E. (2009). A school for peace and justice. *Educational Leadership*, *66*(10). Retrieved September 6, 2009, from http://www.ascd.org/publications/educational_leadership/jul09/vol66/num10/A_School_for_Peace_and_Justice.aspx

Sleeter, C. E. (2008). Teaching for democracy in an age of corporatocracy. *Teachers College Record, 110*, 139–159.

Sobel, D. (2004). *Place-based education: Connecting classrooms & communities*. Great Barrington: Orion Society.

Takahisa, S., & Chaluisan, R. (1995). New York City Museum School. In *Proceedings, Museum School Symposium: Beginning the Conversation*. St. Paul: Science Museum of Minnesota.

Thomas, L. (1974). *The medusa and the snail: More notes of a biology watcher*. New York: Bantam New Age Books.

Worldwatch Institute. (2009). *State of the world: Into a warming world*. New York: W.W. Norton.

Yager, R. E. (Ed.). (1993). *What research says to the science teacher, vol. 7: The science, technology, society movement*. Arlington: National Science Teachers Association.

Zell, S. K. (1998). Ecofeminism and the science classroom: A practical approach. *Science & Education, 7*, 143–158.

Zhao, Y. (2009, August 30). National education standards can end up hurting students. *Detroit Freepress*, 28A. Retrieved August 31, 2009, from http://www.freep.com/article/20090830/OPINION01/908300438/1069/OPINION01/National-education-standards-can-end-up-hurting-students

Chapter 5
Invoking the Sacred: Reflections on the Implications of EcoJustice for Science Education

Maria S. Rivera Maulucci

In the following essay, I reflect on the chapter by Rebecca A Martusewicz, John Lupinacci, and Gary Schnakenberg. I do so from many standpoints: that of scientist, mother, person of faith, middle-school science teacher, and science teacher educator. I do not see these roles as distinct; rather they all help to shape my pedagogical project in ways that strive for coherence, despite the many contradictions.

Enclosing–Opening Possibilities Through Language

Every word we learn encloses some facet of life by defining, naming, and claiming ownership. Yet, every word also opens the possibility of asking new questions. So to learn that something in the world is called a "tree," is to be able to ask: What is a tree? What kind of tree is it? How did the tree get here? How long will the tree live? What does a tree need to live? What animals live in the tree? What do trees do? How is this tree connected to other living things? What makes this tree beautiful? Thus, words have the dialectical power to enclose–open possibilities for inquiry and reflection. Dialectical thinking pushes us away from mutually exclusive binaries, such as enclosed versus open. Rather, enclosure and openness may exist side by side, such that one constitutes the other. A tree may be enclosed by the conventions of language, no longer subject to naming; however, the meaning or significance of the tree remains open to the values or discourses driving the questions that might be asked individually or collectively about the tree. For example, discourses of utilitarianism or capitalism bring forth questions about the commodification of the tree. What can the tree be used for? What is the economic value of the tree as wood, paper, or energy? What are the most efficient and economical

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_1,

ways to harvest and produce products from the tree? How do trees increase property values? Environmental perspectives bring forth questions about the aesthetic and ecological values of the tree in the landscape. How does this tree enhance the beauty of our community, park, or forest? How do trees help clean the air and water? How can trees serve as windbreaks or carbon sequesters? How do trees reduce stormwater runoff and soil erosion? Spiritual values might offer yet another set of questions. What wisdom do tree leaves whisper in the wind? Will this tree help me to sustain life? For example, the tall, eastern white pine symbolizes the Iroquois people's Tree of Peace under which they cast their weapons (Schroeder 1992). The five needles in each bundle represent the Five Nations bound together by the Great Law of Peace, its spreading branches shelter the nations committed to peace, and its white roots spread in the four sacred directions. Imbued with power by its ability to connect the Earth and sky, the tree embodies spiritual dimensions that surpass its physical, biological, ecological, economic, or aesthetic values.

Martusewicz, Lupinacci, and Schnakenberg assert that ecojustice perspectives disrupt exploitation of the world's diverse living systems or the impoverishment of communities as normal or natural outcomes of providing for human needs. From an ecojustice perspective, decisions of how, when, or if people cut down a particular tree would consider a broader array of cultural, spiritual, and ecological values for trees, animals, and ecosystems alongside humans. For example, in the Philippines, the indigenous Ikalahan people light a fire beside a big tree they intend to cut, and if the fire goes out, they see that as a sign that a spirit protects the tree (Senanayake 1999). They do not cut the tree. Moises O. Pindog, Omis Balin Hawang, and Baliag Bugtong explain:

> Our name [Ikalahan] means "the people of the oak forests". … We distinguish ourselves by the type of forest that we live in. ... We feel the presence of these spirits of the forest as we ourselves feel different when we encounter their territories. Sometimes when a large tree is cut, we can hear the crying voices that tell us of its spirits (p. 161).

Science, technology, and the idea of "progress" have been particularly insensitive to the rights and needs of many indigenous peoples to maintain their traditions, cultures, languages, and ways of living in, rather than on the Earth. How might invoking *the sacred* begin to sensitize science and science education to a broader array of cultural, spiritual, and ecological values? One way forward is to understand the ways language, as a medium of expression, carries forward "culturally specific ways of thinking," in the form of unexcavated, taken-for-granted, root metaphors including patriarchy, anthropocentrism, individualism, mechanism, and progress (Bowers 2001). The dialectical relationship, agency–passivity captures the ways our words and languages are not our own (Derrida 1998). Thus, individuals have agency to utter particular words and use them to express ideas, thoughts, or emotions; yet, they are passive to the root metaphors and diversity of meanings others may derive, given their unique and situated cultural and historical experiences. What culturally embedded ways of thinking does the word, sacred, invoke?

Invoking the Sacred and a Sense of Wonder

By invoking the word, sacred, the authors emphasize that all living and nonliving entities are worthy of respect and our inability, as humans, to fathom or control the mysteries of life is the essence of sacred. Rachel Carson (1956) wrote about the importance of nurturing a child's sense of wonder. She argued that adults have a duty to cultivate this sense and that they should focus more on helping children feel than on helping children know particular facts. She wrote:

> If facts are seeds that later produce knowledge and wisdom, then emotions and the impressions of the senses are the fertile soil in which the seeds must grow. … Once the emotions have been aroused – a sense of the beautiful, the excitement of the new and the unknown, a feeling of sympathy, pity, admiration, or love – then we wish for knowledge about the object of our emotional response. Once found, it has lasting meaning. (p. 45)

There is much debate in the literature about the extent to which emotions are hardwired, driven by our biology, or socially constructed, driven by cultural rules that label emotions and specify behavioral expectations (Turner and Stets 2005). There is also considerable debate about the extent to which emotions are conscious or unconscious. Nevertheless, there is agreement that culture strongly influences emotions.

> Not only does culture influence emotions by setting up expectations about what should and will occur in a situation; emotions are the driving force behind commitments to culture. Indeed emotions are what give cultural symbols the very meanings and power to regulate, direct, and channel human behavior and to integrate patterns of social organization. (p. 292)

Although this description of how emotions "function" takes on a mechanistic tone, the idea that emotions give cultural symbols meaning is important. If we extend this idea to the meanings children derive from their environment, both natural and human-made, we can understand why invoking a sense of wonder is a crucial step toward engaging children in wanting to know more about the places they live in and the ecological relationships that support life.

When I was a child, my mother had the ability to notice, then stop, and help us notice and revel in the beautiful and interesting things in the world around us. Whether it was street signs in the city or wild flowers in the forest, she encouraged our questions and helped us to know, label, and feel connected to our world. Now, as a mother of my own children, I try to cultivate their sense of wonder. This summer, we had the incredible experience of looking at the moon with a telescope. We saw the moon's craters and other details we had never seen before, lit with a brilliant light. Each of us needed to look for a long time. Then, turning the telescope toward Jupiter, we were able to see the planet and three of its moons. To me, this was an exciting, humbling, sacred time. I was thankful to share it with my children and consider it one of the highlights of our summer. Now that my children have seen Jupiter and some of its moons with their own eyes, they have a special connection to the bright star that is currently visible every evening in the sky above us. They know the star is Jupiter. They point it out to me and affirm that connection.

For me to define the experience as "sacred," intentionally draws on both secular and spiritual meanings. Sacred includes a sense of wonder at the complexity and beauty of life, and appreciation for the intricate interconnections between me, others, my world, and the universe. Yet, coming from a Catholic faith tradition, sacred also means holy, divine, pertaining to God; mysterious, and infinite (Hardon 2000). Since God is revealed through creation, every tree, flower, animal, rock, star, or planet becomes sacred in that they comprise a medium through which God communicates. Through my belief in Divine revelation, my sense of wonder encompasses the mysteries and miracles of life and fills me with a deep sense of thankfulness and humility for being but a small part of those mysteries and miracles. I am in awe.

Invoking the sacred opens up new questions for science: What are the possibilities and limitations of science in shaping my understanding of the world and its people? How might my appreciation for the sacred shape the endeavor of science? In this way, words such as sacred and ecojustice enclose–open possibilities for new ways of thinking about the role of science in defining and shaping our lives. They allow us to conceive of science imbued with the sacred and immersed in a struggle for justice that embraces ecological, not just human well-being. Yet, the implications of invoking the sacred and ecojustice perspectives in science education are not without challenges. The moment in which I saw Jupiter's moons was sacred to me, but I do not know if it was sacred to my children in the same way. I did not use that language with them or talk about Divine revelation. I know they forged connections, but what is the nature or scope of their connections?

EcoJustice: More than Social Justice in Science Education

In a review of social justice in science education, except for a handful of scholars, such as Angela Calabrese Barton, Alberto J. Rodriguez, and Felicia M. Moore-Mensah, social justice is an idea that is only just beginning to gain representation in the field (Rivera Maulucci in press). Nevertheless, early framing of social justice in science education recognizes the ways science education and science education research could be used as tools and contexts for challenging injustice related to educational inequity and community and global problems. For example, Calabrese Barton (1998, pp. 296–297) wrote:

> In my work, I see the politics of poverty, its connection to race and gender, and its role in perpetuating the vast inequities in school funding, access to knowledge, and life circumstances. Such inequalities illustrate to me how our society places the needs of the larger community as secondary to individual gain, and masks the politics of distribution through an ideology of consumerism.

We live in a world that perpetuates educational inequity, and this inequity becomes particularly obvious in high-poverty communities where the politics of enclosure severely limit children's access to a better life. My work in urban public schools has shown some of the nuances of enclosure at work. For example, one study documented the ways a fifth grade teacher had to resist school policies and structures that limited her students' access, agency, and achievement in science (Rivera Maulucci and Calabrese Barton 2005). For Randi, the joy in teaching stemmed from her ability to make decisions about the curriculum that allowed students to pursue their interests and opened possibilities for them to develop a sense of agency about their learning. By blurring the boundaries between science and literacy and developing performance-based activities she indicated that a broader array of knowledge and skills were valuable in science. Another study documented the societal forces that progressively devalued an immigrant youth's linguistic resources (Rivera Maulucci 2008). The transitional bilingual program in her elementary school focused on English proficiency. She moved into monolingual classes in middle school and through high academic achievement gained entry to a private high school and then an Ivy League college. She found that her second language proficiency, which was previously positioned as a barrier to learning, was highly regarded and prized by the more affluent youth in her high school and college. These small-scale studies mirror the ways current educational policies enclose the forms and types of access students in poverty have to learn science or maintain their native language proficiency. Yet, each child that manages to find a way out of a ghetto, ward, rural town, or homeless shelter and become successful contributes to root metaphors of progress by individual will and determination with rewards in equal measure. Meanwhile, the structures that contribute to poverty in urban and rural communities and the downward assimilation of many poor, immigrant youth remain largely uncontested.

Social justice in science education works to open possibilities for youth from underrepresented groups to take on identities as science learners, to shape the goals and purposes of science learning, and to improve student achievement in science. However, the argument for ecojustice in science education asks a bigger question: "How do we accept the sacred, what is fundamentally "unknowable," while we teach about the systems we care so deeply about?" In the examples given in Martusewicz et al.'s chapter, students work in relevant local contexts in ways that provide them direct experiences with healthy and contaminated soils, forge connections between students and nature, and draw on interdisciplinary ways of knowing. The youth actively engage in understanding the physical, biological, and chemical aspects of soil and unpacking the economic forces that have contributed to exploitation and degradation of soils in their community. The science educators walk a path of "guiding student learning along paths of inquiry that support living systems" while identifying and disrupting "ways of thinking/acting that threaten [living systems]." Ways of knowing emphasize community-based knowledge and an ethic of living in relation to, rather than from, nature.

Yet, do science educators explicitly invoke the sacred that is at the essence of why we care so deeply for soil as a living system? Or do root metaphors, such as separation of church and state, or science and religion as separate ways of knowing stop us just short of using the word, sacred, when teaching science to youth in public and charter schools? Do we fear charges of teaching religion or indoctrinating youth, as if other subjects are neutral and value-free? If we do invoke the sacred, do we understand and accept other schema youth might attach to it? In working with youth "to address ways in which aspects of science knowledge and methods can be used explicitly to protect life," how do we define life? Do we stop short of defining life as including the unborn? When my son is suffering the effects of mosquito bites and asks me, "Why do mosquitoes exist?" do I disrupt his human-centered query and explain the web of life? Do I talk about how even mosquitoes are sacred? Do I draw on Carson's *Silent Spring* (1962) and the mixed legacy of using the pesticide DDT as an example of where human-centered thinking brings us? With my son? All of the above. With children in public schools? I might leave out mention of mosquitoes as sacred. Is the word, sacred, necessary? Is language too messy and loaded with baggage? Can actions speak the words we dare not say? Is the concept of a sense of wonder an adequate substitution? Can my joy in the "discovery" of Jupiter's moons, my wonder and awe at the universe, my affinity for the spirit within the tree, the rock, the flower be enough to open children to the possibility of feeling deeply connected to their world, their responsibility to cherish life in all its forms, and their moral and civic duty to do less ecological harm to the systems that sustain life?

Conclusion

Enclosure has tremendous ramifications for public education. Education is highly commodified and poised to become more so. Multinational corporations have a large stake in the texts, curricula, software, supplies, resources, and facilities utilized by schools. An ecojustice perspective interrogates current moves to privatize and standardize education, particularly in high-poverty communities and questions the ways such moves may serve to de-emphasize place, erase indigenous knowledge, and perpetuate inequity. For schools to promote ecojustice, educators will need to develop ways to open up the practices, policies, beliefs, and language of teaching, uncouple them from the economic engine, and begin to reimagine and revitalize their schools and communities. Revitalizing may involve shedding practices that contribute to environmental degradation and restoring indigenous or communal ways of living where appropriate (Brandt 2004). Revitalizing may also require the creation of new ways of living in multiethnic communities that bring together peoples from many different places with diverse perspectives and values. We will also need to revitalize our languages, to excavate the root metaphors that underlie the ways we relate to ourselves, others, and the environment.

Science taught without a sense of wonder is limited to a body of knowledge and practices without a heart and soul. When science draws on a sense of the sacred, it embodies a fundamental understanding of the beauty and complexity of life that our limited senses, even with the help of modern technological advances, can only begin to grasp. For some, invoking the sacred may connect to spiritual beliefs and values. Furthermore, the sacred does not rely on the consequences of an action to determine worth, value, or morality. Ecojustice and place-based pedagogies have the potential to play a crucial role in bringing people together across the many limitations and possibilities that language and culture present, "to join in understanding local contexts and indigenous knowledge systems, and to test new ways of living in our world" (Brandt 2004, p. 105). To do so, ecojustice pedagogies may also need to transgress traditional boundaries between science and not science in order to expand the genres and ways of doing and being scientists, science teachers, or science learners.

References

Bowers, C. (2001). How language limits our understanding of environmental education. *Environmental Education Research, 7*, 141–151.

Brandt, C. B. (2004). A thirst for justice in the arid Southwest: The role of epistemology and place in higher education. *Educational Studies, 36*, 93–107.

Calabrese Barton, A. (1998). Margin and center: Intersections of homeless children, science education, and a pedagogy of liberation. *Theory into Practice, 37*, 296–305.

Carson, R. (1956). *The sense of wonder*. New York: Harper & Row.

Derrida, J. (1998). Monolingualism of the other or the prosthesis of origin (P. Mensah, Trans.). Stanford, CA: Stanford (original work published 1996).

Hardon, J. (2000). *Modern Catholic dictionary.* Eternal Life Publications. Vatican City: Inter Mirifica.

Rivera Maulucci, M. S. (in press). Social justice research in science education: Positioning, methodologies, and implications for future research. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second International Handbook of Science Education.* New York: Springer.

Rivera Maulucci, M. S. (2008). Immigration, language, and identity in teaching science for social justice: A teacher candidate's journey. *Cultural Studies in Science Education, 3*, 17–27.

Rivera Maulucci, M. S., & Calabrese Barton, A. (2005). Where's the joy? Justice and caring in science education. In N. M. Michelli & D. L. Keiser (Eds.), *Teacher education for democracy and social justice* (pp. 104–129). New York: Routledge.

Schroeder, H. W. (1992, September). The tree of peace: Symbolic and spiritual values of white pine. In *Proceedings of the White Pine Symposium*, September 16–18, Duluth, MN (pp. 78–83). Retrieved September 29, 2009, from http://www.treesearch.fs.fed.us/pubs/13474

Senanayake, R. (1999). Voices of the Earth. In D. A. Posey (Ed.), *Cultural and spiritual values of biodiversity* (pp. 119–166). London: Intermediate Technology.

Turner, J. H., & Stets, J. E. (2005). *The sociology of emotions*. New York: Cambridge University Press.

Chapter 6
Local Matters, EcoJustice, and Community

Opportunities of Village Life for Teaching Science

Wolff-Michael Roth

It is often assumed and reported that students from rural schools do not achieve as well as students from urban areas; and research often appears to overlook the special needs and opportunities that arise for science teaching and learning, in particular, from a rural setting (Tippins and Mueller 2009). Having taught science in rural schools for more than a decade and in different areas of Canada, I have experienced firsthand how there are special opportunities for teaching science that come with a rural context. For example, science can be taught so that local people, local places, and local knowledge matter, allowing students who often do not do well in school, to find themselves and their local environment validated and to excel. This includes students who are treated differently because of a "learning disability" that they come to be stuck with despite the fact that they demonstrably make great contributions not only to their own learning but also to the learning of others. Rural settings provide particular opportunities for implementing the idea of "learning communities," where the term "community" goes beyond denoting classrooms or school and extends to the entire village or municipality. That is, because of the size of the rural setting, greater permeability between school and everyday life is a possibility and students, rather than producing tests and assignments actually contribute to village life and as a consequence, learn in the process of contributing to the social fabric of their setting. This includes coming to understand ecojustice, because natural environments perhaps more so than the manufactured urban environments allow us to understand the connection between the totality of life generally and human life more specifically. Thus, learning science in rural schools is special because students may not only draw on their local knowledge to make sense of more school-based (book) knowledge but also because their engagement is situated in village life and what they produce and learn enhances the amount of knowledge already available in and to the collective. In the process, the students' own local knowledge expands and their action possibilities increase, including those for pursuing academic studies that take them away from their rural setting. But for some – including myself, who, first as a teacher then as a professor – rural life remains so attractive and the preferred lifestyle

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_6,

that they return to it after studies and getting settled in a career. That is, teaching science in a place-based manner, in ways that make local people and places matter, and toward ecojustice, actually produces and reproduces a stronger social fabric in rural areas than exists in many urban environments. In fact, there is evidence from big cities that the introduction of urban gardens fundamentally changes life, including substantial decreases in crime and violence. Teaching so that the local matters and for ecojustice, therefore, may contribute to work against the current movement of people toward urban areas, which has become not only a "brain drain" but also a problem for maintaining the social fabric in rural areas. In this chapter, I provide an extended case study of science teaching and learning in one rural community, where I worked with teachers to draw on the opportunities that a rural area provides for teaching science.

Introduction

Rural education frequently is represented in the literature as a part of society facing difficulties and hard times (e.g., Hardré et al. 2007). Due to remoteness, rural communities and schools generally face serious economic and community resource constraints, a fact that places students in rural schools at risk both in terms of motivation and academic achievement. Rural schools often have available fewer support programs and extracurricular activities than are available to students in more suburban and more affluent regions of industrialized nations. It is not astonishing, therefore, that a considerable part of the scholarly literature uses a deficit discourse when it comes to the situation and the opportunities rural schools and communities offer to the education of their younger generations. But does this have to be?

Here I argue that there are opportunities in rural communities frequently not available to schools in urban areas, which, when entire communities – students, teachers, parents, administrators, and politicians – are encouraged to capitalize upon, may actually advantage rural students over those living in urban or suburban areas. It turns out that I not only grew up and live in (semi-) rural communities – I currently operate a garden in my backyard that produces, year-round, all vegetables that we need and also has a small five-count flock of by-law-permitted chicken – but also spent a large part of my middle- and high-school teaching career in rural communities and subsequently conducted research on teaching and learning science in what are termed "semirural" communities because of their dual, hybrid characteristics that arise when urban characteristics are infused into and mix with heretofore entirely rural communities. In this chapter, I articulate some of the advantages that come from teaching and learning in rural communities as exhibited in a design experiment that I conducted in the semirural community ("municipality") of Central Saanich, British Columbia, where I am also a resident. That project was explicitly grounded in an integrated program of social and environmental justice concerned with involving children and students in building a sense of place both in rural and urban environments (Roth and Barton 2004). I begin with an account of my early teaching, which allowed me to develop an appreciation for rural education and the opportunities it provides to *education* (in contrast to *schooling*) generally. This example also shows that it is not lack of resources that should impede high-quality science education, not only in the life sciences but in the physical sciences as well.

My early teaching career was characterized by a more naïve approach to teaching science, whereby I thought that through hands-on experiences students would get directly into contact with the patterns in the world that science captures in its conceptual knowledge and in its equations. I subsequently learned about cultural-historical activity theory, which provided me with a framework for designing curriculum with goals and intentions that really matter – to (rural) students, teachers, and their community. I sketch the theory to show how one might design a rural school curriculum to which students subscribe and with which they engage because what comes to be done does affect their community, their lives, and the lives of their families. I exemplify my work in rural schools with extensive examples of teaching and learning science in different communities where I taught before summarizing some of the main advantages that derive from rural education.

Teaching in Rural Communities

In 1980, during an economic downturn and as a recent immigrant to Canada, it was very difficult to find a job as a physicist, a subject in which I had obtained a masters degree. I had abandoned the idea of becoming a teacher after very negative school-related experiences when I switched from attending fourth grade in my rural village school to an academically oriented (grammar school-like) "Gymnasium" (in a nearby small city), which I could do only by attending a boarding facility for students from rural communities run by monks of the Franciscan order. I abandoned the idea of becoming a teacher because I did not do well – in part because of an undiagnosed hearing loss – and the city folks, teachers and peers alike, thought that I was just a dumb kid from a farm in the backwoods. But now, searching for a job, I noticed the opportunities available, even without an education background, for teaching in remote and isolated communities in eastern and northern Quebec, 700 km from the next city (Sept Isles). I applied and immediately was offered a job under the condition that during the summer months I would attend university until I obtained the equivalent of a bachelor's of education.

At the moment I interviewed, I did not know where precisely I would be teaching, but the school board in urban Montreal, where I interviewed, represented 15 village schools on the Lower North Shore of the St. Lawrence River stretched out along the 400-mile coastline, most of which to this day is not connected to the road system of the remainder of the province. These villages could be accessed only by boat, by bush plane, or by snowmobile in the winter months. One of these was St. Paul's River (Fig. 1, left), where I arrived one late afternoon during the second week of September. The people there worked as fishermen during the summer or hoped to complete the necessary 10-week employment in the local fish plant so that they would qualify for 40 weeks of unemployment insurance payments. Electricity, running water, and indoor plumbing had been in existence for only a few years

Fig. 1 St. Paul's River on the Labrador peninsula is one of 15 villages on the Lower North Shore of the St. Lawrence River and, in the early 1980s, nearly inaccessible from the outside for many weeks and months of the year (© Roth 1994. With permission)

(since the mid-1970s). But the snowmobile had replaced the dog teams in the late 1960s and the boats had changed: from being rowed to using outboard engines, though none exceeded 27 ft in overall length (Fig. 1, right).

The climate was harsh, and there was snow for 6 months of the year. In the fall, the lakes in the hills near the villages froze over in October and did not open up until May or June. The open ocean beyond the chain of islands that sheltered the estuary was frozen to a thickness of 3 ft. The only way to get to the village was to fly into another, 35-mile distant village and to take the 1.5-h snowmobile ride. There was a Hudson Bay Company store and three smaller stores for the 500 inhabitants, but no restaurant or bar; a snowmobile dealership and a sawmill completed the lineup of businesses.

There were three schools in three different buildings: a pre-school and kindergarten run half-day; an elementary school, grades 1–6; and a middle school ranging from seventh through ninth grades. The middle school where I was to teach turned out to be a tiny building with three classrooms for the 41 students, bathroom facilities, and a staff room for the five teachers (the principal for the elementary and middle schools had her office in a separate building). There was very little equipment of any kind. And yet, I wanted to make a difference in my science teaching; and, equally, I wanted to make a difference in teaching the other subjects I was asked to teach in the course of the 2 years that I spent in the village, including physical education, arts, personal development, and mathematics.

My first "innovation" in the school curriculum came about in science. It turned out that the school had a kit for doing a hands-on science course, Introductory Physical Science, a 1-year course spread over eighth and ninth grades that nobody had used before. Nobody had been using it since the science advisor of the *Commission scholaire du littoral* (i.e., the school board) had shipped it to the school. I wanted to teach science in a way that I had encountered in graduate school, experimenting, the moment I liked best in all of my schooling. I also wanted to have a place to leave the equipment out on the table or in some other storage area. For lack of another room, I explored the basement, which turned out to be a big room with a 6-ft ceiling, which was lower in spots because of the air ducts. (I earned more than a few bumps on my head for not watching.) It was found only after my departure that the two fire extinguishers in the basement were not functioning and that there were cracks in the basement walls making it a dangerous place to be.

More frequently than not we went to the "lab." Because there was no running water, this meant that the students had to bring buckets of water that we needed in some experiments. Since the booklet was small and only had sufficient experiments for a 1-year course, I added other experiments by extending existing ones. For example, we had available the materials to conduct a simple experiment on the thermal expansion of matter. In fact the experimental setup is so simple that it can be made from household and other cheap and readily available materials in a hardware store (Fig. 2).

The idea of the original experiment was simple (Fig. 2a). Get some steam into a pipe fixed at one end with a clothespin and the pipe will expand, especially in length. If the free end of the pipe rests on a needle with a cardboard dial attached to it, even a minute extension in the length of the pipe will be translated into a noticeable turn of the dial, amplified by the small diameter of the needle pin. In the original experiment, comparisons were made between different materials (e.g., aluminum, glass, and copper). As a physicist I knew that the thermal expansion in

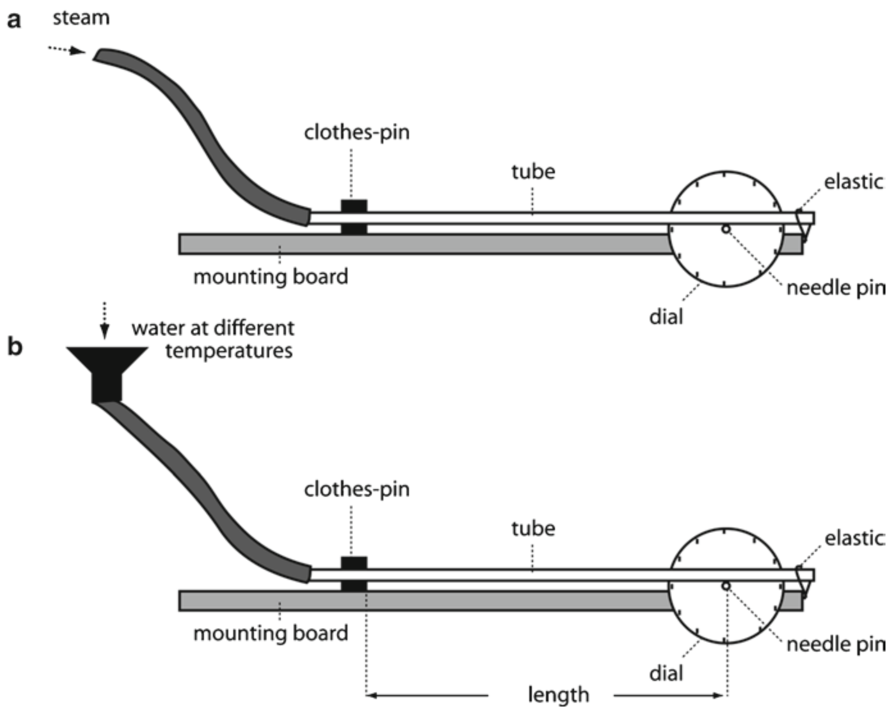

Fig. 2 A simple eighth-grade science experiment on the thermal expansion of matter. (**a**) The original experiment. (**b**) Several variations were made to allow determining the dependence of expansion on temperature, material, and length

length depends not only on the material but also on the temperature difference and on the length of the material.[1] Thus, I modified the experiment so that students could pour water of different temperatures into a funnel allowing them to produce different temperature differences (i.e., ΔT). I also asked them to bring the needle pin to different distances within the clothespin, which varied the effective length of the expansion which was measured. The students now conducted several experiments over the course of nearly 2 weeks, in which they varied the different parameters, noted their results, produced graphs, and so on. I learned from this experience that with a little innovation, the use of any equipment or any experiment could be extended for the benefit of student learning.

I designed and produced other novel learning resources, such as, for example, a slide rule for assisting students in doing or checking their multiplications and divisions. In those days, calculators were expensive and slide rules were slowly going out of fashion. Because I noted that the students had difficulties with their multiplication and division, I asked the janitor to help me build a giant (8-ft) slide rule, which I painted and marked off in an appropriate manner to be able to do multiplication and division (this requires a logarithmic scale). I not only taught my science students how to use it, but also had them employ it for their own applications.

In the seventh-grade biology course, we had a heyday. Nature was just outside the entrance door (Fig. 1), and all I had to do was come up with some useful curriculum. One aspect I felt students should learn is doing scientific research. Every week during our double period, which took all afternoon, we went outside to do experiments. Students learned about random sampling using hoops homemade from wire clothes hangers; students tossed these behind themselves and wherever the hoops fell they sampled plant and animal life. We manufactured 1 by 1-m squares from four wood strips and thereby produced a tool for conducting systematic counts of plant life within the same reference area. We used a 100-m long string, which we marked off in 1-m intervals to produce a reference line for strip sampling. Once the students had learned these techniques on the hill behind the administration building and teacher residence, we were ready to go out and sample different kinds of ecological succession processes – bare rock succession, forest fire succession, pond succession, and so on. A succession is an orderly change from one type of ecological (plant, animal) community to another type. They exist both diachronically, for the same area over long periods of time, and synchronically, with geographical variation. Thus, for example, by laying a strip from a forested area to a pond, students were studying the different plant and animal communities in places where there used to be a pond; or they studied bare rock succession by going on a rock outcrop and then sampling along a strip into a nearby grove. Given that nature started right behind the school, there was so much we were able to study just with the few simple techniques that students increasingly honed as they participated in using them. How often do city

[1]The formula for the thermal expansion Δl of a rod with length l is $\Delta l = \kappa l \Delta T$, where κ is a constant characteristic of the material, thus different for glass, aluminum, copper, steel, etc. and ΔT is the temperature difference.

school kids get to go out to study nature for one afternoon per week? I had begun to love teaching in this rural community and, from then on, appreciated the opportunities village life offered to teaching science specifically and to teaching more generally. It turned out that many years later, I watched a documentary on French village schools extolling the opportunities of rural schooling and not only began featuring it in my arguments for an education involving the entire village community (e.g., Roth 1998; Roth and Lee 2006) but also came to interact with the teacher himself (who wrote to me that more than anyone else in France, I was understanding what he attempted to tell others about the benefits of teaching in small rural schools).

It was not only in the science classes that I made do with what was at hand and thereby created a learning environment that students enjoyed and which allowed them to be successful. In the arts classes, I had students systematically explore color, beginning with one color producing a strip from white to the deepest form they could achieve. Then they did the same with two colors, mixing them along a strip. Then they did the same with three primary colors. In each case, after producing one or more simple (sample) strips, they then painted a picture with the means just explored. Thus, the first picture was made from only one color with differences in intensity. The next one included everything they could and wanted to do with two colors.

In another project, I used black construction paper that I found in the stockroom at the school. I also found four rolls of differently colored transparency film. I asked students to bring scissors, leftover razor blades, and any sharp construction knives that their parents might have. I then asked the students in the three grades I taught simultaneously to make “church windows” graded by age level: abstract designs in seventh grade, rosettes in eighth grade, and Christmas scenes in ninth grade. They began by producing a pencil design, from which they then cut the desired shapes using one of the available tools. To provide them with a greater range of options, I showed how new colors could be created by producing layers from the same or different colors of transparency film. We hung the final pieces onto the school windows, leaving the lights so that – because it was winter and it was dark at 4 pm – the entire village could see their colorful designs even during the late afternoons and early evenings. Again, the simplest of means, and help by students and parents, had provided many opportunities to explore a domain formally and in detail, allowing students to learn tremendously despite, and perhaps because of, the limited amounts of resources we had available. The students had added “value” to their village, their place, by contributing to the way it appeared to them on a daily basis. That is, it was not only a sense that developed *from* living in and appreciating a particular place, but also they were producing a sense for the same place.

For another project, I went with the students to the estuary and we gathered driftwood for the subsequent construction of “feelies,” objects that felt good in the hand. Again I asked students to bring tools from their homes, including (carving) knives, rasps, planers, and sandpaper. I asked them to pay attention to the grain of the wood and they learned, through experience and feedback from me, about working with wood in ways that draw on its strength and possibilities. In this case, the village was a resource and we capitalized on it for providing a better educational experience. The wood had come from the river that they knew so well and provided them and their parents with a living and a resource for leisure activities. I realized only decades later that students could, in turn, enrich village life as part of their educational experience. Because students began to value their village for its natural resources and the opportunities these provided for them including their outdoor life and their artistic interests, they developed a tremendous sense of place in a double sense: place both as a resource and something that one can care for, enhance, and keep as a livable place.

In this rural school, as in other rural schools where I subsequently taught, I also learned to deal with and appreciate the different levels of academic ability. This was important because if I wanted to do justice to the abilities, interests, and needs of each student, I had to come up with ways of addressing what turned out to be tremendous variations. Thus, in my seventh-grade biology course, I had three boys reading at the first-grade level on the Gates–MacGinitie reading test and one girl reading at the tenth-grade level. But these and other students did very well in my course because they loved the environment, knew a lot about it, and, because of my flexible way of allowing them to express themselves, they achieved well, nevertheless.

I also got to teach in the elementary school. Because of the size of the village, there were no substitute teachers available. So when one teacher was ill, the others took on the load. I was the only middle-school teacher willing to help out in the elementary school. By rearranging my schedule, having other teachers take over my middle-school classes, I was freed up to work, for as long as necessary, in a variety of elementary classes, spanning, over the course of the 2 years, all of the six grade levels.

In summary, teaching in this school was a great experience and many times subsequently I was longing to be back in the village and to teach the mix of courses, range of students, and to be close to an entire village as a whole. In my experience, the village had provided opportunities for teaching because life was less regimented, busy, and fast as it had become in the city. There was a general support among students and among the parents to create the best education with the things at hand, even if it meant as little as providing the students with some tools or leftover building materials, or hiking along the beaches to pick up driftwood.

There was very positive feedback from both students and parents, although I had made all decisions about what would be included in the curriculum and what we would do. I was teaching with the belief that knowledge could somehow be found out there or learned through experience. I did not think about the concept of "meaning," although I knew that the students who knew their outdoors also turned out to do much better in my biology class than they were doing in the classes of other teachers who only approached their subjects through the academic route. But I personally did not have the conceptual means that would allow me to design curriculum so that it made explicit use of the inhabited world as a meaningful entity; and by participating in this world all actions took on meaning rather than having to be constructed. That is, it took me many more years until I came to understand that new words and actions accrued to the already meaningful world students are familiar with rather than new words and actions getting meaning as a new attribute. It is for precisely the same reason that some educators now emphasize the role of *place* in learning, which has led to the emergence and development of the concept of "place-based education." But place in itself does not have meaning, it is human interactions and practices that make the lived-in world predictable, produce human control over the environment, and sustain society and, with it, the individuals that constitute it. One theory that captures all these dimensions is cultural-historical activity theory, which I develop in the following section because it underpins much of the curriculum work that I have conducted over the past decade.

A Brief History of Society and Consciousness

In this brief theoretical excursion, I write about the evolution of humanity, because it shows very nicely, intelligibly, and plausibly the core elements of cultural-historical activity theory (Roth and Lee 2007). Pre-hominids were directly exposed to their environmental conditions and could do little but cope. Individual and group, if applicable, accessed the available resources for sustaining their lives. Structurally, this relation between individual, group, and the environment can be expressed in a triangle (Fig. 3).

The figure shows the direct dependence – that is, unmediated by consciousness – of the pre-hominids on the environment. They did not engage in building shelters to protect themselves from a storm. Changes in the environment were detrimental to the group (species as a whole) because required adaptations could not be made within the life span of individuals. But we see that there was a role for the group that already mediated access to the environment, for example, food, such as when wolf hunt as packs or bees cooperate in the securing of food. The matters, however, began to change once new avenues for interacting with the environment opened up, as apparent from the structural relations in Fig. 4.

With tool use, new forms of relations with the environment become possible. For example, different chimpanzee groups have developed different methods by means of which to extract ants or termites from their mounds. Other groups developed means to crack nutshells and thereby access the edible and nutritious seed. This would not have been of much help, however, if one individual had invented such a

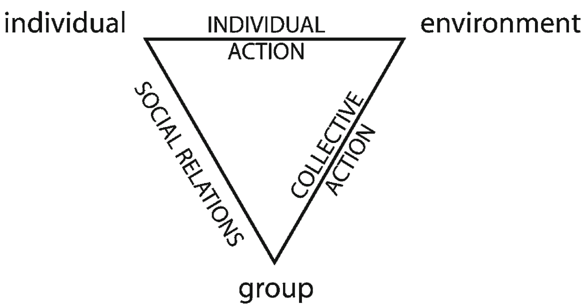

Fig. 3 Structural representation of individual, group, and environment of the life world of pre-hominids

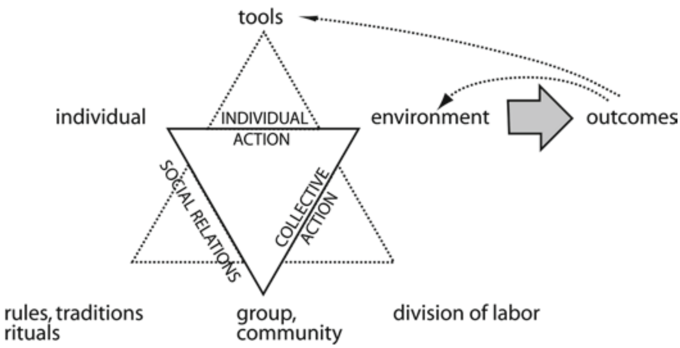

Fig. 4 When forms of relations and orientation toward the environment became available, the latter came under the control of the species

behavior without transmitting it to others in the group. In such a case, the behavior would have been lost. But with the hominids (great apes), traditions emerged; individuals learned how to fish for termites from other individuals (often the mothers). Knowledge came to exist no longer at the individual but at the collective level. Even if one or two individuals never were to fish for termites, never appropriate the skill, as long as there were others practicing the skill and making it available through observational and mimetic means to others, the knowledge survived. This knowledge that allows humans to control the environment has increased tremendously, leading the human hubris of a nearly almighty agent in the environment. But the required knowledge and practices concerning the responsibility for place and a sense for ecojustice – the concept that we cannot make others and other organisms pay for our own power and excesses – has not grown in the same way.

Among the great apes one can also observe a third feature, division of labor. Thus, chimpanzee males hunt for monkeys clearly dividing the task. Some climb adjacent trees thereby blocking escape routes and the "hunter" climbs up the tree where the monkeys sit killing one, which is to be shared subsequently with all others. Alexei Nikolaevich Leont'ev (1978), the father of cultural-historical activity theory, used such an example (his involves "hunters" and "beaters") to explain early forms of division of labor that actually formed the basis for diverse human societies. More advanced forms of division of labor began when some individuals stayed back, producing the tools others used in hunting and gathering, and exchanging the tools thus manufactured against food: The first barter systems emerged and with it, human forms of society. That is, because there are two forms of activity, individuals have the choice to participate in one or the other, and as long as they participate, their needs are met because they can exchange the fruits of their labor with others trading what they have for something that they need. In fact, as long as there is sufficient food produced, even those who do not or cannot engage in one or the other form of activity can survive feeding on the leftovers or what is given to them. These societies are characterized by the conscious production, exchange, distribution, and consumption of things important to the group as a whole. The structure of society is shown in Fig. 5.

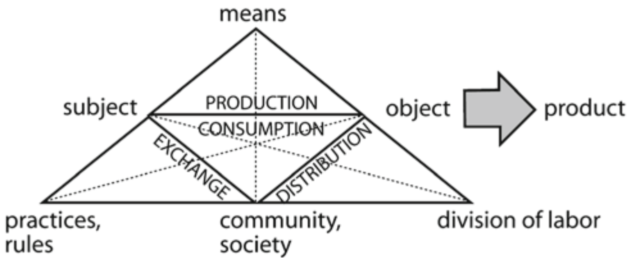

Fig. 5 The structure of human activity systems

Early forms of division of labor led to new forms of activity all of which were important to the survival of the society as a whole. Progressive divisions of labor – including the one that led to the division of those who employed sophisticated theories and those who employed sophisticated practical skills (architects and master builders, education professors and teachers) – led to increasingly diversified societies and eventually to the emergence of early cities (in what is today northern Iraq). But each of these activities is producing something that others need and are willing to exchange something else for it. The theory is powerful because it even explains why professional sports exist, although they do not produce anything useful: People are willing to spend (exchange) money to be able to watch a game for their enjoyment, and the players are willing to do nothing but practice to be able to play at a level where they can make sufficient income to meet all their needs.

An important activity system in the present context is that of formal schooling, where teachers and professors teach, that is, make available the theoretical forms of knowledge that each generation bequeaths to the next. Up to the present day, schooling has prepared younger generations for the work in factories in a more or less stable world, whereas our current lives show – economic turmoil, environmental disasters such as Chernobyl or the cane toad in Queensland – that we need to prepare new generations that are forward looking, prepared for an ever-changing world that may bring more dangers than safety.

Each system has its special forms of knowledge, its means of production, and its physical and social environments. Each system also has its motive that links present materials and final products, such as producing grain (wheat, corn, rice) or making bread, which orient everything that happens on a grain-producing farm and in a bakery, respectively. These systems are inherently meaningful to those who participate in them in knowledgeable ways. Thus, what is a meaningful action in one system would not be a meaningful action in another, or, if there are in fact two actions in different systems, they tend to have a different sense (meaning). Knowledgeable participation, therefore, is meaningful because it occurs within and in the form of a connected and meaningful whole. Participants do what they do because it makes inherent sense to act in this rather than that manner; and individuals participate without asking the question about theories that explain what they do. An easily accessible example is grammar. Children learn to speak their mother tongue fluently without ever having a problem with grammar. And even without knowing any formal grammar at all they distinguish grammatically correct from grammatically incorrect sentences. That is, *knowledgeably participating* is *(the same as) knowing.* A more recent example I have used repeatedly is that of a multi-age, one-room French village school, where newcomers learn as they participate with ongoing forms of activities and the oldest participants leave to go on to different schools. The classroom culture maintains itself because there is a low turnover each year.

To sum up, human activities have evolved in culturally specific and historically contingent ways. Because activities have inherent collective motives (growing grain, baking bread, educating children), everything during participation attains its sense in relation to the overall motive. This allows us to hypothesize that there are opportunities in rural life (villages, municipalities) where students can contribute to the collective life, which is inherently meaningful, and in the process come to accrue new practices to an already meaningful way of living and participating.

This has immediate implications; and once I understood these, I changed the way in which I was teaching and designing curriculum. The first thing I came to understand was that the motive of schooling is not education (knowing), as one might think, but as apparent from teacher and student behaviors, it is the production and exchange of grades (marks), which are ultimately accumulated, like a symbolic form of capital, to access real capital and further opportunities (jobs, coveted university admissions). I realized that if students were to buy in and participate in an existing form of societal relevant activity outside of schools, what they were learning and doing would inherently make sense and students would be able to learn by observing and participating with others they know. More so, what they would be doing would profit the community as a whole and would not just end up in the garbage can – in the way of so many assignments, notebooks, and exams. Throughout my professional career as a teacher and as a critical intellectual, I felt that rural life and rural communities provided so many advantages to creating learning environments that did not exist in the same ways in urban and suburban schools. And I desired to teach in multi-age classrooms because of the possibilities to create conditions for true communities, those that reproduce themselves rather than the ones that teachers spend so much time and effort to create anew each year. All I had to do is find ways in which students picked up some activity, where the motive already existed and orient the actions of participants, then learning was guaranteed. Once students bought into participating in this or that activity, the motive would orient what they did, give sense to their actions, and make participation inherently meaningful because of an already meaningful world preexisting the participation of the student.

Place-Based, Expansive Learning in Environmentalism

Taking my cues from the deinstitutionalization of psychiatric and prison systems, where the residents of formal institutions (with mental disorders or developmental disabilities and prisoners) were moved into community-based and family-based environments and halfway houses, respectively, I argued as early as the mid-1990s for a change in the way we think about and theorize science education (Roth and McGinn 1997). The fundamental findings that led me to this conceptualization was based on the research in situated cognition whereby the everyday mathematical competencies of people in supermarkets, street markets, factories, scientific research, and in a variety of jobs were not at all related to levels of schooling, to the number of mathematics classes they had taken, and not even to the introductory knowledge of their own discipline in the case of academics. Thus, my question, "Why teach mathematics and science in schools if what students learn is not used or unusable in the everyday life?" led me to argue for creating opportunities for children to participate in everyday, by now legitimated activities such as environmentalism. I did so not because of a sense that disaster was impending but because I had developed a sense of, and for, place, organic living, and a protection and enhancement of the environment (e.g., creating a garden that is part of a transit corridor for wild life, including insects and birds), and because I saw the pleasure that comes from growing one's own food. And I provided already more than a decade ago existing examples of how children and students already participated in a variety of activities, including:

- *Environmentalism*, such as when the elementary children of my city neighborhood school were participating in seeding a new green corridor with butterfly pupa.
- *Monitoring pollution,* such as when the high-school students of a nearby municipality monitored pollution levels of the ocean inlet around which their city is built.
- *Salmon enhancement*, such as when the high-school students of another nearby city were repopulating local streams by running small salmon hatcheries in which they raised salmon to the smolt stage and then released them into the creeks where they were imprinted by the mineral environment so that after a long ocean journey they would return, spawn, and thereby bring to life an extinct salmon run.

All of these forms of engagement already were existing activities, with their varying object/motives that orient what people do and give sense to their actions. Because these activities have their own culture, patterned actions, and characteristic tools and instruments, they constitute forms of life; and participating in these life-forms is inherently meaningful, providing meaningful grounds to which new and unfamiliar words, practices, ideas, or resources can accrue and thereby become associated with existing forms of meaning. Students work with others in the community who already participate in these life forms and become acquainted with the way people act toward and talk about the object/motive of their activity. In participating with others, students adopt the object/motives, talk, and patterned actions and thereby expand their own room to maneuver for accomplishing the goals they set themselves.

In subsequent work, I extended these ideas, partially responding to critics who charged that "not everybody has a salmon stream to enhance" and suggested that there are not general or generalizable forms of activities that should drive school curriculum. Rather, it is the local context, the local community, which identifies what is salient and important to the community. This may be a certain form of environmentalism in one instance, salmon hatching in another setting (Roth 2002b), but it may be doing something for the physiological or environmental health of the local community in one instance or a project in ethnobotany and the economic revival of an Aboriginal community in another instance (Roth 2002a). For example, I suggested that some of the Aboriginal communities of British Columbia could bring back part of their culture by taking school children to the traditional seaweed camps where they, through participating, not only contribute to harvesting this traditional food staple but also produce and reproduce the whole culture within which the harvest and consumption of seaweed has been lodged. The main point of all these activities that I had been writing about was to engage students in activities that already existed in the communities where children and students live, and which therefore constituted a meaningful form of life and experiential ground to which new concepts – e.g., scientific, mathematical, cultural, historical, sociological – could accrue.

To show that all of this is feasible, I piloted three times a project of student engagement in environmentalism. So that the teaching strategies would not get lost, I cotaught the unit with local teachers, the later ones learning to teach the unit by participating with earlier participating classes and teachers or by having previous participants come to their classes once the unit had started. The proposal for the work to my funding agency *explicitly* argued for community involvement such that others from the community not only came to the school but that the children in the school would actually get out of their institution and into the community. My sense always has been that such a move of taking students out of the institution and thereby to deinstitutionalize would work especially well in rural schools where many of the hazards present in and characteristic of urban areas – e.g., traffic, distractions – do not exist. That is, place-based education appears to be particularly relevant in rural areas, which not only provide so many resources for educating students of all grades in the community but where the students come with a wealth of knowledge about the local environment, which provides them with many resources for learning – just as I had previously experienced it in Southern Labrador during my first years of teaching. In my own situation, I chose environmentalism for two reasons. First, there already existed a vibrant environmental group in my semirural area, concerned with the ecological health of our main watershed and the creek emptying it into the ocean. Second, I am personally committed to the environmental cause and enact sustainable practices (walking and cycling instead of driving, recycling, and composting, producing all vegetables we eat year-round, etc.). Third, I was able to document a 12-year struggle of one group of residents in my community who did not have access to the water grid and who faced the opposition of politicians and others in their effort to come to be connected. It was this case in particular that allowed me to become aware of the need to include forms of justice – eco-, environmental, and distributive justice – as an integral part of any education.

Fig. 6 Much of the valley has retained its rural character with a mixture of fully functioning and hobby farms, wineries, and orchards (© Roth 2007. With permission)

The Place: Community, Environment, and Watershed-Related Activism

Central Saanich, the community in which I live has retained much of its rural character (Fig. 6), though in the three more heavily populated areas in which much of the municipality's population concentrates (Fig. 7), urban-type (low-density) developments are increasingly appearing. Geographically, much of the community lies in the Hagan Creek watershed, which is dominated by Hagan Creek and its main tributary, Graham Creek (Fig. 7). The map makes it quite clear that the distances from the school to the different, easily accessible sites at which the students investigated the streams are relatively short, within minutes of driving. The landscape is peppered with farms, riding stables, hobby farms, berry farms (Fig. 8), tree and plant nurseries, commercial greenhouses, and wineries.

Despite its location in an area of temperate rain forests, the microclimate of Central Saanich is such that it only receives about 850 mm of rain annually, most of it falling in the November-to-March period and very little during the remainder of the year. The local aquifers are insufficient to supply the community with water, which therefore has to be piped about 40 km from reservoirs situated in the nearby Sooke Hills region. Recent developments have exacerbated the issue by altering the water flow over and through the ground.

To drain the bogs that used to exist before the arrival of the European settlers, farmers had straightened the creek, thereby turning it into a channel (Fig. 9a). These changes allow the water to flow away faster – with the effect that in the summer months, the creek is but a trickle (10–20 l/s), supplying insufficient water for resident farmers to water their fields. A considerable number of wells are used for irrigation.

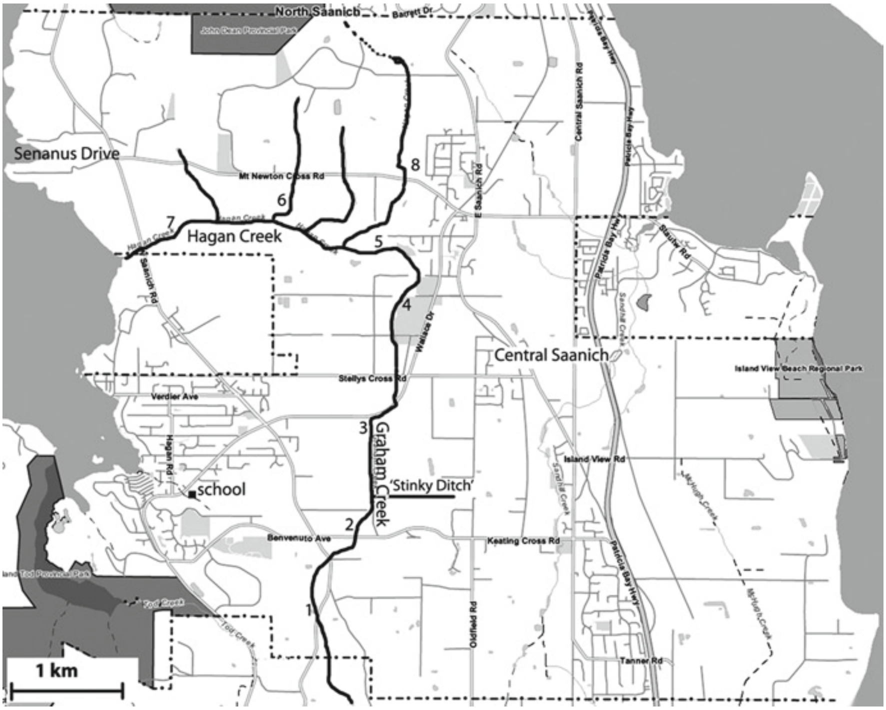

Fig. 7 Along the creek (heavy dark line), farmland is prevalent. The more heavily populated areas are discernible from the density of the streets. The locations of the participating school and the main observation and the research sites along the creek (numbers) are indicated

Fig. 8 The landscape is peppered with berry farms (© Roth 2008. With permission)

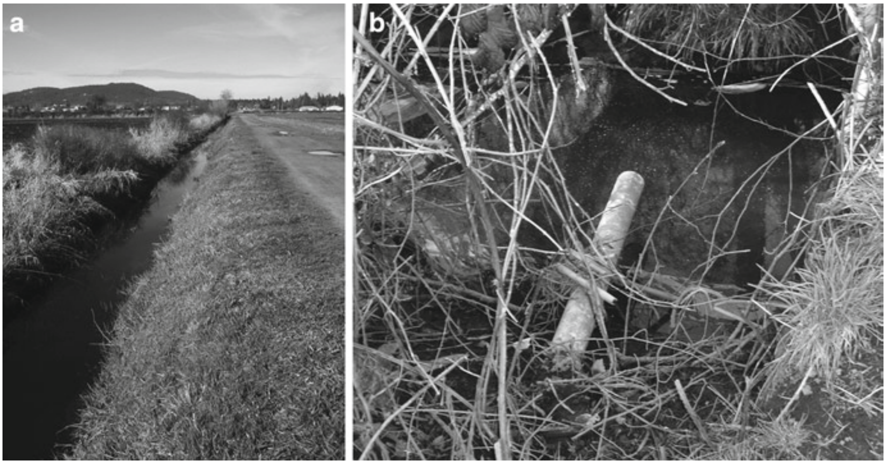

Fig. 9 Industrialization and farming have created heavy pressures on the health of the watershed. (**a**) To drain the water from the heavy winter rains, the creek has been straightened and left without vegetation. (**b**) An industrial site led its effluents into a side-arm of the creek affectionately called "Stinky Ditch" (© Roth 2005. With permission)

The combination of quick runoff and groundwater use for farming heavily tax the aquifer system. Other changes are related to urbanization and the increase in impervious surfaces (e.g., pavement, roofs, and concrete driveways) that come with a concomitant use of storm sewers. Losses of forest cover throughout the watershed and along the stream banks, loss of wetlands and recharge areas, and the loss of natural stream conditions, further increase the pressure on the aquifers. In 1997 and 1998, the leader of a local environmental group quickly pointed out that the Hagan Creek watershed is at the upper limit of total impervious surfaces that still allow for healthy watershed and streams. In addition, stress on the water system came from the many companies situated in a local industrial area (Fig. 7) that spilled their effluents into a side arm of Graham Creek affectionately called "Stinky Ditch" (Fig. 9b).

The water situation in Central Saanich is precarious, and each year beginning with May there is a water advisory, limiting the amounts of water that can be used and the types of application that it can be used for. Each year, lawns may only be watered on 2 days of the week, and then only prior to 9 am and after 7 pm; during other years, the restriction becomes more severe disallowing all overhead watering, car washing, and other forms of open water use. The effect of the restrictions are evident, as all normally deep-green lawns turn brown, a tremendous exception in this area where they are green even during the generally snowless winters, one of the only places in Canada where golfers can play during this season (Victoria is known as "the garden city").

Water problems also have made the news for more than a decade because the residents of Senanus Drive (see Fig. 7, top left), an area without access to the local water main, draw their water from individual wells. These wells take their water from bedrock fissures fed by the local watershed. For years, the local and regional newspapers reported that in the summer months, some well water in the Senanus

Drive area was biologically and chemically contaminated. Sometimes, the residents were advised by the Capital Health Region not to use their water at all or to boil it considerably; many residents have opted to get their water from gas stations in one of the two areas of higher concentrations. In recent years, residents have increased the frequency of their demands and sought exposure in the local media in support of their cause. The residents brought the issues forward to the Regional Water Commission, which decided that the issue was a municipal concern. They were therefore caught and frequently made their plight being heard through the local newspapers. But despite increasing concerns with the water supplies in over 200 communities in Canada, there was no sense of ecojustice in this community, until only a few days ago when, in the face of several large grants, the local politicians finally voted a bylaw allowing the extension of the water main into Senanus Drive. Water and its quality and the environmental health of the entire watershed therefore are at the forefront of many residents' minds and at the forefront of the local newspapers (there have been many title-page features).

The Hagan Creek–Kennes Project arose from the concerns about water quality of three watershed residents, a farmer, professor of environmental policy at the local university, and a stream biologist working at the Institute for the Ocean Sciences, who obtained funding from a federal agency concerned with stream restoration. They used this funding to hire a coordinator, Misty MacDuffy, an experienced environmental campaigner who is very familiar with political conflicts around water. Her experience includes international as well as local campaigns, and she is an accomplished writer and presenter of visual materials. Although she is familiar with the politics of environmentalism and media relations, she is not from the region, and her past credentials as a campaigner do not necessarily help her in her interacting with the largely conservative community members.

Misty was supported by a steering committee of about five-to-seven volunteer members, all from Central Saanich. The steering committee met weekly to discuss the recent events and to plan future activities. Its members included a retired civic engineer, an ecologist/local politician/farm products promoter, a water chemist, two retirees with experience in campaigning and project management at the federal level, and a member of one of the old families of the region who provided the activists with an important connection into daily community politics. The committee members were dedicated participants, but for the most part, were not known as major political players in the community – though the ex-councillor and old family member knew most of those who were "pulling the strings."

The Hagan Creek–Kennes Project enlisted the support of many other people and institutions within the region to help get work done. My graduate students and I helped out in specific areas of the Project at the nexus of numerous personal (research, personal activism) and institutional (community participation, fulfilling degree requirements) concerns. There have been many others who have become involved for the duration of a project or for a summer job while there was sufficient funding. There were rarely more than 15 people actively engaged at a particular moment, and Misty provided for the connection between the volunteers who contribute several hours per week of their own time. In the process of changing the community (e.g., bringing about changes to the Official Community Plan by engaging in the political process), the Hagan Creek–Kennes Project was part of sets of continuously changing relations, along with the creek around which the people have rallied and the community in which they work.

The activists believed that they were working in and against an adverse political climate. Farming continues to be the predominant form of land-use in the municipality. The other major landowners tend to be wealthy individuals living on large 2–10-acre "rural residential" lots. Both of these types of landowners are considered to be conservative, pro-property rights, and suspicious of people who "tell them how to manage their land." Since most of the land in the municipality is private, the activists felt that building and maintaining good relationships with everyone they possibly could was paramount to their success in bringing about desired changes. There is not yet a broader sense that valuing this place, in which we dwell and which provides for us, also requires a broad-based, shared sense of ecojustice. Such a sense, as I articulate below, is part of what got seventh graders so excited about doing something for their community by engaging in Hagan Creek-related activism.

In doing their work, the activists transformed the creek and community (e.g., Fig. 10). For example, as they were planning the construction of a large riffle[2] in a very strategic location, the horse riding community insisted that they still be

Fig. 10 The environmentalists have already brought about changes in the watershed, such as the split-rail cedar fencing (front) that prevent access to the creek and signs that explain historical, biological, and environmental issues (front left). This section of the creek has been revitalized and is trout-bearing once again (© Roth 2007. With permission)

[2]A riffle is a structure from rocks and wood (logs) designed to make the water tumble, thereby introduce oxygen into the water and increase the levels of dissolved oxygen.

allowed access to a section of the creek in the park, so they could train their horses to cross Graham Creek (see location #4 on the map in Fig. 7). Despite the fact that the horse ford was just downstream of the riffle they had planned, and despite the fact that the horses would be passing close to an active trout spawning site, the activists agreed to the removal of some of the riffle structure so that the horses could cross the creek. The activists agreed to do this even though the park manager had previously approved the blockage of the ford if it was important for the fish. The activists made an arrangement with the most vocal horse owner that would allow her access to the stream at times when the fish did not spawn. To the steering committee of the Hagan Creek–Kennes Project, it was more important to have the horse owners "on-side" than it was to have a perfect riffle – that is, a riffle that emerged from a perfect translation from an imagined world, the world on paper, into its material format. The riffle, in this location, was a hybrid that included the concerns of the horse owners. Stream restoration science was transformed in its re-creation as a set of local relations at this particular site.

A Place-Based School Curriculum Oriented Toward EcoJustice

Given the water-related problems in Central Saanich, it was not difficult to convince teachers to participate in an experimental curriculum where students would learn science by investigating the Hagan Creek watershed. During 1998–2000, I cotaught science to three seventh-grade classes over 2–4-month periods. In these classes, students designed and conducted their own research in and along Hagan Creek, Graham Creek, and their tributaries (see Fig. 7) with the intent to report their findings at an open-house event organized each year by the members of the Hagan Creek–Kennes Project. The underlying idea in these science classes was to get students to become active citizens and to contribute to the knowledge available in and to the community. Other students at the middle school – and at the local high school – already conducted research in the watershed as part of their involvement in the regionally funded "Streamkeepers" program or for producing entries in local and regional science fair competitions. In this way, some students already participated in creating knowledge available to their community and the activists. Members of the Hagan Creek–Kennes Project, the authors, parents, and First Nations elders contributed in various ways to the teaching of the children in my experimental curriculum by providing workshops, talks, and assisting them in framing research and collecting data.

It was not difficult to enlist the students in this curriculum, especially after we were reading with them an article in which Misty MacDuffy called for community participation in doing something about the poor environmental health of the watershed. The children, many of whom came from farms, hobby farms, and (hobby, commercial) fishing families knew firsthand about the water problem. Their parents, especially those from the local First Nation, could no longer gather shellfish along the beaches because the pollution of Hagan Creek also polluted the inlet (left, Fig. 7).

The students from the farms knew about the problem accessing water, the building of ponds, the use of wells, and the problem some of the wells had with their levels of biological and chemical contamination. During the first lesson, almost all students wanted to do something about the creek out of a sense of environmental justice. More so than their parents and older village inhabitants, they sensed that something was wrong and that *they could and should do something about it.* And the desire to do something became even stronger once Misty MacDuffy herself had given them a presentation about the work she and her project had been doing.

Individuals already working in their professions on issues concerning the creek assisted not only the Hagan Creek–Kennes Project but also participated in introducing our students to research and practices. For example, Kelly Cabreras, a water technician working for a local farm, showed the students where and how she measured the water levels, how she measured the temperature and oxygen levels, and how the construction of riffles and the planting of trees alongside the streams increased oxygen levels (e.g., in sites #6 and #7 on the map, Fig. 7). Chris Parks, a biologist normally working for a consulting firm, spent one afternoon with the students, showing them, among others, how to use a colorimeter to measure the turbidity (cloudiness or haziness caused by suspended particles) of the water (Fig. 11). The students subsequently got to use the instrument to conduct measurements in various parts of the creek and to correlate these measurements with other variables of their interest, for example, with the speed of the stream or with the kinds and frequencies of certain microorganisms, worms, and so on.

Fig. 11 A trained biologist working with and for the environmentalist group explains middle-school students how to use a dissolved oxygen meter, which they subsequently use to conduct measurements (© Roth 1998. With permission)

Parents, activists, aboriginal elders, scientists, graduate students, and other community members were an integral part of the science units. They mediated, as shown in the activity theory structure (Fig. 5), what, how, and who for the students worked, researched, and learned. For example, every other week the classes spent one entire afternoon (noon–2:30 pm) in and around the creek. Parents assisted both in driving children to the different sites along the creek and participated in teaching by asking productive questions, scaffolding, and supervising children. Thus, Mr. Goulet, for example, was very eager to contribute to the teaching of students. I therefore invited him every time we went outdoors; and during the 4-month period, he only missed one outing. After I had told him that there was only one rule, "No Answers! Only Questions!," he always went off with a group of male students (i.e., not including his daughter) and, through his questioning, allowed students to learn a lot not only about biological phenomena and relations, but about physical and chemical characteristics of soil, the creek, and the water (e.g., which objects float in the creek).

Members from the environmental activist group also contributed giving presentations, assisting in teaching kids how to use particular tools and how to do research in the creek and how to analyze the data and organisms brought back to the classroom. Students from classes that had already completed or were near completion of their unit talked about their work in another class that was just beginning, and assisted their peers during fieldwork and data analysis (Fig. 12).

This involvement of community members, therefore, integrated the children's activities with activities in the community in two ways – much in the way it had done

Fig. 12 The middle-school students conduct various kinds of research projects in and alongside the creek. In the back (white shirt and shorts), a boy who has previously completed the unit assists newcomers to field study (© Roth 1998. With permission)

in the French village of Moussac that often served me as an example. First, the village community came to the school, assisting students and teachers in their activities. Second, the student activities were concerned with a pressing issue of the community; the science lessons took children out of the school and into the community. That is, the children's activities were motivated by the same concerns that drove the activities of other community members. In terms of the activity theoretic model (Fig. 5), there is, therefore, legitimate (peripheral) participation because the motivation that drives the activity system shares many moments.[3] It is this overlap with the activity system characterizing everyday life in the community (motivation, subjects community, and tools) that makes the children's work "authentic." Rather than preparing for a life after school or for future science courses, children participated in and contributed to social life in the community. It is in the process that learning – belonging to the various conversations of which individual persons are – was occurring.

Although the activity–system-defining object was the same in most instances for all student groups, Hagan Creek and the watershed it drains, different tools and rules mediated the relations in different ways leading to very different outcomes (Table 1). Nevertheless, the various outcomes ultimately contributed in their own ways to the totality of the findings generated by one or more classes. Here I understand the students' activities authentic in the sense that their activities were motivated in the same way and by the same concerns that other activities in the community were motivated. Table 1 also shows how different members of the community in general and the activist group in particular participated in the activity system that describes the students' activity. Other similarities with the activity systems in the community (Table 1) are some of the tools (colorimeter, rules). Not surprisingly, some of the *outcomes* of the student-centered activity system were, therefore, similar to those in the activity systems in the community. For example, the use of colorimeter, pH meter, or dissolved-oxygen meter all led to numeric representations of stream health. Similarly, middle-school students and students working on the Hagan Creek–Kennes Project as a summer job produced very similar graphical representations – such as stream cross sections. In addition, forms designed by scientists (water-quality assessment, physical assessment) assisted students in their summer job and middle-school students in producing representations (*outcomes*) that could be used by the environmental activists to pursue other goals (e.g., getting grants, proposing restoration work).

The unit ended with a presentation of students' work as part of the open-house event that the Hagan Creek–Kennes Project organized every year. At the open house, the children were not away in some corner designed to present "kiddies' stuff," but rather they were central participants of the event and, according to the environmentalists, a reason for the great success of it. Thus, the students' exhibits

[3]In activity theory, a *moment* is a part that cannot be understood independent of the other parts because each enters the definition of the other. Thus, a subject is a subject only in relation to a specific object, and the object exists only with respect to the particular subject engaged in the production of something in which the object constitutes the material resource.

Table 1 Outcomes in an activity system (seventh-grade science class) as mediated by the tools

Outcomes	Correlation between stream speed and profile	Classification and frequency of organisms, stream speed	Radio-like reportage, slides, website	Processes of investigating, environmental health	Dissolved oxygen levels, organism type/oxygen level correlation
Division of labor	Timer, releaser, measurer, recorder	Measurer, recorder	Roles in research team		Roles in research team
Rules	Repeated timing and averaging	For use of stopwatch			
Community	Central Saanich parents (Mr. Goulet) activists, scientists	Teachers, students from other classes [Davie]	Teacher, Michael, Stuart	Researchers, fellow students	Teacher, Michael, Misty, community
Tools	Stopwatch, tape measures, ruler	Tape, stopwatch, Serber sampler	Cassette recorder, camera	Video camera	Dissolved oxygen meter, Serber sampler
Object	Hagan Creek	Hagan Creek	Graham Creek, shore line	Student researchers	Hagan Creek
Subject	John, Tim	Seventh-grade students (John, Len, et al.; Lisa et al.)	Michelle et al., Kathy et al.; Chris	Gabriel	Jodie et al.

could be found right next to the water-level chart that Kelly Cabrera had recorded on her farm, enhanced by adding bars for the size and date of rainfall events, and that Kelly now explained to interested visitors (Fig. 13).

Given the different tools that the children had used to conduct investigations and construct their representations, the variety of the displays came as no surprise (Table 1, last column). There were maps, photographs, drawings of invertebrate organisms, instruments and tools, live invertebrates and microscopes to view them, larger organisms in a glass tank, interview transcripts, and a variety of scientific representations (graphs, histograms). The type of representations used was little different from those used in the various exhibits by the environmental activists. That is, the children's representations were a reflection of those that are characteristically used in a community-based science. In the following, I provide several brief descriptions and transcripts to articulate scientific literacy in the community involving children.

Michelle and her three (female) teammates had been interested more in qualitative than in quantitative representations of the creek. For example, one of their

Fig. 13 At the open-house event: A water technician, who also works with the environmentalists, explains a chart on which she records in a continuous manner the water levels in the creek, and onto which she has mapped the daily rainfalls for an entire year (black spots on the top of the chart) (© Roth 1998. With permission)

projects involved a tape recorder, used to record verbal descriptions of several sites along the creek, and a camera for saliently depicting some issue identified by the girls. Accordingly, their exhibit contained many photographs, exemplifying, for example, the differences between the creek where it had been turned into a ditch and where it was in a natural state. The work they had conducted in the field was represented in narrative form.

In another situation, Jamie came to interact with one of the cofounders of the Hagan Creek–Kennes Project (Fig. 14). Unbeknownst to Jamie, the cofounder political scientist living in the community was interested in assisting local people in empowering themselves concerning the environmental health of their community. As Fig. 14 shows, the political scientist was very interested in the outcomes of the students' investigations and interacted with a number of them. In one instance, he asked Jamie about an instrument on exhibition, the same type of instrument that the summer work-study students had been using to conduct and produce water-quality assessments. In the course of their interaction, knowledgeability relating to a particular instrument and its operation was being produced.

Miles: What is this?
Jamie: A calori– meter. It measures the clarity of the water.
Miles: Ah! A calori– a colorimeter?
Jamie: You take the clear water and you put it in this glass and then here [puts it into instrument] (*Pushes a few buttons*) and you take the standard which is like the best there is. And then you switch this (*takes different bottle*) and put the one with

Fig. 14 At the open-house event: A middle-school student explains the use of a colorimeter, which is used to measure turbidity of water by comparing it to a sample of clean water, to local resident very interested in the environment (© Roth 1998. With permission)

the water from the creek. (*Covers sample*) And then you scan the sample. And then you see what the things floating in the water is.
Miles: Over-range, what does that mean?
Jamie: (*Pushes a number of buttons*)
Miles: Oh, it is when it is over the range, I see.
Jamie: First I have to do the standard again. (*Does standard*) Then I take the creek water. (*Enters bottle into instrument. Pushes buttons.*)
Miles: Oh, I see. This is really neat.

This interaction did not lead to a contrast between an all-knowing adult (expert) and a child; there was no belittling. Rather, the conversation involving Miles and Jamie allowed the articulation of an honest request for understanding and an illustration of the operation of the device. Scientific and technological literacy emerged from the dialectic tension between a request for information and the production of an answer in the form of a demonstration.

In summary, then, this (triple) teaching experiment that I conducted with my graduate students showed that children participated in activities with similar motivations as those of adults, and they participated in a variety of forms of conversations with adults other than the regular teachers. More so than most of their village elders, they had felt spoken to their sense of ecojustice when they heard about the dire straits of the local watershed; and more so than most of their village elders, they felt the need to do something about the situation. The conversations they had with individuals and collectives, therefore, broke the mold of normal modes of schooling, opening up the possibility for lifelong participation in such an activity and therefore the possibility for lifelong learning without the discontinuities that characterize the transition from formal schooling to other aspects of life. If the motives underlying school science and environmental activism, stewardship, or volunteerism are similar, based on the nature of tools, rules, divisions of labor, and community, we can expect individuals (subjects) to move along trajectories that do not exhibit discontinuities characteristic of other transitions. Students who participate in activities that contribute to the knowledge available in their community will develop into adolescents and adults, continuing to participate in the activities relating to environmental health. The possibility for such transitions is clearly indicated by a variety of situational organizations that foster the participation of students and nonstudents alike. For example, as a result of my work in the schools, middle- and high-school students conducted science–fair-related investigations. As part of their career preparation, some local high-school students chose to participate in "Streamkeepers," a program fostering the recovery and restoration of ecosystems, and open to any individual or group. Three national youth teams worked together one summer to help the Hagan Creek–Kennes Project to improve the watershed by moving native plants before clearing 11,000 m^2 for a pond and wetlands that helped improve the water quality in the area.

High-school and university students contributed to the data collection as part of funded summer-work projects. Masters students at the local university became key people in constructing community surveys to yield multilayered (GIS) representations, involving maps that displayed groundcover (vegetation), surficial geology, soil, aquifers, topological, and present land-use (housing, zoning, or cadastral) information.

Rural Education Has Great Advantages

In this teaching experiment, knowing and learning were taken as moments of culturally and historically situated activity. Learning, which I understand as changing participation in a changing world, is discernable by noticing self and others' changing ways of going about interesting and community-relevant issues. Because interaction and participation cannot be understood as the sum total of an individual acting toward a stable environment, learning cannot be understood in terms of what happens to individuals. Rather, if learning is culturally and historically situated and distributed in this way, educators must focus on enabling changing participation, that is, enabling new forms of societal activity that is collectively generated. I am, therefore, particularly interested in forms of participation that are continuous with out-of-school experiences and, therefore, have the potential to lead to lifelong learning rather than to discontinuities between formal and informal learning settings. Building on children's sense of, and *for*, place, which constitutes their real dwelling, also awakens their sense of ecojustice.

In my view, rural education comes with the advantage that the kinds of engagement described here are much less problematic than they might possibly be in urban situations. Here, the parents participated driving their children and peers to the different research sites and thereby engaged to make this interesting educational context possible. The sites were close and easily accessible, facilitating such a curriculum in a (semi-) rural setting, whereas they may not be easily accessible in (sub-) urban settings. Given the size of the municipality, it was not surprising that the participating parents knew each other; they were chatting about this different approach to teaching and learning and compared it to the normal approaches that also characterized their own schooling. In the past, I have written a lot about another rural school, this one in France, about which I had seen a documentary; I subsequently exchanged emails with the teacher (Bernard Collot) and he sent me the book he has written about teaching in rural schools. Like I, he is actually in favor of the context, which, in his situation, meant teaching in a 500-soul village. Here, too, elementary school children went into the village, for example, to post the letters they had written to pen pals around the world; and parents and other village folk came to the school to engage the children in various forms of activities, like the older lady coming to play chess with them or the gentleman who helped them build and tend a vegetable and fruit garden. It turned out that the school eventually became a totally open environment where young and old would come after school and in the evening to make use of existing resources that allowed them to expand their own room to maneuver, such as using computers and accessing the Internet.

Bernard Collot (2002) suggests that the schools in rural communities have an advantage in that they may constitute small heterogeneous assemblies that are the sources of dissipative, self-organizing structures. Once the structure is in place, you do not need much to sustain these structures because they are self-sustaining. For example, when there are classes gathering all students from K–6, then each year there are only a small number of incoming and a small number of outgoing students, the remainder being the same as during the previous year. Thus, students just continue what they have done before and the incoming students become part of the existing patterns of doing things. When I took my seventh-grade students and allowed them to become part of the network of conversations and actions surrounding the health of the watershed, they, too, were like the incoming students in Bernard's class, learning by participating in doing what others already were doing.

Bernard Collot suggests that small villages also can function like dissipative structures concerning knowing and learning more generally, structures that stand in a mutually constitutive relation with the school. In fact, school life and village life no longer is distinct – schools become deinstitutionalized in the way I have been advocating for some time now. Bernard showed that one does not have to regulate children to achieve *better* than the national average on standardized examinations. In fact, his students arrived at the school in the morning when they wanted, and then wrote *their* own daily curriculum objectives on a chalkboard. They were completely free in their choices, though they tended to enact particular activities, composing music, writing to pen pals, gardening, constructing something, attending a play put on by other individuals, or participating in a discussion (e.g., the one I watched was a discussion among K–3 students concerning the question of whether god exists). The teacher Bernard never lectured, and when he wanted to talk he had to ask the current chairperson (a student from the group) permission as anyone else participating in the situation.

The literacy that the students in this study evolved constituted the outcome of a live, place-based curriculum. It was a form of literacy that had as one of its central features an ethico-moral dimension that characterized not only the activity (Roth 2008) but also the particular forms of identity that students developed (Roth 2007). Such ethico-moral dimensions are central to a form of education that I refer to by the term *education as ecojustice project*. Such a project is inherently open-ended, always to come (Fr. *à-venir*), with results never achieved and achievable but always in the future (Fr. *avenir*). In this nonfinalized way, we can never be satisfied with having achieved ecojustice, but always have to strive further, always enacting rather than achieving it – ecojustice as performative:

> A performative produces an event only by securing for itself, in the first-person singular or plural, in the present, and with the guarantee offered by conventions or legitimated fictions, the power that an ipseity gives itself to produce the event of which it speaks – the event that it neutralizes forthwith insofar as it appropriates for itself a calculable mastery of it. (Derrida 2003, p. 152)

As performative, we cannot ever achieve ecojustice other than in concrete praxis. That is, ecojustice achieved is ecojustice not attained, for, as other phenomena including forgiveness and democracy, only an inner, irresolvable contradiction keeps it alive. Moreover, it is only in the first person that ecojustice gives itself as ipseity, which is neutralized as soon as we think we have attained and mastered it. The children in my studies practice ecojustice but never can attain it, even if they practiced for the remainder of their lives. And precisely in such reproduction and transformation of ecojustice praxis, they retain it as a viable form of human life.

Ethico-moral stances, ecojustice, and sense of place in rural communities contribute to a greater aim than transmission and handing down of knowledge. Rather than studying to be admitted to higher levels of learning (school subjects as propaedeutic) students actively participated in the social life of their community – both in Bernard Collot's and my examples; they did so in my case by contributing to the available database on the health of one local stream. For my students, science was a lived curriculum, in which students "have a feeling that they are involved in their own development and recognize that they can use what they learn. This venture in science curriculum development recognizes the socialization of science and its relevance to how science impacts our culture, our lives, and the course of our democracy" (Hurd 1998, p. 411). A lived curriculum requires a collective endeavor involving not only one subject (e.g., science) but also disciplinary knowledge in the social sciences, humanities, ethics, law, and political science. However, an interdisciplinary approach gives all subjects an epistemologically equal place among all others rather than attributing to it an epistemologically exceptional status. Truly democratic forms of education (not in the sense of serving capitalist interests) allow individual members to develop their own representations of salient issues.

In my approach, education moves outside the school and thereby becomes, at least partially, deinstitutionalized. Conceptually, this deinstitutionalization shares some similarity with the institution of halfway houses or with the group homes that replaced mental hospitals in some countries. In both situations, the members are no longer locked up in institutions (prison, psychiatric clinic) but participate in (limited ways, sometimes under supervision) the everyday affairs of their community. In my situation, students' activities take their place in the community more broadly rather than being something relegated to particular locations (schools) with local and temporal effects. The outcomes of students' work has relevance and contributes to the broader life world that they inhabit together with their parents, siblings, elders, town council members, and others in the community. If science is to be for all, then there have to be opportunities to participate in ways that emphasize students' strengths, and address their interests, rather than setting up situations that bring out inability, disability, and problems. Science in rural communities thereby contributes to the reproduction of village society so that we may conceive of education as one that focuses on the achievements of the collectivity and consider "best teaching strategies" to be those that lead to new forms of collective activity. Science education conceived in this manner not only builds on the sense of place that locals feel, but also builds on the sense *for* place, which generally comes with a sense for the need of ecojustice.

When rural educators focus on creating situations with the potential for scientific literacy to emerge and for lifelong learning along trajectories not marked by currently prevailing discontinuities when school boundaries are crossed, new instructional possibilities and difficulties are likely to emerge in nondeterministic ways. This is a direct result of the school and rural community being small, order-generating entities that produce and evolve new self-sustaining structures. Documenting these possibilities and difficulties, as well as knowing and learning what emerges from them, remains virtually uncharted terrain. Much research remains to be done to study the forms distributed and situated cognition to take in the approach we propose. Before policy recommendations can be validly made, such research has to show that our proposal can be implemented more widely in a number of different domains and with more diverse student populations than that participating in this research.

Coda

Academics often decry the poor state of rural education. The situation may well be such that it can be decried, but this is not a fault of the nature of *rural* schools and communities. There are other moments of society mediating what happens in rural schools, the undesirability of teaching there, poverty, poor funding and endowment, or low teacher pay. The fact is that only the sky is the limit for someone wanting to innovate and capitalize on the opportunities rural communities offer to the educator and to its students. In this chapter, I provide a number of examples of how with very simple means rather innovating curriculum can be planned and enacted.

Academics also can do something for developing a sense of place in their colleagues and through their own actions. Writing about ecojustice in the disembodied and dispassionate ways of an Immanuel Kant can only do disservice where the core phenomena, such as sense of place and ecojustice, are related to embodied knowing and emotion. In this article, I use photographs to communicate more than a successful approach to teaching in rural settings. One of my purposes is to produce a gut-level understanding of what these places are like where I have taught and to which I have developed a deep sense of emotional belonging, awe, and responsibility. I am growing here the food I eat, and I contribute to the maintenance of an environment that also is my dwelling on which I depend. But these specific places I inhabit are only placeholders, metonyms for the world we inhabit more generally and in which we ought to take the place of caretakers rather than of abusers. There are other places, where through my actions I can contribute to ecojustice and a sense of place, by buying organic and fairly traded products (e.g., clothing from organically grown cotton and bamboo, organically grown and fairly traded coffee). I abandoned my car and now do everything by bicycle and bicycle trailer. We cannot just write about changing the world, we must change it both through action and by example. Place, ecojustice, and rural community *ought not* remain (empty) slogans and lines in the manuscripts we compose but have to be taken up in the way we conduct our lives.

Michael Mueller (2009) suggests, we must not take “ecological crisis” as the lynch pin of our arguments on ecojustice or sustainability. I agree. My own sense for ecojustice and caring for the environment emerged when I was a child. My mother often talked to us about the hoopoe – which, because it defecated in its own nest, was to stink to such an extent that “stinking like a hoopoe” has become a familiar expression – when she wanted to make sure that we did not litter and make sure we were clean. Ever since those days, the image of human beings on earth like the hoopoe in its nest – we pollute our own place of dwelling. It is out of this sense of dwelling and the care it needs that my own sense of place and ecojustice has evolved rather than out of a sense of environmental crisis and sustainability (which may in fact not be possible when viewed on a global scale).

Acknowledgments The research for this article was funded by a grant from the Social Sciences and Humanities Research Council of Canada.

References

Collot, B. (2002). *Une école du troisième type ou “La pédagogie de la Mouche*. Paris: L’Harmattan.

Derrida, J. (2003). *Rogues: Two essays on reason*. Stanford: Stanford University Press.

Hardré, P. L., Crowson, H. M., Debacker, T. K., & White, D. (2007). Predicting the academic motivation of rural high school students. *The Journal of Experimental Education, 75*, 247–269.

Hurd, P. D. (1998). Scientific literacy: New minds for a changing world. *Science Education, 82*, 407–416.

Leont’ev, A. N. (1978). *Activity, consciousness and personality*. Englewood Cliffs: Prentice Hall.

Mueller, M. P. (2009). Educational reflections on the “ecological crisis”: Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.

Roth, W.-M. (1998). *Designing communities*. Dordrecht, The Netherlands: Kluwer.

Roth, W.-M. (2002a). Aprender ciencia en y para la comunidad. *Enseñanza de las Ciencias, 20*, 195–208.

Roth, W.-M. (2002b). Taking science education beyond schooling. *Canadian Journal of Science, Mathematics, and Technology Education, 2*, 37–48.

Roth, W.-M. (2007). The ethico-moral nature of identity: Prolegomena to the development of third-generation cultural-historical activity theory. *International Journal of Educational Research, 46*, 83–93.

Roth, W.-M. (2008). Agency and passivity: Prolegomenon to scientific literacy as ethico-moral praxis. In A. Rodriguez (Ed.), *The multiple faces of agency: Innovative strategies for effecting change in urban school contexts* (pp. 135–155). Rotterdam: Sense.

Roth, W.-M., & Barton, A. C. (2004). *Rethinking scientific literacy*. New York: Routledge.

Roth, W.-M., & Lee, Y. J. (2006). Contradictions in theorizing and implementing "communities. *Educational Research Review, 1*, 27–40.

Roth, W.-M., & Lee, Y. J. (2007). "Vygotsky's neglected legacy": Cultural-historical activity theory. *Review of Educational Research, 77*, 186–232.

Roth, W.-M., & McGinn, M. K. (1997). Deinstitutionalizing school science: Implications of a strong view of situated cognition. *Research in Science Education, 27*, 497–513.

Tippins, D. J., & Mueller, M. P. (2009). As if local people and places mattered: A relational, ecological, and pragmatic framework to guide projects of rural education. In W.-M. Roth & K. Tobin (Eds.), *The world of science education: Handbook of research in North America* (pp. 529–542). Rotterdam: Sense Publishers.

Chapter 7
Engaging the Environment: Relationships of Demography, EcoJustice, and Science Teacher Education in Response to Wolff-Michael Roth

Kurt Love, Teddie Phillipson Mower, and Peter Veronesi

Kurt: Wolff-Michael Roth provides a valuable description and analysis of students working in their own community to be part of a democratic, ecologically based dialogue. At the core of this community activism is a movement away from top-down traditional teaching practices, or even liberal/progressive teaching practices that steer students toward the "right" answer, one that is often decontextualized from the students' own natural, social, and cultural communities. As community activism is inferred, this type of teaching, namely, using one's community as the curriculum, is a real and necessary departure from a curriculum that exists everywhere and nowhere. This begs the question of how future science teachers can be prepared and how current science teachers can be supported to develop teaching practices that are strongly rooted in connections between science, culture, social hegemonic structures, and ecological identities. A question follows. During a time when science education is often specifically named in political rhetoric to developing more workers in science-related fields largely driven by corporate agendas and ultimately the profit motive, how can science teacher educators and science teachers create an effective learning experience that is not significantly overcome with corporate and political motives?

Teddie: In his chapter, Roth states that he comes to know about ecojustice and place-based (science) education not through a doomsday perspective, but from an emotional attachment of caring, which he describes. This sensitivity emerged when Roth was a child and was reinforced throughout his life, through interactions with physical and social environments. Traditionally, environmental educators intuitively subscribe to the myth that environmentally appropriate behavior begins with knowledge of the environment, which in turn, leads to awareness and then action.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_7,

More aligned with Roth's ideas, however, environmental education research focused on human behavior indicates that "sensitivity" plays a significant role as an entry level factor in awareness and action (Hungerford and Volk 1990). Individuals, who have many experiences outdoors over the course of their lifelong education, develop affection and empathy. Roth notes that science educators can change the world through action and by example. This idea resonates with research where environmentally sensitive individuals report the importance of teachers who are sensitive and willing to act. However, not all teachers have had comparable experiences from which to develop these skills. A further question is how to inspire a teacher to consider, adopt and advocate for more humanistic school science perspectives.

Roth describes his conceptual transformation as one that informed his new practice, from that of *schooling* to *education*. He associates *schooling* with extrinsic motivation (e.g., focus on grades, promotion, and ultimately symbols of wealth) that the traditional school movement endorses to value above the intrinsic motivation of meaningful knowing, critical, and independent (or shared) thought. The implicit message is one of consumeristic training that devalues learning and plays itself out in many ways. One example in higher education is that some students argue that paying for a class and showing up makes them deserving of an "A," or as Roth puts it, "a symbolic form of capital, to access real capital and further opportunities." Furthermore, this training promotes greed, power differentials, and disconnect from meaningful societal and ecological interactions (as a result of the pursuit of "the symbol" and what it may or may not represent). Through knowledgeable participation in meaningful contexts, learners develop their capacity to contribute to the larger community and grow their "sense of place." In doing this, students become more invested and personally motivated to learn.

However, Roth points out that it took him many years to develop the conceptual means to design curriculum that used the human interactions and practices students were already familiar with to enhance learning. How do we support teachers in developing the necessary conceptual framework to facilitate this type of learning over fewer years?

It seems imperative that teacher educators engage preservice teachers in learning opportunities that allow future teachers to experience learning and teaching in a variety of communally authentic and relevant ways. The old adage, "teachers teach in the way they were taught," points to the importance of experiences that push teachers to the edge of thinking about and implementing instruction that leads to learning outcomes necessary for a twenty-first century citizenry capable of applying knowledge to novel situations in their community and environment. Supporting teachers (and fresh teacher educators) as they take the needed risks associated with leaving their comfort zones for less traditional delivery practices, creates cutting-edge ways to think about and implement science curriculum. The importance of time to explore personal epistemic and sociological beliefs is a necessary component and prerequisite for teachers. As Aikenhead (2006) points out, science teachers are attracted to and "socialized" through university science programs that promote decontextualized science and soften the transmission of cultural myths that uphold a scientific worldview that is embedded in positivism and realism. Roth acknowledges his own concerns of teachers returning to the *status quo* when he describes co-teaching a unit, so that teaching strategies will not get decentered. In subsequent pilot testing of his projects, he had newer teachers participate with previous participating teachers thereby networking a teaching community through "cultural transmission."

Roth argues that the rural environment offers some advantages for ecojustice and place-based science education over urban situations. He notes that parental participation, the close proximity of research sites, and ability of teachers and students to leave formal settings helps to engage them with the natural world more fully. Roth also mentions that the small size and energizing qualities of the rural school and community contribute to enhancing learning and teaching. People know each other in rural places and resources are readily available (both human and material) and contributed by invested businesses and parents. Newer ideas can be self-sustaining once introduced, because prior program participants serve as cultural transmitters of knowledge (and expertise). I am not sure how generalizable these characteristics should be for all rural environments and, furthermore, if some of these features are not also available in some urban environments, having lived and taught in a variety of contexts. But Roth notes that critics of his earlier work charge that the opportunities he describes, such as the rejuvenation of a salmon stream were not available to drive science curriculum in all places. Thus, he responds to these critics with what he views is important to the community, which mostly determines what is incorporated in the science curriculum. Surely, urban environments have their important environmental issues from which meaningful engagement and learning can take place (e.g., lead in soil, brownfields, higher levels of asthma and students at risk, "stinky ditch" streams, combined sewer overflow systems, and so forth). Roth's points are made considering the knowledge and social relationships that are generally found in smaller isolated rural communities and are definite advantages for learning opportunities.

Peter: It has been a historically common theme among economically advantaged countries, whereby undesirable environments (e.g., landfills) are located near the poorest communities in society. Some examples include petrochemical plants, landfills, or interstate highway corridors. Indeed, a review of newspapers across the country at any given time will show people in local communities protesting various development plans that adversely impact them. The latest protest issue near where I live in the northeast is whether or not to permit wind turbines near private real estate. This issue is widespread. The "Not in My Backyard" or what is described as the NIMBY syndrome is real. Roth's arguments bring out both implicit and explicit ideas of science education as a framework that makes better understanding the natural world in rural places simultaneously result in an ever-strengthened or healthier local community (as the goal of such education efforts). Strengthened community can develop through a sense of empowerment for the residents of such communities. Ecojustice, as Roth describes it, which is the underpinning of his work, is an innovative concept emerging with some of the forward-looking individuals who sense that human beings and other organisms from all Earth's environments should be able to share in a healthy life *without* situations whereby the less fortunate populations "pay" for the excesses of the more affluent, powerful, or more connected.

Ecojustice offers a holistic philosophy and framework for science education such that the consequences of living near a landfill or Superfund site can be defended as morally and ethnically wrong.

As I see it, there are at least three major arguments in Roth's work. First, local science matters. Second, local experiences with nature trump classroom science experiences, and third, a marriage between the former and latter arguments seamlessly weaves together a so-called sense of place. Consider the following. I can imagine a child spending their childhood summers pulling up stones in a frequently visited stream to find a crayfish. While the child may not know it at the time, he or she is doing a solid "Explore Phase" of the 5Es Learning Cycle that will come in handy during a habitat unit for school curriculum designed around the local community at some future date (Lawson 2001). This scenario is only one of many extracurricular experiences that a child will pull from in order to understand the conception, *habitat*. And, while this experience may well have been completed during a summer vacation, it is still nonetheless an experience.

However, for more than a decade now, the constant and growing pressure from high-stakes testing consistently displaces these types of authentic learning experiences (pulling up stones in streams to locate a crayfish) as Roth describes, not only on a backburner, but more effectively "removing the pan completely off the stove!" Ecojustice theory reminds us to focus on places where nature still has a strong influence and where people are more likely to understand natural processes. Ecojustice also reminds us to embrace local inhabitants, to understand science in ways that will bind our communities together. When students find themselves in a science classroom, the connections between experiences they have and science competency become stronger than connections made by students in more abstract settings that do not have the same strong influence of these more natural experiences.

Living in rural areas, Roth argues, does not have to hinder high-quality science education. Frozen ocean, estuary, the need for fuel, and fishing, have numerous scientific competencies associated with them. Roth richly describes the diverse, natural world that exists in remote or more rurally developed areas. Observable natural-world phenomena abound in these settings! Designing a rural-school curriculum that uses the platform of local science important to students makes sense intuitively and can be elaborated to have roots in Vygotskian "constructivism" (1978). A science teacher recognizing this idea can use the context of a local stream where students fish to logically produce a sense of motivation from the students' vantage point and build on what these students construct as a meaningful experience. While living with nature's bounty and using that living experience to explore the natural world aids in students' finding that "sense of place," the very cultures and traditions of the communities where they live should also be considered as relative reasons for the full development of this tremendous sense of place.

Many cultural groups that never moved into urban settings have longer histories of respect for their land. Native Americans, for example, and of course with few exceptions, embrace the natural rhythms developed with a deep connection with the land to survive the pollution of Hagan Creek, as Roth describes it. This example is one of a community with a more limited voice who "pay" for the benefit of a few.

Authors such as Robert Yager and Pinchas Tamir (1993) are early advocates of teaching science using these issues of local importance. The use of issues, specifically, designed for understanding the connections between Science, Technology, and Society (STS) in science teaching corresponds with Roth's writings. Teaching science in a manner that connects more fully with the larger community or environment creates an immediate and meaningful "need-to-know" for developing science competencies (a reason beyond testing students). The advantage is greater buy-in from students where students do science instead of having it done for them (National Research Council [NRC] 1996).

Roth's own personal story, his journey of becoming a science teacher, is one of "hope" for science education. As is often suggested, the teacher is perhaps the most critical agent for meaningful science learning. Roth describes how much he wanted to make a difference for his students. The creative and resourceful science teacher is one who uses limited available materials (wherever they find themselves) and expands these details to enrich the experience of their students. It may also be that Roth implicitly makes a connection between teaching science in the remote village, this village's innate connection to the land in meaningful ways, and the division of labor within certain jobs. The idea is that "knowledgeable participation" is meaningful for the participant. This idea suggests for "formal" education, a way to prepare students for their future world which will undoubtedly have dangers (e.g., global climate damage and environmental disasters) seen in recent times. A "local matters" manner of teaching science creates a greater understanding of community and nature. Correspondingly, it is a needed challenge to equate understanding local matters with keeping residence in one local area, while at the same time, recognizing the incredible pull of economic opportunities within urban areas.

Kurt: Working with students in a rural setting can sometimes mean working with students who have an elevated sense of local agency. This is not to say that students in suburban and urban environments do not also have a strong sense of local agency. The social systems of government and industry are evident and numerous in urban settings – quite intimidating – and give a perception of one's diminished ability to act locally. A rural setting can be perceived as more accessible because of generally perceived smaller populations, more locally operated businesses and community events. As a child taught in a rural setting in Connecticut, I also remember observing that rural students who are inclined to think about local issues seem to feel like they have more significant levels of access to government officials and business leaders. Roth demonstrates this idea. He shows how it plays out with students communicating their findings to local policymakers and community members. With that stated, I am not presuming to describe some sort of spectrum of agency that correlates with where one lives. These experiences might be superficial trends that a teacher observes when working in a rural setting or someone with limited experiences in a more urban setting. Strong, moderate, and weak feelings of agency can certainly exist in any setting, which creates the need to *dissolve* notions of agency as it is associated with place. In other words, this *dis*(placed) idea means that teachers need to understand the levels of agency present in order to be able to help students engage and connect with the community and community learning experiences.

Rural (as well as urban and suburban) teachers can tap into this sense of local agency as a way to build local, place-based science-learning experiences. Regardless of the setting, teachers need to address feelings of internal domination (Irwin 1996) and perceptions of surplus powerlessness (Lerner 1986) when situating curriculum in present community issues. These issues may present themselves as initial barriers that produce apprehension and unwillingness for students who engage with community issues. Internalized domination is an internal perception that reminds us that we cannot always act in a particular way, because of some attention and backlash associated with all acts. Surplus powerlessness is the overwhelming feeling that despite our best efforts, change is seemingly disproportionate and unlikely to happen (also see "nihilism"). When a general sense of agency within a group of students or in a school district reflects a sense of access and mobility in ways that allow for voices to be legitimized and part of a community's decision-making process, they become more likely to take action (articulated by Roth). However, if feelings of disempowerment, disengagement, and disenfranchisement persist and dominate the classroom setting (often fueled by a larger sociocultural condition or a euro-western industrialized culture of for-profit agendas, hyperconsumerism, and rugged individualism), teachers need to simultaneously develop learning experiences that focus on "desocialization" (Shor 1992). Another way of thinking about desocialization is developing a student's deeper consciousness about social structures interwoven in the production of our own thinking, feeling, and acting which occurs within a social and ecological context. Just as we should be aware of teaching in ways that produce extreme or even moderate feelings of "ecophobia," teachers should also approach these ecosociocultural topics in ways that do not exacerbate feelings of internalized domination and/or surplus powerlessness, which is often characterized as a doomsday description. In other words, teachers need to attend to students' feelings of agency or lack thereof, regardless of the places where they live. The strength that place-based experiences offer is that students will be able to interact more directly with some of the relevant issues within their environments and see how their contributions play out in tangible ways.

Ultimately, as scholars, it is crucial that we do not set up binaries between urban/rural, urban/suburban, and suburban/rural settings, with one setting producing more or less feelings of agency or surplus powerlessness, and therefore, abilities to teach with place-based science practices similar to Roth's description. As science teachers, it is important to know and create place-based pedagogy around one's social, cultural, and ecological community. But it is equally important to understand the social community and levels of agency that are present in order to work with students and community members in ways that connect with their beliefs, feelings, and perceptions of empowerment or powerlessness (along with the origins of these worldviews). To fully understand the robust community-based, ecological issues within science education means to understand the intersection of sociocultural and ecological within a community.

Teddie: Both of you bring up the all important role of the teacher in identifying authentic opportunities (and ideologies) that will advance science learning, promoting feelings of empowerment and sense of place, attending to learners' sense of agency, and fostering a deep understanding of community values and cultural factors that regulate localized ways of knowing and acting (political, cultural, economic, aesthetic, religious, historical, to name a few). Increasingly, teachers ought to get the types of authentic training and experience now needed within teacher programs that will enable them to be successful in the roles you both describe. Furthermore, teachers may possess unexamined "baggage" (ideologies) that will prevent them from enacting these roles successfully. Cultural transmission models of university science (and other disciplinary) knowledge and skill do not always allow for critical exploration of deep-seated personal values and the equally important opportunities to deconstruct "pure science" endorsed in universities.

Aikenhead (2006) points out that transformation of science knowledge as everyday knowledge is highly demanding because the world is complex and involves interdisciplinary knowledge, value judgments, and sociocultural elements of know-how. Without this transformational experiential science knowledge, science remains unusable for most people outside of the science classroom. Additionally, science education methods courses seem to exert longer-term influences for how a science teacher teaches when far fewer science teacher educators use lecture-based approaches. One such approach is when science educators use didactic methods to present interactive teaching strategies in their classes. Much more influential than science methods courses are the student–teacher-mentorship relationships that develop, where the cooperating mentor becomes a mediator for helping the students emerge into the teaching profession. When the mentor negates embedded science learning as an "ivory tower fantasy" within a standards-based reality, the opportunity to practice with critical support will be spent on "ivory" or traditional forms of delivery. Regardless of the community in which teachers will work, practical teacher training could explicitly provide opportunities for teachers to develop, practice, and reflect upon knowledge and skills that will help their students apply science to a twenty-first-century world. But this innovation requires a commitment to providing teachers and their eventual students with authentic and multiple opportunities to do this. The place-based situations described by Roth can be interpreted to do this very thing.

Roth describes his transformative experience from constructing "novel learning sources" and experiences for his students, to adding value to the community and concomitantly valuing community resources, to the "explicit use of the inhabited world as a meaningful entity." As a scholar and experienced teacher, Roth accesses theory to inform his practice and enjoys the cognitive demands that come with theoretical and practical change. He also enjoys cultural tradition and skill. He is confident in his content knowledge and pedagogical skill. Many teachers do not possess this confidence and/or motivation to access and initiate tradition *and* change in their teaching (on their own). In addition, school culture and power hierarchies that pervade the K-12 arena do not always support teacher-identity formation, as decision makers and agents of tradition and change.

My personal experience with school-based professional development is that it perpetuates teacher-as-deliverer or "top down" curriculum instead of teacher-as-professional who tries out, inquires, reflects, revises, takes risks, and shares ideas to develop curriculum. This leads to what my colleague Carol calls, "canvas bag mentality," where teachers attend popular practitioner-oriented conferences and other professional development opportunities expecting to be told what to do, or even better, to be given step-by-step activities modeled with "take home stuff" – ready to use out of the box!! As most teachers know, these ready-to-use items rarely get used when they get unpacked. Often this lack of use is because of the misappropriation of thought, reflection, and prior revision to meet the needs of their own individualistic style of teaching and class context. Another related barrier to authentic, sociocultural, or humanistic science learning, are the intellectual and ethical developmental levels of the teacher. My experience in giving a survey to over 600 teachers indicates that the majority of teachers are in late Multiplicity. According to this level, teachers in this position will view knowledge as somewhat certain with gaps to be filled in later. There is an appeal to Authority (with a capital "A"), but if that Authority does not know the correct answer, all opinions become equally valid. In other words, the teacher has the right to interject "the Truth." Teachers in this stage understand the role of evidence to support these truths, but often base them on social norms. If individuals move into the next stage of the scheme, namely, Contextual Relativism, they see knowledge in an entirely different way – open to debate, analysis, evaluation, and contextually embedded. Without support, however, teachers can easily move back into the lower levels of this scheme including Dualism, or that knowledge is certain, and there is no need for evidence – the world is dichotomous (right or wrong, good or bad).

These barriers to community, contextualized teaching, and learning emphasize that not all teachers have the conceptual or professional self-identity to successfully engage their students and the community in the type of meaningful science that Roth describes (again, on their own). Roth cotaught a unit he piloted with local teachers to keep the integrity of the teaching strategies, and he was able to develop a sustainable system for cultural transmission that systematically involved including the initial teachers he worked with, so they could work with subsequent teachers that joined the program – a nice strategy that seems to work for Roth. He reminds us that teachers' experiences in authentic contexts are a necessary foundation from which to draw upon when engaging in building skills in the development and implementation of novel teaching methods.

My own research on cognitive development, from several perspectives, indicates that a more concrete-to-abstract progression of thinking involving new information and the negotiation of that information encourages meaningful development by communities of teachers who are involved in that mode of learning. Recently, I found myself in a large underfunded (soon to be unfunded) project that involved a community environmental youth summit. The Youth Summit involved approximately 100 student delegates and their teachers from local schools who came together to learn more about local environmental issues (twice a year). Experts from the community and university were invited to come in and talk to the students in breakout groups after which students would get together and talk about what they learned. While Summit planners expected the students to "do something" before the next Youth Summit, there was no explicit call for action or discussion about what the students might glean out of the process. As I walked around in the breakout sessions and listened to students during my first Youth Summit, I noticed a didactic transmission of knowledge from “the expert” to the students about what they should follow up and do. A few students questioned these motives. However, at the follow-up planning meeting that was held 3 months later, I found out that the selection of the experts was based more on political clout than on their ability to communicate with students. I asked what the teachers and students were supposed to do as a result of coming to the program and if there were any evaluations or assessments. I was told that the teachers were supposed to help the students work on an environmental project and then share the project with other students at the next Youth Summit. And yet, very few teachers actually did what was expected. My observations of the Youth Summit confirmed it. The next Youth Summit was a repeat of the first. Despite that, the third Youth Summit involved a volunteer student steering committee that met monthly to plan the event with help from the education coordinator of a Louisville Metropolitan Government organization called “Brightside.” The 12 students, ages 12–17, decided to plan an art and environment Youth Summit to be held on Earth Day. They had some great ideas but difficulty articulating what they wanted or needed from the adults. The adult collaborators did not follow through with a number of plans including getting the word out. The Youth Summit was attended by only about 20 students, but they did have a good time making art out of recyclables.

Prior to the subsequent Youth Summit, I was introduced to two programs: the Kentucky Green and Healthy Schools (KGHS) and the national Earth Force CAPS (Community Action and Problem Solving) initiatives. We received funding to use these initiatives in the Youth Summit. Both these programs offered frameworks that the teachers readily understood in practice. I was able to attend and send eight teachers to a 2-day Earth Force training where they experienced the “steps to action” in what I would consider an abstract, generic way. However, because of the opportunity for interaction with the other teachers from around the state, and some encouragement from the Earth Force staff, each “step” was critiqued, contextualized, and revised by teachers. As a science educator who understands the importance of discussing what a model is and its limitations, I appreciated this component of the training. Both the CAPS and KGHS programs are student-centered and designed to encourage community-based problem solving and the development of decision-making skills. The teachers felt it offered an opportunity to reevaluate their thinking about implementing student-centered, community-action projects. One teacher noted that she was particularly informed by “step six,” which involves celebrating the learning that took place during the project regardless of the actual progress made toward the original goal. She said that she had allowed herself to feel like a failure when the problem was not solved or the project did not work out in the way she intended. This feeling of failure transferred to her students in how they saw the project and their ability to act. She later stated that, once she started to focus on and celebrate the learning that took place, the students were able to take pride that they contributed to a knowledge base. She decided that it was important to document their work in a way that students would learn from previous groups and choose to work on this project the following year with the ground work already established for them. Each time, a new avenue of the project would become investigated.

While I know some teachers or teacher educators may cringe at the use of a model or framework, the reality is that teachers and students do not always come to the table equipped to ask questions that will take them to "next steps," or actions. Without appropriate scaffolding, as suggested by Peter above, students and their teachers could potentially lose the interest that is needed to propel important environmental programs. Frameworks create a conversation. They can be changed with time. One change for the Youth Summit was acknowledging the importance of a community inventory. The KGHS inventories are large sets of questions constructed by experts on nine different topics that students download from the Internet and answer with their teachers. Some inventories are difficult and most require talking with adults at the school or district levels. If students begin to lose interest in completing the inventory, I go to the school and support them in making a decision to complete the inventory, and work with them to do as much as they want to do, before going on to the next step, or go to a completely different questionnaire. I find that once I do this, students understand that they can make appropriate decisions that matter to them and still continue with our program. The CAPS program asks teachers to take their students on a community walk (generally around their school building), where students are asked to make observations and inferences, and ask questions about their student-defined community. I have worked with many teachers who needed support for how to do this community walk by pointing out what they could be looking at and suggesting ways for them to involve community professionals who can lead the students. This type of support provides for more informed inventories from which other student groups can continue to work with the project. Through our involvement from the institute, we are able to support teachers in their process of involving students in the ownership of selecting good experts and how these professionals can be contacted. These examples serve to elaborate points made in Roth's article about the relevance of experts.

Since incorporating the KGHS and CAPS programs, we have had to limit the number of schools that participate in the Environmental Youth Summit. The breakout sessions emphasize the use of tools and skills necessary to collect, analyze, and interpret both quantitative and qualitative data in six different topics. Last semester, these topics included greenspaces, transportation, energy consumption, solid waste, storm-water runoff, and carbon sequestration. The breakout sessions end with an explicit discussion of how what the students learned can be implemented into their schools in different ways. We have added a "showcase of schools" component, where students share what they are working on with other students, community members, and administrators. We also have started a new mentor program where community experts are trained to support the ongoing projects when requested by students in between Youth Summits.

Students and their teachers are now working beyond the frameworks offered and are beginning to develop their own approaches to community-embedded science learning. A student in one of our high schools sent out an e-mail to other schools asking if they would like to work together on a project that involved public transportation. This type of collaboration was not initially envisioned. In another case, students at a middle school have decided to grow native plant seedlings in their greenhouse for an outdoor classroom at another high school and also a community space. Students at a downtown middle school have started a garden and donate items to a farmers' market in the same area. This part of Louisville is considered a food desert. While this particular project has continued because the teacher remains invested, similar to Roth, he uses the cultural transmission model, where previous students induct new students into the program every year. Students in a more rural location, decided to landscape an area around a gazebo that sits in front of the high school with native plants as a way to increase wildlife habitat locally. In addition to learning about native plants, local soils, climate, and local wildlife habitat preferences, these students are finding that the gazebo has historical significance to the community (because of conversations about what the students are doing around it). The students have asked for donations to repair the gazebo. As town people contributed in supplies and labor, they offered additional stories about the proposals, pranks, picnics, and public gatherings that have taken place around this beloved town monument. The project continues to stir up community spirits similar to those of Roth's students and the students in this region and supporters are in the planning stages of restoring the park.

Peter: These kind of blended experiences provide greater agency for students. These experiences connect with the areas where they live. It was Jacque Cousteau who said that people take care of what they love, and it seems to me that students who are involved in environmental learning experiences develop a greater sense of ownership as they dig into community projects. Linking these kinds of projects to the science classroom is yet one more way to bring the richness of meaningful science learning into the lives of students.

Potential Limits and/or Hidden Curricula

Kurt: The connections between theory and practice are very important for developing one's teaching practices and creating learning experiences that are geared toward the longer-term. Much like the common trends and mindset that exist in doing education, we get lost in models, approaches, and overemphasizing "experience," as a way to frame thinking (Britzman 1991) if teachers are not attending to the needs of their local communities and do not have deep understandings of the conceptual frameworks (theories and pedagogies) that create these models. Developing teaching practices come from the model that teachers develop for their own community while considering other models and pedagogies that exist in relation. In other words, we should be aware of any framework or model that takes a technocratic approach or emphasizes a "methods fetish" (Bartolomé 2003). Teaching practices need to connect deeply with students and the communities in which they are practiced. Roth's examples show how teachers used communities as sources of knowledge and investigation for students. Roth neglects to offer which frameworks (or pedagogies) govern both the teachers' and the students' decision-making processes. Were these teachers and students operating in an environmental education framework (framed by?), ecojustice theory, ecofeminist guidance, some kind of hybridized framework, or something else? In my own teaching at Central Connecticut, my students and I attend to the potential limits and/or hidden curricula that are always present in different teaching practices as well as the pedagogies in which they are rooted.

For example, ecofeminist theorists have discussed relationships and mindsets of humans being separate from nature and human domination over nature rooted in descriptions like being environmental "stewards" or using a "problem-based learning" model where nature is unintentionally viewed as a problem that humans need to solve (Spencer 2005). This "separation" might be carried forward through discourse present in an environmental education framework if not attended to more explicitly. Teachers need to be supported in their teacher education programs, as well as in their in-service professional developments, to know the technical practices, but also discourse and theory that undergird these things. This support helps them and their students identify and create questions for their own investigations that do not perpetuate hegemonic thinking or actions. To be clear, I bring this idea up only as a general point to be included in our discussions about how to support teachers and students moving toward some deeper levels of understanding how to live for the longer-term.

There is no doubt that teaching toward the longer-term is both possible and challenging. It challenges us to deeply question industrial culture that is well-established and heavily invested in the USA and other nations. There are deeply rooted issues of morality, ethics, and metaphorical mindsets that make up the "water" discussed in Roth's chapter, which may be initially difficult for the "fish" to see. We are fish too! Roth shows us that students are very successful in their explorations and community participations and that these things help to connect students with their environment. This type of teaching provides much hope and guidance in terms of how we might continue to develop our thinking, teaching, and relationships with nature and the larger community.

Teddie: Your point is well taken and while the frameworks chosen for the Environmental Youth Summit are meant only as an introduction to community-based action to empower students and their teachers, they offer a step-by-step approach that could limit creativity (and thinking in relation to underlying ideologies). Furthermore, frameworks do imply an end-point arc once the action project has taken place or the problem is dissolved. Because of limited time and resources for working on community projects, I chose these frames/models to begin a process in the hopes that teachers and students will continue to question and replace their perceived rules for engagement that these models might promote. In some cases, it works. I have been pleased with the longer-term school and community partnerships that I already mentioned. But unfortunately, these things are short-lived and are the exception – not the rule. Most teachers need the "personal touches" that our program provides to keep their projects going, which is included as part of the structure of the framework. I have more success when using models in my courses when there is time to also consider theory and encourage critical reflection. Without these things, the opportunity to learn through the community is limited. I agree with you, Kurt, in terms of why it is important to elaborate which theoretical frames are used to foster the kind of longer-term learning that Roth described.

I use a powerful experience to emphasize this point: an Environmental Justice tour of Louisville. Most teachers are unaware of the local environmental history and current issues and how it disproportionately affects some more than others. By actually taking them to physical locations instead of just reading about them, teachers are confronted by the realities of peoples' situations and the way it may impact their lives (some of whom are my teachers' students), as well as others further down the Ohio River. The Louisville Environmental Justice tour was developed by my friend and colleague Russ Barnett who is also the Director of the Kentucky Institute for the Environment and Sustainable Development. Russ took me on the tour when I first came to Louisville to help me better understand this urban environment. It has become a mainstay in many of the classes that I teach. A main portion of the tour focuses on an area called Rubbertown, named for the prevalence of rubber-making plants that were built here in the 1940s. It is well-known as the largest source of industrial emissions releasing over three million pounds of air toxins annually, according to air toxic monitoring completed by a partnership between concerned citizens, the University of Louisville, the Environmental Protection Agency, Rubbertown Industries, and so forth. The residents (zip code 40211 and 40202) are primarily African American, single, and the median income is significantly lower than US averages – according to the 2000 US census report. The residential communities in this area were developed in response to the increasing need for housing associated with rubber jobs during World War II. The west end is not seen as a desirable place to live. The monitoring program found cancer risks from long-term exposure near Rubbertown in 2005. The findings were 4–60 times higher than a monitoring station on the east end. As a result of foul odors and visual pollution, the community and industry established the West Jefferson County Community Task Force (www.wjcctf.org) to identify environmental issues in the community and "to empower residents to make informed decisions on environmental justice issues" (www.wjcctf.org/about). This engagement has led to increased community awareness and agency, which I have seen from the active community members as they work to improve the area. At the same time, I cannot help but to question the "hidden agendas" represented in the websites above. The task force make up is not reflective of the community at large. Is the sense of community agency one where the community members gain meaningful involvement to have a say?

As part of the E-Justice tour, other areas visited are Smoketown, where a large population of African Americans settled in the 1860s and 1870s because they believed they would be freed. There is the Bourbon Stockyard and Butchtown, where unused animal parts from meat processing eventually make their way into

Beargrass Creek, which carries them to the Ohio River. There are stops on Beargrass Creek, which represent a sampling of almost every water-quality problem that can be imagined. The Ohio River and the McAlpine Lock and Dam are where students hear about why Louisville's location is a poor choice because of drainage and flooding problems, and because Louisville's excessive energy demands cheap coal that can be easily transported by barges on the river. There is the Trolley Barn brownfield site, representing a success story, where city cleanup resulted in the redevelopment of a Russell neighborhood and African American Heritage Center. Finally, there is Distler's Warehouse, where illegal storage and hazardous waste disposal took place unknown to the owner. Even those students who have lived in Louisville their entire lives are surprised by what they see and hear. They begin to have a better sense of the complexity of Louisville's environmental justice issues and the ideologies implicitly endorsed and embedded within many of these issues. For example, consider the illegal storage and disposal of hazardous wastes at Distler's Warehouse and the resultant reduction in property value and health issues in an already poor neighborhood. A man convicted had been under investigation for illegal dumping at two other (now Superfund) sites when he decided to store the hazardous wastes at the warehouse. He received a 2-year jail sentence and a $50,000 fine. The owner could not rent or sell the warehouse because of the contamination, and he stopped paying property taxes. The responsibility of the cleanup was passed on to the state and federal governments, where it does not rank as a high priority and the state the annual budget for all cleanups is less than what it would cost. Contamination signs on the property are seen by students as they walk to a middle school located across the street. Students have mentioned in their portfolios that not only were they naïve in thinking about what justice issues are comprised of and the degree to which they occur in their city, but they were also surprised by a lack of simple solutions readily available.

Building on the EJ-tour, ecojustice theory concepts of worldview, globalization, hyperconsumerism, the cultural and environmental commons, and sustainability are much better understood and developed with students. Understandably, we connect the information garnered by walking the banks of the Ohio River and McAlpine Lock and Dam when we discuss local consumption of energy and how excess energy needs also have endorsed mountain top removal. Kentucky's electrical energy costs are the fourth lowest in the USA, and 92.2% of Kentucky's electricity is generated from coal. Further, surface (mountain top removal) mines accounted for 39% of Kentucky's production of coal in 2006 (Expanded Online Kentucky Coal Facts 2008). As a result of lower electricity rates, Kentucky's energy consumption rate per capita is among the highest in the nation (Iyer et al. 2007). Corporate industry is attracted to Louisville and other parts of Kentucky because of these advantages, but Louisville leads the state in energy demands. The increasing need for energy creates more demand for the coal locked in the mountains. Most students in my environmental education courses have developed environmental sensitivity and awareness but are naïve in discussing solutions. They blame the coal company and the coal miners, but seldom think about how "they are" the people and political structure of Louisville or how they contribute to the problem of surface coal mining and the loss of biodiversity, water quality, and cultural traditions.

Analyzing Deeply Embedded Ideologies (Situated in Practice)

Peter: Connections to the natural world through thinking, teaching, and relationships with nature and community in ways that involve students have also been developed and promoted through environmental curricula such as Project Wild or Project Learning Tree. While well-intentioned, these prepackaged curricular materials focus on the management of natural resources and are implemented through teacher training workshops. While the original intent of these kinds of activity-based experiences might contribute to developing a sense of connections with the earth, from an ecofeminist or ecosociocultural worldview, they have been seen by some educators as a demonstration of man's separation from nature (dominance) because of the reinforcement of "humans managing the land." These kinds of environmental curricular resources seem to be a poor stepchild to the greater expectations of traditional science content standards and therefore do not hold the same ranking of importance in school classrooms, even while they may develop important aesthetic and affective cognitive affiliations in science. When these activities are used in classrooms, with a focus on our "connectedness with nature," rather than our "separation from nature," many schools offer them as "electives" in environmental science, which appeals to a handful of interested students. When workshops are provided for Project Wild and other similar Project et al. programs, they usually occur over a period of only a few short days. This short-term training provides teachers with a snapshot of what might be engaging and mind-provoking, or how they might challenge ideologies embedded within the curricula, as well as activities for students to learn about the natural world, including ways in which teachers and students can challenge popular modes of thought.

One way in which science teachers become more aware of the interconnectedness of the physical and living environment is to incorporate elements of these Wild et al. projects with environmental and science concepts into their courses while simultaneously providing opportunities for students to take responsibility for their action. Doing so enables stronger links between the interconnectedness we all have to nature while concomitantly eliciting a context for students to think about what they pay attention to. Not only do these kinds of activities reinforce environmental education and ecojustice then, but they engage a more diverse and growing population of learners in US schools.

Before moving on, I want to address a significant issue that arises out of Teddie's discussion of mountain top removal. It is valuable to further explore a few vulnerabilities.

"But the Mountain Does Nothing for Me!" A Paradox of Misunderstanding and a Rationale to Enrich Vulnerable Environmental Education.

It can be argued that environmental education has always been in a precarious position within the greater scheme of education. From the early 1970s with the advent of Earth Day and environmental nightmares that occurred over subsequent decades, environmental education has been around, but always it seems, at the periphery. People who seemingly have no direct connection with a region of the Earth disregard the importance of it, because they do not see it or understand any connections of their relationship with nature. Now consider again, mountain top removal for coal mining. In recent years, this practice has gained national exposure because of the extreme destruction of the practice. In short, small mountain tops are literally removed down to the seam of coal and the "overburden rock," which covers the coal, is pushed into an adjoining valley. One could argue that this practice does not resonate with people, because they feel it does not impact them directly. Simply put, people say things like, "what does the mountain do for me?" I need the coal to make electricity, or something similar. These kinds of mindsets provide an excellent rationale for the strengthening of environmental and science education at every level, including the teacher education level. It is well-known that many jobs are linked to mining. Educators prepare students to enter these jobs and many other jobs which have destructive impacts on the Earth, without thinking more fully about the ramifications and responsibility to the story. This story should be told through environmental and other forms of education.

While a mountain may indeed do nothing for any one person, its destruction causes unintended consequences over the longer-term. For Clarion County in Pennsylvania, decades of strip mining have left thousands of miles of streams devoid of aquatic life and a resident population of students who will grow up seeing (literally) dead streams near their homes. This neglect resulted from over 100 years of coal mining with very little thought about the cultural assumptions being perpetuated in schools or the consequences after coal was extracted for energy consumption. A healthy 100 or 200 m soil and rock profile, taking millions of years to develop, is violently altered in just a few months to the point where chemical reactions in the iron-rich rock cause a process known as acid mine drainage (AMD). No one ever knows if or when it occurs, but for the most part it continues to destroy streams, some with a pH of <3. This pH is far too acidic to support most kinds of native animal life, with a few exceptions. So, the initial impact is habitat destruction, and the longer-term maintenance (government management) of AMD involves the use of caustic chemicals such as sodium hydroxide to raise stream pH levels to support animal and plant life.

Despite that, the contradiction between those who are much concerned with issues of mining and drilling and those who are not, mining practices are currently continuing. There seems to be enough environmental awareness at the national level that most people would muster behind the protection of some un(fore)seen places while other un(fore)seen places seem to be on the table for destruction (because of the lack of thought associated with neglected or future places not mentioned in the textbook or classroom). Positive intervention is occurring with the debate of drilling in the Arctic National Wildlife Refuge or "ANWR" on the north slope of Alaska. While almost no one will ever travel to this distant location, and this place does not abstractly "do anything for them directly," there is enough cry from advocates of this place to force US and Alaskan legislators to debate and converse about the issue. This debate demonstrates the positive implications of environmental education when linked with what children learn in schools and about distant places over the last 40 plus years, while also considering the thinking Kurt notes.

When environmental education comes into play, we wonder about its impact on meaningful learning. Fourth and fifth graders attending Earth Camp in Kentucky last summer were asked: "Where does your energy come from?" They had no idea. Not a single student was able to articulate that the energy near their homes comes from the coal mined within a very short distance of where they live. These students were shown Google maps of the region and they were shocked to learn that the energy used when they watch television or use a computer, comes from the coal obtained and the destruction of mountains near their city. How is this information not known to them at all, let alone in a meaningful way (Phillipson Mower, 2009, personal communication)?

Considering the information that youth can access is important for school. It is well-known that The Lorax (Dr. Seuss 1971) was banned in schools in the Pacific Northwest because children of loggers came home saying: "Why does daddy hate the Earth?" Of course, the parents of these children do not hate the Earth, but without an understanding of the relationships between people and the Earth conveyed with resources such as The Lorax, simplistic views emerge and books are banned. Could it simply be that where big business establishes a foothold, nearby communities are kept in the dark about issues that may directly or indirectly have an economic impact on them?

It may always be an uphill battle to maintain a healthy environment education curriculum when healthy economies are concurrently at stake. However, students need scientific and environmental knowledge, understandings, and the skill sets to make informed voting decisions and ask a potential employer about associated risks with a job. People who only want to earn a living and raise a family may in fact do so at their own peril without even realizing it. This idea is what occurs when students do not think about their assumptions and how their assumptions frame their behaviors toward the Earth. Air pollution deaths in Donora, Pennsylvania, are one particular example. For decades, people worked a hard life in the steel mills of the Pittsburgh area. They went to work each day and earned a very difficult living. Over time, air pollution increased to such a degree that it caused the first known deaths in the USA due to the quality of air. Donora, Pennsylvania saw a temperature inversion settle over the smog-filled valley 1 week in October 1948. During this time, day became night, and people did not know the friends they passed on the street. Twenty people died quickly of asphyxiation, and 30 more died within days. More than half of the 14,000 residents became ill as a consequence of the regional air pollution. This event started a chain of clean air reactions and advocacy that eventually led to the first clean air legislation in the 1950s and further regulations that put a "checks and balances" on local Pittsburgh businesses. The bottom line to my message here is that, while there has been a vast improvement of corporate stewardship and responsibility for the environment other corporations place much greater emphasis on their short-term interests (and investors' interests) rather than longer-term implications for local people or the long-term survival of their businesses. While many businesses in Pittsburgh are changing (e.g., car companies), corporate greed still exists and that fact alone is an ample rationale for strengthening environmental education.

Educating Generation R (Responsibility)

> Well, I have my rights, sir, and I'm telling you I intend to go on doing just what I do! And, for your information, you Lorax, I'm figgering on biggering and biggering and BIGGERING and BIGGERING, turning MORE Truffula Trees into Thneeds, which everyone, EVERYONE, EVERYONE needs! (Dr. Seuss 1971)

Many students learn to take for granted that "green is good" through environmental education and working at various projects in and around their community. Look at how vulnerable students become when they do not also recognize how corporate entities are manipulating them through green deception and even outright fraud. The media sells ideas to students who are eager to buy them, which is where environmental education has become very vulnerable and requires more in-depth considerations of the ideologies promoted through the green. Ideas, then, are endorsed and carried forward to the next generation, leaving many students with false conceptions of the way the natural world works. A favorite example is the popular SUV commercial where a large SUV is being driven very fast through mud and water, and up abandoned roads to a final "peaceful" often, green destination. Where is the balance to this powerful commercial? Who will mediate the messages that students receive? Millions by the day if they watch television, listen to the radio, or read a magazine. Where is the "split screen" that shows the cultural and environmental erosion that occurs from this one-sided view? Who owns the land? How much fuel was used to rip and tear up to this green place? How many SUVs is one too many for this stretch of road? The list of environmental questions that could be included as part of the environmental and science education curriculum and that mysteriously do not appear on these kinds of marketing schemes is endless. This green vulnerability shows a massive disconnect between the way the economy is promoted within the curricula of schools, media, and so forth, and the way nature works and relations to it.

Blumstein and Saylan (2007) argue that we should have *personal responsibility* as the hallmark for the next generation of environmental education (maybe changing the term Generation E to Generation R). When linked with consumerism and the wants of people, a focus on the true "costs" of things, and the impacts that people have on the environment is based upon responsible (environmental) choices which ought to become the most important focus for developing environmental education. Having students create projects or work on aspects of service whereby they are active, participating members of their community might go a long way in helping them realize the impact they each have on the environment. But it is not enough.

They must also be able to think about some future bombardments of commercials and "green" trends. They will become the designers of these things. Other scholars argue for the explicit connection to character development for students and relating character to green socioscientific issues that have a direct impact on their lives (Zeidler et al. 2005). In recent years, studies by researchers such as Richard Layard of the London School of Economics demonstrate that happiness does not coincide with increased wealth. And to make matters worse, the wealthier people become, the more stress they will encounter and the more competition will enter their lives. Finding ways to educate people so that they will enjoy the more tangible (and simple) things that the Earth already provides in the wind, soil, forest, and how to limit their consumption of these agricultural and natural resources equates with happier lives for many people. Why not include these ideas in environmental education? When they are included, they provide a greater rationale to teach about the environment.

What sorts of mediation could be associated with environmental activities and goods so that future costs are addressed at the onset of a "purchase" (meaning the actual purchase of goods, but also the engagement of youth in buying into a curriculum). Who takes care of car tires, appliances, and other products, once they are broken or discarded? Should these things come with a government-mandated warning label similar to cigarettes and cigars until corporations find responsible ways to deal with how they are treated once people dispose of them? Why should disposal always be the responsibility of consumers?

On the other hand, in the USA, people purchase items without having to be responsible for knowing a "cradle to grave mentality." Cradle-to-grave questions might well be tackled by students at various levels as they are involved in projects that directly relate to their impact on the local community or environment. What sort of activism would students engage in by informing consumers of the "grave?" How would the unlocked potential of creativity and innovation of youth be redirected in ways that demonstrate that Generation R understands that buying more stuff has a direct link to cutting down rainforests? When we ask for more stuff rather than being happy with what we have or could share, do we inadvertently ask businesses to continue to cut down more acres of rainforest to grow more soy beans and cattle to supply their demands for consumption? Having environmental and science education questions that explicitly guide thinking about the relationships and associated exercises corresponding with them do much to foster Generation R! Because we as a species are continuing to use greater amounts of resources and energy from the Earth, it seems prudent to continue to increase our responsible efforts toward strengthening environmental education so that this current Generation E of human beings does not become one of the most vilified in human history.

Teddie: Actually, I think that the last generation (MTV, X, and Y) and decision makers during the past 10 years will be more to blame than this current Generation R. I have strong hopes for environmental education and R! We are making much more headway in encouraging critical thinking and introspection than 5 years ago at the height of the standardized testing buy-in. Marketing companies continue to find new ways to get consumer attention, but younger students seem to be pretty savvy about this. And, social marketing has found its voice. Fallacies of logic still pervade thinking, but the questions are being asked. I find that it is much easier to discuss population issues, the foundation of most environmental issues, than in the past. The renewed emphasis on all things local (but also not forgetting about global relationships), as we are discussing here, is providing many people with the new found social ties and cultural traditions necessary.

It is no secret that I had difficulty adjusting to urban life when I came to Kentucky. Even here in Louisville, I find individuals who are connected to the Earth and social relationships that remind me of my rural upbringings. Claude Stephens, founder of Louisville Local 1339 of The Professional Porch Sitters Union, made me feel like I was at home again. Claude received national attention when he advocated for sitting on the porch as a pastime, which he says, is an important part of being part of your community. He says you should spend quality time with your neighbors, regardless of if they have anything to say or not. I have also developed an urban farm girl identity, which has allowed me to bridge cultures and offer help to those neighbors who want to build backyard gardens – complete with training in composting and bartering vegetables.

I think the most important thing we can provide for our future teachers is the ability to develop interest, curiosity, and a respect for the community they may live and teach in. I share very little background with the majority of people in academia and most of the middle-class students in my programs. However, I have the ability to adjust (not necessarily adapt) to new ideas and ways of thinking. These differences are wonderful opportunities to explore local society and tradition culture since the unfamiliar stands out.

"Technology Has Become Our Ecology"

Kurt: The connections between our understandings of an issue, especially in a critical manner, whereby we expose injustices both social and ecological, as well as help students understand and explore "thick descriptions," make visible the relationships and tensions that exist in any given action, situation, or condition (Bowers 2006). These situations are relationships that exist wherever and whenever social norms, cultural values, traditions, and practices not only compromise sociocultural, socioecological, and ecological communities, but also the tensions that may exist if those norms, values, and practices were to just cease to exist. An educational system that expects its students to understand not only the injustices, but also the interwoven and very complex relationships that make this a potentially "messy" world, is an educational system that can truly be liberating. This social, cultural, and ecological net needs to be understood in great detail through authentic investigation. Thomas Jefferson spoke quite frequently about his vision of education being the backbone of a democratic society. In this current society, it is not enough to teach about history through the eyes of the colonizers, science through the lenses of only western paradigms, and literature through Eurocentric canon. An educational system that has the expectation and goal of creating a stronger democratic and diverse populace must include an environmental and science education that takes a highly nuanced, contextualized, and intersectional approach where the interconnections, relationships, and tensions between the value systems of science, western industrial culture, and local/global ecologies need to be looked at together in concert with one another. When I teach my preservice teachers about ecojustice pedagogy, I often include a phrase that I have developed in order to have students consider, explore, and interrogate: “Technology has become our ecology.” This statement is often one of disequilibrium for preservice teachers and encourages them to do a deconstructive analysis about the intersections of social, cultural, and ecological practices and mindsets in local and global contexts. Ultimately, they need to generate questions for their students to investigate around these intersectional relations in order to more fully understand the pressures and tensions around environmental conditions, as well as to be able to authentically participate in their communities.

Why is having this complex level of understanding something that I consider to be “liberating” in an educational context and especially in environmental education? In many ways, this is the difference between a short-lived “feel good” experience and a more potentially tumultuous and arduous experience that has greater potential for a longer-term effect. In the process of uncovering the null curriculum, or the messages that are typically silenced, ignored, or marginalized, there can be some overwhelming feelings of sadness and despair. Thoughts and feelings of surplus powerlessness (Lerner 1986) might be present in the initial stages of uncovering injustices and practices and mindsets that produce them. However, Roth shows us how students who actively engage in their community with very challenging environmental topics thrive and deepen their understandings, as well as, feel mobilized and empowered to do this type of work in their communities. There is no doubt that the political realms of these students’ communities are connected to the ecological when they present their findings in a public forum to local government officials. This political experience shows students that the social, cultural, and ecological are all connected and that we should not shy away from potentially “hot button” topics. It also is an important opportunity to discuss how to engage in a dialogue that has intentions of building community rather than creating polarization and divisiveness, something that is unfortunately all too common in the current political landscape in the USA. When Roth describes students authentically investigating current ecological conditions and engaging in dialogue in their communities, this demonstrates a “liberatory education,” a Freirian notion of education connecting with the empowerment of marginalized groups, whereby students contribute their voices toward the raising of awareness and advocating for more balanced approaches and sustainable relationships. In doing so, students are also interacting with the tensions that cannot be ignored, whether they are economic or social pressures. This ambiguity caused by the tensions at the intersections of social, cultural, and ecological conditions is the larger reality, and to be able to operate democratically, one must be fairly comfortable and certainly able to maneuver in the ambiguity of those tensions.

As we consider and explore the strengths and weaknesses that different contexts like urban, suburban, and rural might involve for teachers and teacher educators, we need to keep a constant eye on the horizon line of a place-based (science) education. That horizon line may well be where "thick description" and community-based involvement occur. Having those horizons as the targets may move education as a whole in ways that bring about higher rates of literacy in many different content areas including science and environmental education because of their connectedness to a "real world." As we continue in our efforts to work toward sustainability both ecologically and socially, we will need to focus our attentions on understanding relationships and tensions more clearly and how important it is to get out of the classroom and in natural and social communities.

References

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. New York: Teachers College Press.

Bartolomé, L. I. (2003). Beyond the methods fetish: Toward a humanizing pedagogy. In A. Darder, M. P. Baltodano, & R. D. Torres (Eds.), *The critical pedagogy reader* (pp. 408–429). New York: RoutledgeFalmer.

Blumstein, D. T., & Saylan, C. (2007). The failure of environmental education (and how we can fix it). *PLoS Biol, 5*(5), e120. doi:10.1371/journal.pbio.0050120.

Bowers, C. A. (2006). *Revitalizing the commons: Cultural and educational sites of resistance and affirmation*. New York: Lexington Books.

Britzman, D. P. (1991). *Practice makes practice*. Albany: State University of New York Press.

Dr. Seuss. (1971). *The Lorax*. New York: Random House.

Expanded Online Kentucky Coal Facts. (2008). Retrieved December 29, 2009, from http://www.coaleducation.org/Ky_Coal_Facts/default.htm

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *Journal of Environmental Education, 21*(3), 8–21.

Irwin, J. W. (1996). *Empowering ourselves and transforming schools: Educators making a difference*. Albany: State University New York Press.

Iyer, S., Kinne, S., & Douglass, D. (2007). An overview of Kentucky's energy consumption and energy efficiency potential. Retrieved December 29, 2009, from https://louisville.edu/kppc/files/kppc/KYE2PotentialStudyFinalReport82207_508.pdf

Lawson, A. E. (2001). Using the learning cycle to teach biology concepts and reasoning patterns. *Journal of Biological Education, 35*, 165.

Lerner, M. (1986). *Surplus powerlessness*. Oakland: The Institute for Labor & Mental Health.

National Research Council (1996). National Science Education Standards. Washington DC: National Academy Press.

Shor, I. (1992). *Empowering education: Critical teaching for social change*. Chicago: University of Chicago Press.

Spencer, M. E. (2005). *Exploring elementary science teaching and learning through an eco-feminist perspective: Narratives of embodiment of science.* Unpublished Dissertation, University of Alabama.

Yager, R. E., & Tamir, P. (1993). STS approach: Reasons, intentions, accomplishments, and outcomes. *Science Education, 77*, 637–658.

Zeidler, D. L., Sadler, T., Simmons, M., & Howes, E. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education, 89*, 357–377.

Chapter 8
Moral–Ethical Character and Science Education: EcoJustice Ethics Through Socioscientific Issues (SSI)

Michael P. Mueller and Dana L. Zeidler

Socioscientific issues (SSI) provide situations where science teachers and students analyze complex issues associated with ethical, political, and social dilemmas, such as whether animals should be kept in zoos or whether plants should be genetically modified. While engaging in socioscientific issues, students become informed about scientific conditions and develop epistemological styles for dealing with scientific research and the consequences thereof. During a time of increasing awareness around cultural diversity, biodiversity, and ecological degradations, epistemic development is paramount for helping students evaluate how they frame their relationships with others including nonhuman species and physical environments. In this regard, social justice movements have been too limited and exclusive, with a higher priority for humankind. Social justice, as currently conceptualized in the science education literature, is seldom extended to nonhuman animals, plants, and the land. Social justice is often associated with disparities between the haves and have-nots, which is historically contrived with middle-class values, norms, and conventions. It is inherently limited to what is considered right for humans without considering how decisions convened around social justice will impact nonhumans.

When scholars say that life is sacred they rarely bestow that principle beyond the human condition. Otherwise, social justice would apply to life in all its variant forms. Killing a rat in the name of science would be just as wrong as murdering a human being. This is where ecojustice is a more encompassing paradigm which expands and enlarges social justice to consider the intertwined relationships among humans, nonhumans, and the Earth. The aim is for educational reformers, school administrators, teachers, children, and so forth, to better protect the local community and environments from possible global community threats, by framing conversations around the needs of diverse cultures, biodiversity, and ecosystems.

The first premise of our chapter is that ecojustice can offer a diversity of perspectives needed by stakeholders for local policy and school reform.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_8,

Withstanding social justice scholars who emphasize more than human-centric concerns, a review of the literature in science education will often reveal a concern for nature while the implications of that concern remains limited to humans. By contrast, we suggest that social justice is better served and characterized by socio-scientific movements (Zeidler and Sadler 2008) when the welfare of ecosystems becomes inseparable from communities. Ecojustice, under our view, is an enlarged conceptualization of how this idea is cultivated through SSI.

The second premise of this chapter rests on the idea that socioscientific issues can provide a contextualized learning environment for understanding the complexity of living and nonliving interrelationships, both in the classroom and in natural settings. Ironically, many of the teaching methods employed within the SSI framework are not separate from what occurs within professional science, yet science education tends to lag behind the times and schooling is slow to change. With the emerging SSI movement, however, students debate, discuss, argue, and reflect on the pros, cons, and the many shades of grey and green on environmental issues such as the impacts of local food movements or renewable fuels. Unfortunately, many of these issues are taken for granted by society as inherently good or bad, when these issues almost always require a more nuanced analysis. Similar to scientists working within the professional sector, youth are not limited to scientific evidence when constructing solutions to ethical, political, and social dilemmas. They discuss previous knowledge and experiences, beliefs and values, and philosophical ideals, and wrestle with their actual decisions.

Our third point is that the literature shows that socioscientific issues cultivate moral–ethical reasoning and the development of character, which should be part of school sciences (Fowler et al. 2009). A large part of SSI pedagogy is responsible for guiding students through epistemic and ontological or character development. This pedagogy fosters what is termed *socioscientific reasoning* (Sadler et al. 2007). Socioscientific reasoning entails the recognition of complexity inherent in SSI, the consideration of issues from pluralistic perspectives, the recognition of ongoing inquiry relative to SSI, and the demonstration of a healthy degree of skepticism when confronted with evidence and data. This type of reasoning runs the gamut of rationalistic, intuitive, and emotive thought and evokes imaginative thinking to navigate through the landscape of ill-structured problems (Sadler and Zeidler 2005). Socioscientific reasoning specifically involves wrestling with morals and ethics, and personal views, that is, fundamental beliefs and values (Fowler, Sodler and Zeidler 2009). Moral–ethical reasoning of this nature has not always been recognized as part of how students learn in science education. But this oversight does not negate the fact that students' shared values are partly shaped by the social norms of people who lived during a particular time, inculcated as metaphors, encoded and reproduced intergenerationally.

As a context for deeper consideration and analysis, this chapter will elaborate on significant moral dilemmas facing schools today, and discuss how teachers should be prepared to deal with the topic of genetically modified species. With increasing genetically modified organisms (GMOs) such as Yorktown Technologies' patented GloFish™ making their way into classroom laboratories, socioscientific issues and

Table 1 Presuppositions of ecojustice ethics through socioscientific issues

Ecojustice Ethics through Socioscientific Issues and Reasoning (i.e., Functional Scientific Literacy)
• SSI advances science education beyond the limits of social justice
• Socioscientific inquiry is better aligned with the professional sector
• Science rarely exists apart from ethical, political, and social judgments

reasoning can better serve as an effective strategy for analyzing the moral and scientific concepts embedded within this issue, developing a sense of character, and considering obligations to life proper and the physical world we inhabit. We will describe this idea hereafter as "functional scientific literacy" (Zeidler et al. 2005). Two assumptions follow: Functional scientific literacy in the pedagogical context of science education includes moral–ethical inquiry as a part of the larger process of becoming informed and participating more fully in community decisions, and school science is a microcosm of the larger worldly domain (Table 1).

GloFish

One fish, two fish, red fish, blue fish; black fish, blue fish, old fish, new fish (Dr. Seuss 1960).

Science teachers have used aquarium fish for decades in the classroom to engage students in lab studies of fish behavior and to cultivate scientific understandings. A popular fish for scientific studies is the zebrafish (*Danio rerio*) or zebra danio because this fish is hardy in aquaria habitats and fairly inexpensive. This fish is also important for and used extensively in scientific research. The zebrafish is a tropical species native to South Asia, the streams of the southeastern Himalayan region, native to streams, canals, ditches, ponds, and lentic waterways in India, Pakistan, Bangladesh, Nepal, and Myanmar. This fish has been introduced to Japan, Canada, Australia and the USA. The zebrafish is also noted in countries where it is not native, perhaps due to people releasing them from aquaria. In the USA, the zebrafish is cultivated in commercial fish farming operations in Florida. More recently, scientists at the National University of Singapore, Singapore, developed a line of GMO or transgenic zebrafish as an ornamental pet (Gong et al. 2003). Originally the "GloFish" was developed to glow red in the presence of certain environmental pollutants, therefore serving as a biological sensor that is rapid, mobile, highly visible, biodegradable, and regenerative. The Starfire Red® zebrafish expresses a red fluorescent protein from a sea anemone. This glow-red zebra danio was immediately called one of the "Coolest Inventions of 2003" by *Time Magazine*. By December 11, 2003, *Yorktown Technologies, L.P.* had announced that it would market GloFish in the USA at the beginning of 2004 without oversight and regulation from the US Food and Drug Administration (FDA) or any other federal agency.

The FDA provided the following online statement on December 9, 2003:

> Because tropical aquarium fish are not used for food purposes, they pose no threat to the food supply. There is no evidence that these genetically engineered zebra danio fish pose any more threat to the environment than their unmodified counterparts which have long been widely sold in the United States. In the absence of a clear risk to the public health, the FDA finds no reason to regulate these particular fish (n.p.).

The fact that GMO pets are not federally regulated nor have undergone sustained research study for much time explains why California, Canada, and the European Union banned sales of GloFish respectively. Despite the ban, Glofish have been located in California and European countries as consumers purchase them elsewhere and import pets (Bratspies 2005). What follows is the possibility of importing them to South Asia, which may have unintended environmental consequences not yet known. These consequences have been de-emphasized or ignored in light of refuting possible environmental consequences for ecosystems where GloFish are legally distributed (see letters of *no harm* from scientists at http://www.glofish.com).

Yorktown Technologies' mantra is "Experience the Glo™" which has teachers and parents in a glaring trance, according to Georgia pet store owners (M.P. Mueller, 2009, personal observation). As more science teachers purchase GloFish for their classrooms there are very few conversations about the ethical, political, and social implications for society. Pet store owners are not required to say anything about whether the GloFish is a "natural" or genetically engineered pet. However, some pet store employees have started to disclose information about GloFish to customers in order to reduce the number of returned fish when customers become upset. GloFish, having become "cool new inventions," are now available in a mosaic of other colors such as Electric Green® and Sunburst Orange®. What educators and their students may overlook is that genetically modified pets are more "socioscientifically" sophisticated than what meets the eye.

GloFish in the Classroom

A science resource company, *Carolina Biological Supply Company* (http://www.carolina.com/) has partnered with Yorktown to distribute interesting lesson plans and activities for investigating Glofish behaviors. One lesson (Yorktown Technologies 2009a) "It's Cold Outside: Exploring the Effects of Temperature on GloFish® Activity" provides background information for the teacher asserting that the GloFish is a genetically modified zebrafish and so it has the same range of habitats as the wild type. Without referencing their sources, Yorktown's lesson concludes for teachers and students that scientists have determined zebrafish are unable to survive in North American waterways. This becomes the "correct answer" that learners are supposed to derive from these lessons and associated activities. In the *Possible Answers to Discussion Questions*, Yorktown indicates that the GloFish or wild-type zebrafish would not be able to inhabit lakes and streams in North America, suggesting, "*No, lake and stream temperatures in North America would* *be too cold for them to be able survive. This is the reason that zebrafish do not populate waterways in North America"* (2009a, n.p., emphasis original). This answer is compelling but does not reveal the whole picture. It is essentially based on what we now know about zebrafish which are released into US waterways. This idea is less plausible when we consider all of the land extending northward from the Columbia-Panama border, Central America, Mexico, the Islands of the Caribbean Sea, the Artic Archipelago, Canada, and Greenland as part of what constitutes the landmasses of North America. In other words, there is a sense of ethnocentrism that privileges our nation but not others when GloFish have the potential to be released into ecosystems where they may survive. We will see that this issue becomes more important later as we discuss recent data.

Another "correct" answer for Carolina and Yorktown has to do with "Biotech Animals: Science, Benefits, Risk & Public Sentiment" (Yorktown Technologies 2009b). The objective of this lesson is to explore the enhancements that can be made to animals and concerns associated with GMOs. The focus of the lesson is clearly on the advantages of GMOs and resolving concerns for the GloFish. Subsequently, any discussion of ethical issues is conspicuously absent; one wonders how students may possibly construct informed positions on such a controversial socioscientific issue. Indeed, if teachers were to follow Carolina's lessons exactly as written, students would be questioning the legitimacy of their values and beliefs instead of embracing them as part of the process. The message conveyed is that personal values are inferior to the progress of science; science clearly trumps all other human knowledge and experiences. For instance, one worksheet question asks students whether arguments against GMOs are scientific or ideological. The implication of this question is that if the argument is ideological (which is how almost all ethics are warranted by philosophers) it is shortsighted. Another asks what strategies are good for separating fact from fiction (again referring to the ideological) as if GloFish have been "proven" to be ecologically safe. An additional question asks what steps have been taken to ensure GloFish are safe. But again, "safe" is a term constrained by what is implied by "North America."

Another aspect of this issue, which may not be discussed in classrooms, is whether the FDA should be regulating GloFish. Currently, the FDA classifies transgenes as new "drugs." With this guidance, every new GMO will be evaluated as if it contains a new drug (rDNA), which means that the general public will have to trust the regulatory authority of the FDA which may not be appropriate for genetically modified species. With new drug applications and assessments, the FDA operates behind closed doors to protect application details by federal law. This process protects highly competitive pharmaceutical companies who are competing for patents and market rights. It seems disingenuous that the public has access to these controversial decisions only after decisions have been determined. Not regulating something is a political charge to avoid sharing responsibility. But if the sales of ornamental fish are not federally regulated, then who will be responsible?

One might argue that the general public is responsible for what they purchase (i.e., purchasing power) and that a public "vote" is a way of regulating things. Perhaps so. But purchasing power is more relevant when people are educated to be informed consumers of science and technology, especially when "informed" means schooling will adequately engage students in an increasing awareness and understanding of the underlying assumptions inadvertently perpetuated and deeply embedded in issues such as the GloFish (Mueller 2009). Informed in this sense means being able to exercise socioscientific reasoning. It also assumes a functional degree of scientific literacy. In contrast, the reality is that our educational system often fails students in this regard. It teaches them to be complacent, to have unerring faith in science and technology, and to trust governments to protect consumers. But any degree of trust becomes suspect when the US government overlooks the impacts of GloFish on ecosystems in other countries beyond the USA. Normative or criterion-referenced tests further complicate these imperatives to educate students for/as empowered as scientists and other community professionals by reducing informed decision-making to a series of tested concepts. In contrast, SSI and socioscientific reasoning offer more promise and opportunity for digging in deeper and for better informing people's perspectives and enabling actions, where Yorktown Technologies and Carolina Biological fail to provide adequate science education. Now let us explore whether GloFish is a socioscientific issue.

Is GloFish a Socioscientific Issue?

To be fair, the FDA did provide a forum for people to comment on GloFish. In September 2008, the FDA finally provided an online draft of guidelines for its regulatory approach to GM animals for public comment. The FDA received more than 29,000 comments by December 2008 from consumers, academics, animal advocacy groups, trade and professional associations, consumer and environmental groups, foreign governments, other federal and state government agencies, developers of GE animals, meat producers and purveyors, and pharmaceutical companies. In a response report to these comments called "FDA's Response to Public Comments" (2009), FDA notes the following:

> We recognize that many commenters have strong views on these subjects; however, they are largely outside the scope of FDA's authority. The statutory and regulatory review and approval requirements for NADAs ensure that only drugs that are safe and effective are approved. In this guidance, our goal is to describe how the existing new animal drug regulatory structure applies to GE animals. The moral, ethical, and socioeconomic issues outlined above [that genetic engineering may have adverse social and economic consequences] do not fall within the scope of this guidance. It is the FDA's intent, however, that the regulatory approach described in the guidance will provide a predictable science-based framework that will ensure the safety and safe use of GE animals (n.p.).

A final report was produced by the FDA on January 15, 2009 called, "Regulation of Genetically Engineered Animals Containing Heritable Recombinant DNA Constructs" (US Department of Health and Human Services 2009). However, this guiding document was produced to provide recommendations rather than enforceable responsibilities. It reflects the FDA's ideology. This ideology is conveyed by the report title (i.e., "Recombinant DNA Constructs") which is also interesting when we consider how the FDA's recommendation regarding the labeling of GMOs for consumers plays itself out. The FDA assumes a similar position for animals as it does for GM plants, which provides that, unless food nutrition values (or other attributes of food itself) are different from the nonengineered counterpart, it does not have to be indicated in the food labeling. For the purposes of labeling, difference matters. Difference also matters when applying for intellectual property rights (i.e., patents).

When applying for US patents, the applicant must make a strong case that they have invented something new. A patent provides intellectual and property rights. In the case of GM foods, Vandana Shiva (1997) questions whether patents for the life spaces of plants and animals through private intellectual property rights should be accepted. She explains that patents for new life forms have been justified on the circular argument that scientific institutions or corporations are the sole constructors of nature, so it must be their property. Ironically, the same institutions or corporations turn around and claim that the GMO is nature, which enables GM products to be placed on the shelves of supermarkets (without the need for labels).

Now consider the patent for the ornamental transgenic zebrafish (Gong et al. 2006). The "invention" claimed is a transgenic fish, comprising a fluorescent protein gene which is expressed in the presence of sunlight, a new and inheritable trait, which makes the unnatural fish and technology eligible for patent. Subsequently, the patent privatizes the fish and technology and defines it as a natural zebrafish! Obviously there is an important debate about what is natural and what constructed, which begs the question: If the GloFish were food, would they need a label "GMO?" Imagine the trademark: "The Glo in Your Mouth Meal!" According to FDA's guidelines, a GMO will never be labeled as such, as long as the material data is included. Would consumers begin to wonder if their food glows green under the grocer's lights? The point is that the debate is not over. What remains is a significant conversation of the caliber other SSI entail. Let us explain further.

Philosophical Research and SSI Analysis

Socioscientific issues (Zeidler et al. 2002) comprise many facets of everyday life (ethical, environmental, political, social, etc.) where students invoke a spectrum of reasoning to decipher best choices for action. SSI are controversial and often philosophical problems such as whether animals should be used for medical research, whether people should eat meat, or whether plants should be genetically modified to resist certain herbicides. Other SSI may not be considered controversial for scientists in the professional sector, and yet prompt a significant discussion in the classroom, for example, whether global warming is occurring, or whether it is natural or anthropogenic climate change. Early on, SSI were used to better engage students through debate and eventually led to teaching many science subjects through varied modes of discourse. In the case of teaching the nature of science (NOS), for example, explicit instruction combined with relevant SSI serves to provide real-world environments important to students and anchored in their everyday lives (Walker and Zeidler 2007). In other words, class discourse focused on the significance of the students' backgrounds may alleviate some fears of participating more fully in conversation around issues. Dialogue includes their interactions with community members, cultural events and ceremonies, and narrative. The SSI framework is a way of teaching and a way of conceptualizing how we might organize situated science curricula such that scientific issues that are controversial, and embedded with moral–ethical characteristics will be approached through augmentation or socioscientific reasoning.

Under the SSI framework, "reasoning" is not meant to subjugate emotion, intuition, or other forms of human knowledge and experiences. Reasoning is what we do when we invoke a spectrum of thought – combining rationalistic, emotive, and intuitive justifications and actions. Socioscientific reasoning is aligned with Dewey's (1916/1966) classical theory of American pragmatism despite some of the limitations of how progressivism may be interpreted by some scholars as limited to rejecting the old for the new (Bowers 2001). Progressivism is also thought of as connecting the new with the old. Pragmatists generally believe there is a direct link between thought and action, that existence and time are relational and fluid, thought is ecosociocultural and historically contextual, and universal truths are problematic. Pragmatists focus on their experiences and the experiences of others. Dewey (1938/1963) used pragmatist philosophy to learn about the disconnections between thought and action embedded in contemporary societal problems. He advocated that teachers should share some of the responsibility for setting things right in society. Pragmatism is a philosophy of becoming informed so that we can participate more fully in the choices of the community including advocacy for affected others who may otherwise be excluded (Zeidler 1984), including animals and plants (Mueller 2009).

Similar to Dewey, SSI scholars (Zeidler et al. 2005) believe that socioscientific reasoning involves the psychological and epistemological growth of the child; hence it differs from science–technology–society (STS) approaches that do not typically aim to develop moral characteristics or virtues. In contrast, socioscientific reasoning purposefully elicits students' moral–ethical commitments, personal values and beliefs, and the use of evidence-based reasoning. With few exceptions, traditional STS has not been interpreted as a way to develop moral–ethical character and functional scientific literacy (Zeidler et al. 2005) in the science education literature. Historically, for the most part, traditional science teaching corresponds to the notion that science should not involve ethical, political, and social judgments.

Value Judgments

Universities may require new scientists to have some background in ethical inquiry or Internal Review Board training, and some corporations require ongoing ethical training as part of the job. But consider additional cases where ethical reasoning is considered a large part of what it means to engage in the community and environmental sciences. Most major scientific documents discuss the ethics of engaging in investigations, for example, the International Panel of Climate Change (IPCC 2001):

> It is critical that the IPCC process remains truly representative of the scientific community. The committee's concerns focus primarily on whether the process is likely to become less representative in the future because of the growing voluntary time commitment required to participate as a lead or coordinating author and the potential that the scientific process will be viewed as being too heavily influenced by governments which have specific postures with regard to treaties, emission controls, and other policy instruments. The United States should promote actions that improve the IPCC process while also ensuring that is strengths are maintained (p. 5).

Another example is the *Manual for Addressing the Ecological and Human Health Effects of Genetically Modified Organisms* (1998) by the Scientists Working Group on Biosafety at the Edmonds Institute (Seattle, Washington). This report notes that genetically engineered organisms (GEOs) will improve agricultural crops and crop yields, plant susceptibility to insects and diseases, and cultivate microbes for bioremediation that can be used for projects such as environmental cleanups, and yet genetic engineering may also lead to environmental hazards to human health and hazards. The Scientists Working Group explains that there are high uncertainties with GEOs: changes may include but are not limited to growth rates; reproductive outputs; tolerances to physical and chemical variables; hybrid organisms; and the allergenicity, toxicity, and nutritional composition of foods. The risks linked with these changes may include new evolutionary competitions, gene transfers, human well-being, and unforeseen ecological surprises. Because of the potential dangers involved with GEOs, the Scientists Working Group advocates careful scrutiny, or biosafety assessment, which "systematically examines the potential consequences of the deliberate or accidental release of a GEO and does so with sufficient thoroughness to enable a reasonably confident determination of whether the particular GEO can be used safely" (p. 5). Working with GEOs requires something not always acknowledged as scientific work and good pedagogy – the anticipation of the effects of research on the cultural and environmental milieu (or the prevalence of care, concern, and commitment in the profession).

Where the IPCC (2001) advocates the ethics of protecting science investigations from political influences, the field of epidemiology promotes engaging in ethical, political, and social judgments to resolve racial disparities and to do better science (de Melo-Martin and Intemann 2007). Scientists evaluate issues associated with attempts to eliminate diseases, improve patient care, and use resources more effectively. There is a broad agreement on the need to eliminate racial disparities, improve health care for racial and ethnic populations, understand why particular races and ethnic minorities are susceptible to particular diseases, and understand why various groups respond differently to medicines and treatments. Defending racial and ethnic groups in scientific research to reduce racial disparities "requires scientists to evaluate political and social factors that bear on the efficacy of genetic knowledge" (de Melo-Martin and Intemann 2007, p. 217). For example, if some racial and ethnic populations do not have access to genetically tailored drugs then these drugs do little to remedy health inequalities stemming from racial and ethnic genetic differences. Epidemiologists make ethical, political, social evaluations, and so forth, with respect to their scientific research programs that will diminish longer-standing health disparities. Such actions resonate with the caring-emotive aspects of socioscientific reasoning.

One objection to the aforementioned point is that scientists should not be involved in the political aims of scientific research (IPCC 2001). But this assumption cannot be defended because scientists are typically not as involved in the policy-making as much as they are involved in reducing health disparities through the selection of their research goals. The goal of research on health disparities is to accurately describe health differences and to determine their causes; it is also to make better predictions, prevent greater disparities, and improve health (de Melo-Martin and Intemann 2007). Scientists make ethical judgments about the best data to collect, how that data should be measured (regardless of whether race is socially constructed or biological), and how to compare data to monitor and track improvements or reductions in health disparities. Although there remain other categories (genetic markers, disease incidence, socioeconomic status, education, etc.) for epidemiologists to consider, without the ecosociocultural contexts of racial and ethnic constructs, the value judgments do not accurately represent the goals of trying to reduce health disparities. Ethical inquiry is good for epidemiologists because it helps them to be more conscientious human beings, which in turn, helps them to be better scientists. Ethical inquiry helps epidemiologists evaluate whether the value judgments they make result in reducing health disparities and whether local resources are being allocated appropriately. It can be argued that the development of these characteristics is essential to more equitable scientific progress.

In contrast, consider FDA's de-emphasizing ethical, moral, or socioeconomic matters. This lack of emphasis likely creates (un)intended disparities, vulnerabilities, or threats for humans and the Earth. The way that the FDA represents science and their responsibility to investigate GMOs does not resonate under the SSI framework. Socioscientific reasoning provides opportunities for students to wrestle with the ethical, moral, and socioeconomic matters associated with GloFish in a way that may even be used to challenge the FDA's views of their scientific responsibility. Reflective judgment and character development (e.g., moral sensitivity) is shown to advance through SSI (Fowler et al. 2009). When the conditions for a more humanizing science and science education exist, scientists and teachers share some of the responsibility for engaging those affected with ethical, political, and social judgments.

Guided Inquiry and SSI

Zeidler and Sadler (2008) suggest that "educational programs and research focused on promoting argumentation and character development should attend to how well students are able to article coherent and internally consistent arguments, recognize potential threats to positions and counter-positions, and form rebuttals" (p. 212). They recommend that science teachers encourage students to explore their inspirations, assumptions, and the implications of their value systems by following these suggested guidelines of SSI pedagogy:

> Teachers may accomplish these tasks by (a) highlighting the significance of argumentation in scientific and socioscientific contexts, (b) providing opportunities for students to engage in these argumentation practices, (c) emphasizing the connections between science and morality especially with respect to SSI, and (d) scaffolding students efforts to engage in critical reflection of their own positions and argument patterns as well as those of their peers (p. 213).

What teachers select as moral–ethical implications to highlight for their students will depend on their preparedness for ethical inquiry. Often teachers design lessons and curriculum with the notion of "backward design," that is, starting with the end in mind. In other words, when addressing students' value systems, science teachers need to know what is important to highlight and what to pay more attention to.

Related to this idea is whether or not teachers should be value-neutral. Often teachers say that they must be "value-neutral" in the classroom. While this stance seems, at first blush, appropriate for beginning SSI pedagogy, it is not feasible under the umbrella of Dewey's pragmatic progressivism. Concomitant with scientific practices already mentioned, the teacher cannot avoid ethical, political, and social judgments when working with SSI and reasoning. Teachers share some of the responsibility for facilitating and guiding SSI and students' reasoning, which means that they should help their students to make value judgments and confront disparities for affected peoples, plants, animals, and the environment. This means that educators will need to help their students to be aware of their own inspirations, assumptions, ethical values, and the implications of their actions. While one might argue that students are impressionable and they will be easily influenced by their teachers, this argument is not defensible considering how teachers are involved with SSI and reasoning for longer periods of time than students. Society expects teachers to have this degree of experience when working with youth to become informed such that they participate more fully in local decisions. To ask teachers to be value-neutral appears to contradict the aspects of SSI that make it an appropriate and significant context for developing moral–ethical character and functional scientific literacy. Functional scientific literacy then becomes one of *participatory* socioscientific reasoning around issues, where teachers and students collaborate with a full spectrum of knowledge, skills, and learning experiences, which are inseparable from the community. In other words, ethics play larger roles in reasoning when diversity is acknowledged, which aligns with why science teachers ought to be prepared for ethical inquiry in their classrooms. Teaching with ethics requires awareness and understanding of students' interests as well as their larger communities and ecosystems. The pedagogical value implication here is that teachers should share some responsibility for local actions. This is the place where functional scientific literacy merges with Dewey's progressive pragmatism.

The next section will further demonstrate through the SSI topic of GloFish, the process of guiding socioscientific reasoning. In the same way that scholars (Zeidler et al. 2002) have argued that nature of science should be taught explicitly, moral–ethical sensitivity also needs to be explicitly developed. Science education researchers argue that it is difficult for students to develop understandings of NOS without a teacher who serves as a cultural-mediator. Most science teachers do not derive historical and philosophical awareness and understandings of science without some careful guidance of how to interpret and analyze NOS within school science. Science teachers need to serve as a value-mediator in terms of promoting ethical/moral reasoning and character development. How might teachers and their students play out their roles in this intriguing conversation?

Functional Scientific Literacy

SSI serves to promote scientific awareness and understanding. What follows is the science of zebrafish and GloFish. We make a purposeful distinction between the ornamental GloFish and the wild-type zebrafish because recent scientific reports (e.g., Cortemeglia and Beitinger 2005) are noted exceptions to the aforementioned conclusion that there is no difference between the wild-type zebrafish and the transgenic ornamental GloFish. The zebrafish is named for the horizontal stripes on the side of its body. In the wild, the zebrafish can grow as large as 6 cm but generally in captivity it only reaches lengths of 3–4 cm. The zebrafish diet consists of zooplankton, insects, and phytoplankton. It reproduces in 3–4 months and may live for more than 5 years. The zebrafish is also considered a model organism for studies of vertebrate development and gene function. It is one of the few animals to visit space as a traveler aboard US space shuttles. The zebrafish is used extensively in science research. More recently, the zebrafish has been genetically modified to glow green to detect estrogen in rivers and lakes; they have been modified with see-through bodies which help researchers find individual blood stem cells and cancer cells in the living adult (White et al. 2007). With some background knowledge on the wild type zebrafish, students will better analyze emerging controversies around the GloFish.

GloFish Science Inquiry

The introduction of nonnative species in US ecosystems is an increasing problem that some scientists (Cortemeglia and Beitinger 2005) say, results from aquaria releases by fish hobbyists and others. In schools, summer break often coincides with few available caretakers for classroom fish pets. Sometimes these pets are given away but teachers or their students who are not aware of the consequences such actions may have on native animals, plants, and habitats may also release them into the wild. When fish are released in places where they are not native, they can have a negative impact through competition, habitat alteration, hybridization, predation on other species, and the introduction of diseases and parasites. If those fish are genetically modified, then they may have adverse effects on native populations of the same species when modifying genes facilitate increased growth rates. We see this phenomenon occurring within salmon populations for example. A salmon that grows to adult size or larger in 18 months versus the normal 30 months may swim slower but have more reproductive success because of its larger size. If the larger salmon is an easier target for predators, then population declines may result. This theory is called the *Trojan Gene Effect* (Muir and Howard 1999). The most significant point for zebrafish, salmon, and other genetically modified fish, is that genetic modifications can have serious and unintended consequences for native populations and habitats – a detail worth considering before release.

But the FDA and others say that GloFish are not capable of living in US waters. The reasoning for this conclusion is based on the idea that zebrafish have not been found in US waters over the last 20 or more years they have been sold. However, Cortemeglia and Beitinger (2005) conducted a study using wild-type and transgenic GloFish to determine their lower and upper temperature tolerances. Although Yorktown Technologies provides scientific letters specifically affirming that the transgenic GloFish cannot withstand the temperatures of US waters, Cortemeglia and Beitinger note that their “review located no published studies of thermal tolerance of zebrafish” (p. 1434) – with one exception which does not cite supporting studies. Although FDA notes they will not regulate GloFish because geographic distributions will be the same as the wild-type zebrafish, Cortemeglia and Beitinger found “statistically significant differences in both upper and lower thermal tolerance between wild-type zebrafish and genetically modified zebrafish at two acclimation temperatures” (p. 1435). While statistically significant, the standard deviations of the fish groups examined were 0.54°C or less which means that the geographic distribution will be similar for both wild type and GloFish. The authors recommend that transgenic technology be more carefully scrutinized because temperature tolerance in different fish species could be affected differently by genetic modification, which in turn, may lead to unintended consequences for native populations and ecosystems. Their findings also suggest that both the wild type and transgenic zebrafish can extend their lower temperature limits when acclimated to lower temperatures. They note that the colder temperature tolerant zebrafish has a good chance of being naturally selected, similar to the common carp (*Cyprinus carpio*) which has a similar temperature tolerance to the zebrafish and yet has been successfully introduced into most freshwaters of the USA. Based on their data, they suggest that zebrafish have the potential to live and overwinter in Florida, southern California, and Texas.

If zebrafish (wild type or transgenic) have a good chance of living and overwintering in some southern US states, then it follows that they would have at least an equal potentiality in warmer waters south of the border. This idea refutes Yorktown and Carolina Biological’s claims that the zebrafish cannot survive in North America, assuming North America includes geographic locations south of the US border. Since zebrafish have been introduced in places where they are banned (Bratspies 2005), it follows that they will eventually make their way back toward native populations in southern Asia. This idea begs the question of whether the FDA should regulate GloFish if they are likely to impact other ecosystems outside the USA. At the very least, should FDA regulate the labeling of GloFish for the consumer? What might a GloFish label include? A primary objection is that these GloFish studies have not revealed any significant behavioral differences between the wild type and the transgenic zebrafish. Intuitively, a transgenic GloFish will have less chance of surviving in US waterways because of its bright appearance in sunlight, which may provide less evolutionary advantages in terms of protection from predators. However, there are many organisms in the natural world that are brightly colored as a way to indicate that they are highly toxic to predators, while other organisms employ mimicry to protect themselves against predation. Thus, it does not necessarily follow that brightly colored zebrafish will be genetically disadvantaged in freshwater systems. It is alarming that there are few scientific studies focused on the potential implications of the phenotypic characteristics of ornamental GloFish on their social behavior.

Several scientific researchers (Snekser et al. 2006) found that body coloration relates to social and reproductive contexts of the zebrafish. These researchers note that "the red coloration found in transgenic GloFish™ does not influence choice of same-sex shoal-mates. Yet, in some circumstances, body coloration does influence preference for individual, opposite-sex fish" (p. 183). Shoaling with fish of similar body coloration, body shape, body size, parasite load, and body pattern is thought to reduce the likelihood of being preyed upon. Snekser et al. found almost no preference in the GloFish and wild-type zebrafish. They do conclude that the zebrafish can detect the color red. The red coloration affects mate choice when fish show a preference for GloFish over wild-type fish of the opposite sex. The researchers noted that although a strong preference for one type over the other was not detected in dichotomous tests, further exploration focusing on the success of actual spawning attempts are now needed, particularly with the emergence of other transgenic colorations now publicly available in pet stores.

Our review of the current scientific literature produced no such follow-up research, albeit Yorktown's "GloFish®: Experience the Glo! ™" website notes the importance of advancing scientific research with a portion of the proceeds from the sale of every GloFish. As we now know, science research agendas are the by-product of ethical judgments about where scientists and others decide to pay selective attention. It would be interesting to know whether proceeds from GloFish sales will also be used to support scientific research aimed at understanding GloFish distributions in North America and abroad, and to what extent GloFish are truly safe for public health and *all* of the world's environments. This is where ecojustice enhances SSI as a way to engage students with more of the ethical considerations.

EcoJustice, Environmentalism, and Socioscientific Reasoning

Ecojustice philosophy (Mueller 2008) can be thought of as a way of enhancing functional scientific literacy, where there exists a holistic relationship between humans and all other living and nonliving entities connected to the environment. Under this philosophy, SSI serves as a vehicle for reasoning about scientific issues where ethics plays a major role in considering choices for action (Mueller 2009). Ethical decisions become significant for participating more fully in actions that affect our communities and our larger ecological habitat.

Ecojustice scholars (e.g., Bowers 2006) pay particular attention to the ways in which vernacular language has inadvertently perpetuated root metaphors such as *consumerism*, *constructivism*, *evolution*, *individualism*, *mechanism*, *patriarchy*, and *scientism* in western, and now, eastern societies. The idea is that metaphors (or cultural assumptions) are inculcated in language during particular time periods, and are evaluated and possibly endorsed by future generations. For example, there is an unerring faith in rushing out to obtain the latest technological "advances" which de-emphasizes or ignores potentially adverse impacts on the environments. People throw away cell phones, appliances, computers, and other e-waste without considering whether these things will be recycled or end up in oceans and streams. This behavior is influenced by what counts as generally accepted cultural assumptions toward basic needs and wants. These influences have been perpetuated since the Industrial Revolution and are inadvertently propagated by what is privileged in advertising, media, and schools (Martusewicz 2005). The point of SSI and functional scientific literacy is to help students evaluate these choices and make the best decisions for action by providing them with a method to approach any problem despite their different geographies.

According to Dewey (1935), complacency is cowardly. We agree. Unless students are taught to engage in their world, they will not know when or how they should act. People do not spontaneously take actions to resolve degraded conditions for communities or the environment without some knowledge or baseline of what is important, or what is healthy in our bodies, communities, and ecosystems. This is where teachers become cultural mediators; they have experiences within particular geographies where they learn to become more attentive and learn to address deeply embedded assumptions about that environment. Students play a large role in addressing these cultural metaphors, because their experiences are at the center of what makes ecojustice authentic and meaningful. A goal of ecojustice-oriented teaching is to address particular underlying cultural assumptions and actions that frame the world, but not to necessarily address these things in the same manner everywhere. This is where ecojustice philosophy challenges the supposition that schooling should be the same everywhere or that there is one right way to learn science (Mueller and Bentley 2009).

Now let us consider the SSI GloFish where interesting ethical questions begin to emerge. Should the FDA's analysis take into account the potential implications for other nations? Should it matter if zebrafish can be imported to places where they could interrupt native populations and destroy habitats if there is no perceived harm in selling them in other markets where they may not likely survive? Should GloFish and other genetically engineered pets (GEPs) be labeled in a way that provides consumers with appropriate information for making decisions about whether to buy GEPs or not? Is it good, just, or right to patent intellectual property such as living GMOs? These questions are considered in the next segment of this chapter.

EcoJustice Inquiry

Yorktown (2008) notes the following four ethical principles on their website under *GloFish® Fluorescent Fish Ethical Principles*: (1) environmental safety first; (2) humane treatment of fish; (3) advancing scientific research; and (4) open and informed discussion. We will analyze these principles one at a time.

> **Environmental Safety First.** We believe it is of paramount importance that all the fluorescent fish we offer for sale be safe for the environment. To ensure that we are successful, stringent testing will be performed before any fish is made available to the public, with specific emphasis placed on analyzing growth rates, temperature sensitivities, and mating success. Any line of fluorescent fish demonstrating increased strengths or successes in these areas relative to nonflourescent fish of the same species, or otherwise displaying any characteristic that poses an environmental concern, will not be offered for sale (n.p.).

This "ethic" depends on the market share because the environment has been constrained to "North America" within lesson plans. All of Yorktown's supporting letters of no harm for the environment privilege the US waterways and do not include other nations' waterways as considerations. The importance of company stakeholders seeking to maximize profits for Yorktown may create a conflict of interest when evaluating environmental safety. Whether or not environments will really be upheld over profits is not clear. Since a particular environment is not specified, we have to assume that if environmental safety is first, then it will include all of the relevant implications for ecosystems worldwide. Asia should be included as well as other nations constituting the North American continent, and so forth. But there is no mention of conflicting research, or documented cases where GloFish have reproduced in aquaria (Bratspies 2005), or concerns from scientists about GMOs wreaking ecological havoc when released (Stokstad 2002) on Yorktown's website or in instructional lesson plans. There is no mention of whether there will be any stringent testing preformed in diverse geographies outside of the market share. This idea is aligned with how companies in the USA have historically solved their problems with cheap labor, where they exploit natural resources, and where they locate industrial pollution and consumer waste. Workers in economically marginalized countries are exploited for cheap labor, while the natural resources are consumed without regard to longer-term consequences. Many times, waste is also relocated to these countries. If we cannot see it, then it does not much matter, withstanding fair trade and other efforts to make things more equitable for others. Yorktown endorses the hubris and ethnocentrism implicit in the presumption that as long as GloFish minimally impact US waterways they may be sold, despite the huge consequences facing other nations which may not be able to protect their cultural communities and local environment from being degraded by GMOs. Yorktown has a responsibility to consider the ethics of perpetuating an assumption of superiority over others, and this idea should be represented when teaching ecojustice ethics.

Next, consider Native American communities in the northwestern USA where cultural traditions around salmon migrations are severely threatened because of the escape of an estimated half-million farmed salmon from 1987 to 1997, which are now spawning in British Columbia and other places along North America's west coast (Stokstad 2002). Farmed fish may ease pressure on wild fisheries, but there is an increasing emphasis on producing GMOs that will rapidly outgrow wild salmon and if released, will continue to out-compete wild fish for food. Transgenic fish can eat up to three times as much food as wild-type salmon. Additionally, farmed salmon are typically raised in crowded conditions which increase the likelihood of diseases that could spread to wild populations threatening already declining populations of salmon. What about wild-type zebrafish?

There are concerns that current understandings of the environmental biosafety of transgenic fish and shellfish have not been given enough attention or research (Kapuscinski 2005). In many parts of the world, native fish populations have a direct impact on the livelihoods of people in the community. Often fish are part of cultural ceremonies or events that have occurred over thousands of years. When cultural erosion and environmental degradation occur, cultural and economic connections with fish decline. If there are significant consequences for communities where wild-type zebrafish are part of some important ecological relations, then it ought to be included as part of what constitutes an ethically complex environmental safety first principle. Yorktown's principle of environmental safety depends on where it is geographically situated, and henceforth, does not include all environments as equal moral subjects, because if it did, the Earth's environmental safety would already be compromised. It is not right, good, or just to privilege some environments over others, especially when all environments depend on each other as much as humans depend on them.

Now reconsider FDA's statement that they will not regulate GloFish because they have not been shown to have an adverse affect on public health or any greater threat for the environment than wild-type zebrafish. The FDA also limits environmental impact to the USA. But since US environments are dependent on the health of environments worldwide, it does not make sense to reduce the environment to US boundaries. But could GloFish adversely impact ecosystems in Hawaii or Caribbean and Pacific island territories (ecosystems)? If these locations are considered as part of the analysis for determining adverse effects, they are not mentioned on FDA's website or anywhere else. Unfortunately invasive organisms have been a huge problem for Hawaii (Wilson 2002). Will GloFish impact Hawaiian islands? A scan of Honolulu's pet stores indicates there are two or more places where GloFish are currently sold in Oahu. Hawaii's waters are at the same latitude as where zebrafish are native in southern Asia. Concomitant with the FDA policy on GloFish, other countries, such as Costa Rica and other significant biodiversity hotspots are being held to a double standard when targeted by scientists and environmentalists to protect rainforest ecosystems within their boundaries because of some adverse implications for other environments worldwide (including the USA). Will the FDA also be required to evaluate the consequences of policy for others?

The FDA notes there is no public health risk because humans do not eat zebrafish. However, since public health cannot be separated from the health of environments worldwide, the FDA has a responsibility to consider whether there is any threat to people's food livelihoods. Declining food livelihoods when environments become degraded to the point that they no longer support farming have led to serious consequences for public health, such as farmer suicide in India. Insignificant degradations for the world's environments may eventually add up to involve much larger and more difficult problems, similar to global climate change. These things require a precautionary principle, which addresses problems when they are small, and before they escalate beyond what can be addressed by humans.

Yorktown's (2008) next ethical principle is:

> **Humane Treatment of Fish.** We are committed to humane breeding practices, and the distribution of GloFish® fluorescent fish will make every effort to provide an exemplary, healthy environment for our fish throughout their life cycle. We encourage our customers to remember that, which unique, beautiful, and interesting, these fish are living creatures and not toys, and should be treated with the utmost care (n.p.).

Zoo animals are provided what is deemed to be minimally sufficient, healthy environments. However, animals in captivity rarely grow to the size they would in their native environments and they do not reproduce (which is generally considered the "gold standard" for whether zoo animals are living in exemplary, healthy environments). The same is true of zebrafish in captivity. They do not grow to nontransgenic size. But the nontransgenic zebrafish are able to reproduce if the conditions are right in most personal aquariums. However, GloFish are sterilized so that they will not reproduce for the aquarium hobbyist. Sterilization is one way to protect the company's interests from infringements on intellectual patent rights. Recall that GloFish are considered "inventions" so they can be patented and trademarked. It will be difficult if not impossible to determine whether GloFish are sufficiently cared for (beyond providing the proper water conditions and food needs for life itself). It should not be surprising if consumers of GloFish treat them as toys. Toys are inventions too. Most importantly, GloFish life cycles are not treated with the same moral status of human life cycles. But should they be?

Singer (2000) writes that in the western tradition, the natural world exists for the benefit of human beings. Humans are the only morally significant creature, members of the Earth. If the destruction of nature's animals and plants does not adversely impact humans, then it does not matter whether or not they are destroyed. Some advocate that nature should be conserved because it cannot be separated from human health. For example, the destruction of forests is harmful because it affects carbon dioxide and other greenhouse gases abundant in the atmosphere and this contributes to global warming and rising sea levels, which displaces coastal cities. GloFish were not modified to protect them from diseases, or native population collapse, or from environmental pollutants emitted by industrial factories and cars. They were modified for the pleasure and happiness of humans (Gong et al. 2003).

A different argument can be made that the intrinsic worth of nature is directly proportional to our current needs. But this argument is shortsighted when we consider that future generations will also have to support their communities and will rely on many of the same agricultural and natural resources that current societies use to survive today. Nature should be preserved in the same manner that we currently protect deeply embedded cultural thinking patterns (e.g., the cultivation of social memory, Green 1988) from being eroded.

Singer (2000) argues that we should regard using nonhuman species as luxuries for our pleasure and happiness as wrong, especially when species become threatened, more vulnerable or even lost at the expense of our happiness. When this idea is applied to the GloFish, it becomes clear that we are using these fish to serve as our luxuries, at the expense of wild-type zebrafish that become more vulnerable. Moreover, zebrafish, in order to be genetically viable, need to be able to reproduce successfully. The humane treatment of GloFish should include the option for these fish to reproduce. The question of whether GloFish are natural or unnatural, and whether they should be patented, should become clearer. If GloFish are just toys or luxury pets for human pleasure and happiness, then perhaps they should be patented so that the property of companies with a vested financial interest in research can be protected. But Yorktown's second ethical principle is not defensible on the grounds that GloFish need to live in exemplary, healthy environments with the capacity to carry out their life cycle.

This brings us to Yorktown's (2008) third ethical principle:

> **Advancing Scientific Research.** We value the potential of the technology that brought us fluorescent fish, and we will work to support additional medical and scientific applications that utilize this technology. GloFish® fluorescent fish were originally developed to detect pollutants in our water, one of the many discoveries with roots in the ongoing biotechnology revolution. This revolution promises to aid in the fight against countless diseases and significantly improve peoples' lives and environments. We will work to promote and support this research; a portion of the proceeds from the sale of every GloFish® fluorescent fish will go towards this effort (n.p.).

Some science educators (van Eijck and Roth 2007) have argued that instrumental value should be used to determine whether something is science and whether that science should be used to inform science education curriculum. The logic here is that if organisms are used in scientific research and that research benefits human beings, then it is science and it should be used to inform science education curriculum. We agree with those who might argue that if GloFish are used in the classroom, then they should be used in a way that is science and informs what is emphasized in science education curriculum. Teachers should have opportunities to discuss the SSI of GloFish with their students in a way that they will become more knowledgeable and able to act using evidence-based decisions. But there are two ideas working here. On the one hand, there is science which has an instrumental value for ensuring the basic needs of humans are met. For example, the zebrafish is being used to find causes of cancer, which cuts human life short. On the other hand, there is science which has an instrumental value for luxury or nonbasic human needs. Although there is a blurred boundary between what is considered luxury and what is not, the GloFish clearly has no other purpose than the pleasure and happiness that comes from humans owning a fluorescent fish pet. The ethics of using the proceeds to fight against diseases and improve peoples' lives is admirable but is it defensible in light of the fact that the zebrafish is being modified for purely luxury needs (Gong et al. 2003). Stopping with a red fish might have been defensible in light of producing "accidents" that meet luxury pet needs. But Yorktown did not stop with red, they produced green and orange colors, which are not currently being used to fight against disease or improve livelihoods. This sets the stage for producing glow-in-the-dark dogs, cats that bark, dogs that meow, cows that lay eggs, and children with culturally desirable traits. Currently, GloFish do not come with labels or information that identifies whether phenotypic traits are invented, inherited, or natural. A more careful analysis of the purpose and by-products of scientific research are warranted.

Yorktown's (2008) fourth ethical principle:

> **Open & Informed Discussion.** We recognize that new opportunities available through increased scientific understanding must be weighed against potential risks. We will regularly consult with leading experts through our Scientific Advisory Board and with appropriate state and federal agencies in support of comprehensive scientific research. We encourage an engaged and informed public discussion surrounding these issues, and provide information about our fish to enlighten the debate (n.p.).

A strong case has been made in this chapter that evidence is not provided that demonstrates that Yorktown is providing information about GloFish to enlighten the debate. Yorktown and Carolina Biological's lesson plans evidence this claim. The consumer walks into a pet store today and walks out with a cool invention. They fail to recognize that the wild-type zebrafish that has been popular for aquarium hobbyists for over two decades is now in one of the bottom tank displays. GloFish are now at eye level. The wild-type zebrafish are now used as a feeder. Consumers may not know what is needed to make an informed decision about the hidden cultural and environmental expenses associated with purchasing GloFish. Part of the FDA's mission is education. But does the purchase of GloFish by science teachers or consumers provide tacit support of Yorktown's comprehensive scientific research that does no regulating or monitoring of GloFish in the environment? Do our purchases imply we need not become engaged in public debate or make informed decisions surrounding it? While the medium for such a debate could be provided by Yorktown on their website, to date, it is not present. The FDA could require companies treading in muddy GMO waters to provide discussion forums for these types of debates that are publicly accessible, but they do not. Pet stores could be providing information on GloFish to customers, but they are not required beyond alleviating concerns with returned fish. Schools could encourage students to become educated and act on the information, but instead they promote high-stakes tests which emphasize concepts and facts. When teachers are limited to what they have to do to keep their jobs, they may not find time to engage students in SSI unless they find time to reengage their curriculum (Zeidler et al. 2009). So the question of whether GloFish should be labeled has much more to do with the information provided; it is a question yet to be decided.

Implications for Science Education

"Context is almost everything" (Atkin and Black 2003, p. 171)

This chapter serves as a model for how ecojustice is cultivated through SSI and socioscientific reasoning. Our premise has been that the exploration of science necessitates the exploration of ethics, personal beliefs, and values. It is not merely desirable, but necessary that students can become more fully informed to participate in everyday life choices and become "activists" in their own learning. In short, there are three major implications for combining SSI with the learning of ecojustice.

First, context is the most important aspect of learning about SSI, developing functional scientific literacy and for incorporating ecojustice in everything we do as teachers. An important challenge for standards-based schooling is to diversify science education and focus on the places where children live, play, and work. Its success will depend upon teachers who have the inclination to learn about students' knowledge, interests, and experiences, and the ways in which they may apply that knowledge to the community. Although teachers are not often held accountable for the ways in which youth interact with the community and what they do to make it better, teachers can be responsible for the degree to which a society values such ecological engagement. Teachers need to be afforded higher degrees of freedom to share responsibility for addressing issues in society and working with youth to have a voice in their physical environment.

Second, functional scientific literacy, as described by us, is different from what is occurring in school today, with some noted exceptions throughout this chapter. Building on these cases will fuel an SSI movement toward reaching fruition, where science education becomes better aligned with the professional sector. Standardizing schools is not the answer and it will not produce the higher-quality data that are now needed to understand how regional climate changes will effect regional species distributions, and when students and their teachers begin engaging contextual-sensitive issues in collaboration with scientists and other community professionals (Sadler 2009). Participatory action research is a way to shift SSI, functional scientific literacy, and ecojustice, toward social movements that extend beyond the classroom (Mueller and Tippins 2010). Objections that SSI is somehow separate from the community are no longer defensible in light of the ways that it has and will continue to influence ecojustice, environmentalism, and sustainability. "Paying it forward" in science education means community engagement and youth activism in environmentalism in a manner that explores implications and options for policy. These forms of schooling go beyond teaching to the test. It may be, at first, more difficult to teach this way, but worth it because it consistent with what responsible scientists do, is more motivational, and may lead students down the path to science careers. In a larger sense, SSI is needed to further democratize science, policymaking, and the ways in which people advocate for those who do not have a voice otherwise.

And third, functional scientific literacy is a better way of describing the kinds of science education advocated for by the National Science Education Standards (National Research Council [NRC] 1996), the Benchmarks (American Association for the Advancement of Science [AAAS] 1993), as well as many other international progressive missions of science education (Zeidler and Keefer 2003). Functional scientific literacy encompasses argumentation and reasoning inculcated as ethical, political, and social judgments where students' lived curriculum is reflected through a deep analysis of problems. Scientists analyze and evaluate issues in depth to become informed so they can make sound research judgments. Science has to do with paying attention to our assumptions, asking essential questions, selecting protocols, designing investigations, collecting high-quality data, and being morally and ethically scrupulous with the formulation and representation of conclusions. The same characteristics should apply to the science education of our students. Our students should become involved in authentic studies of local problems and become empowered to offer resolutions. As young citizens, they may have untainted perspectives worthwhile of policymakers' consideration.

A Final Note

How should we live in relation to others? How far should we travel to consider the impacts of our policies on others? During rough seas, when do we navigate our ship on a new course or uncharted waters? If these problems are deemed appropriate and significant for science education, ecojustice through SSI will shed some light on solutions, which may take us in directions never traveled or least traveled by. Regardless of whether we stay the course, our students should have opportunities to consider the consequences of their actions on others.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy: Project 2061*. New York/Oxford: Oxford University Press.

Atkin, J. M., & Black, P. (2003). *Inside science education reform: A history of curricular and policy change*. New York: Teachers College Press.

Bowers, C. A. (2001). *Educating for eco-justice and community*. Athens: University of Georgia Press.

Bowers, C. A. (2006). *Revitalizing the Commons: Cultural and educational sites of resistance and affirmation*. Lanham: Lexington Books.

Bratspies, R. M. (2005). Glowing in the dark: How America's first transgenic animal escaped regulation. *Minnesota J.L. Science and Technology, 6*, 457–498.

International Panel on Climate Change (2001). *Climate change 2001: The scientific basis. Contributions of working group I to the third assessment report of the International Panel on Climate Change.* UK/New York: Cambridge University Press.

Cortemeglia, C., & Beitinger, T. L. (2005). Temperature tolerances of wild-type and red transgenic zebra danios. *Transactions of the American Fisheries Society, 134*, 1431–1437.

de Melo-Martin, I., & Intemann, K. K. (2007). Can ethical reasoning contribute to better epistemology? A case study in research on racial disparities. *European Journal of Epidemiology, 22*(4), 215–221.

Dewey, J. (1916/1966). *Democracy and education.* New York: Macmillan.

Dewey, J. (1935). The teacher and his world. *The Social Frontier, 1*(4), 7.

Dewey, J. (1938/1963). *Experience and education.* New York/London: Collier Macmillan Publishers.

Dr. Seuss (1960). *One fish two fish red fish blue fish.* New York: Random House.

FDA statement regarding glofish. (2003, December 9). Rockville, MD: US Department of Health and Human Services. Retrieved August 3, 2009, from http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm161437.htm

FDA's response to public comments. (2009, June 25). Rockville, MD: US Department of Health and Human Services. Retrieved August 3, 2009, from http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm113612.htm

Fowler, S. R., Zeidler, D. L., & Sadler, T. D. (2009). Moral sensitivity in the context of socioscientific issues in high school science students. *International Journal of Science Teacher Education, 31*, 279–296.

Gong, Z., Wan, H., Tay, T. L., Wang, H., Chen, M., & Yan, T. (2003). Development of transgenic fish for ornamental and bioreactor by strong expression of fluorescent protein in the skeletal muscle. *Biochemical and Biophysical Research Communications, 308*, 58–63.

Gong, Z., He, J., Ju, B., Lam, T. J., Xu, Y., & Yan, T. (2006). Chimeric gene constructs for generation of fluorescent transgenic ornamental fish. *United States Patent, 7*(135), 613.

Green, T. F. (1988). *Voices: The educational formation of conscience*. Notre Dame: University of Notre Dame Press.

Kapuscinski, A. R. (2005). Current scientific understanding of the environmental biosafety of transgenic fish and shellfish. *Science and Technical Review, 24*, 309–322.

Martusewicz, R. A. (2005). Eros in the commons: Educating for eco-ethical conscientiousness in a poetics of place. *Ethics, Place & Environment, 8*, 331–348.

Mueller, M. P. (2008). Ecojustice as ecological literacy is more than being "green!". *Educational Studies, 44*, 155–166.

Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism and sustainability. *Science & Education, 18*, 1031–1056.

Mueller, M. P., & Bentley, M. L. (2009). Environmental and science education in developing nations: A Ghanaian approach to renewing and revitalizing the local community and ecosystems. *Journal of Environmental Education, 40*, 53–63.

Mueller, M.P., & Tippins, D.J. (2010). Citizen science, ecojustice, and science education: Rethinking an education from nowhere. In B.J. Fraser, K. Tobin, & C. McRobbie (Eds.), Second international handbook of science education (pp. 00–00). New York: Springer.

Mueller, M. P. (personal observation, 2009, June 15) noted that employees at pet stores in Atlanta, Georgia, address how glofish sales have rapidly increased for teachers and parents without much conversation around the implicit implications of GMOs for society.

Muir, W. M., & Howard, R. D. (1999). Possible ecological risks of transgenic organism release when transgenes affect mating success: sexual selection and the Trojan gene hypothesis. *Proceedings of the National Academy of Sciences of the United States of America, 96*, 13853–13856.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Sadler, T. D. (2009). Situated learning in science education: Socio-scientific issues as contexts for practice. *Studies in Science Education, 45*, 1–42.

Sadler, T. D., & Zeidler, D. L. (2005). Patterns of informal reasoning in the context of socioscientific decision-making. *Journal of Research in Science Teaching, 42*, 112–138.

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education, 37*, 371–391.

Scientists Working Group on Biosafety. (1998). *Manual for assessing the ecological and human health effects of genetically engineered organisms*. Edmonds: The Edmonds Institute.

Shiva, V. (1997). *Biopiracy: The plunder of knowledge and nature*. Boston: South End Press.

Singer, P. (2000). *Writings on an ethical life*. New York: Ecco Press.

Snekser, J. L., McRobert, S. P., Murphy, C. E., & Clotfelter, E. D. (2006). Aggregation behaviour in wildtype and transgenic zebrafish. *Ethology, 112*, 181–187.

Stokstad, E. (2002). Engineered fish: Friend or foe of the environment? *Science, 297*, 1797–1799.

US Department of Health and Human Services. (2009). *Regulation of genetically modified animals containing heritable recombinant DNA constructs (CVM GFI #187)*. Rockville, MD: Center for Veterinarian Medicine.

van Eijck, M., & Roth, W.-M. (2007). Keeping the local local: Recalibrating the status of science and traditional ecological knowledge (TEK) in education. *Science Education, 91*, 926–947.

Walker, K. A., & Zeidler, D. L. (2007). Promoting discourse about socioscientific issues through scaffolded inquiry. *International Journal of Science Education, 29*, 1387–1410.

White, R. M., Sessa, A., Burke, C., Bowman, T., LeBlanc, J., Ceol, C., et al. (2007). Transparent adult zebrafish as a tool for in vivo transplantation analysis. *Cell Stem Cell, 2*, 183–189.

Wilson, E. O. (2002). *The future of life*. New York: Vintage Books.

Yorktown Technologies. (2008). GloFish® fluorescent fish ethical principles. Retrieved August 3, 2009, from http://www.glofish.com/ethics.asp

Yorktown Technologies. (2009a). It's cold outside: Exploring the effects of temperature on GloFish® activity. Retrieved August 3, 2009, from http://www.glofish.com/classroom.asp

Yorktown Technologies. (2009b). Biotech animals: Science, benefits, risk & public sentiment. Retrieved August 3, 2009, from http://www.glofish.com/classroom.asp

Zeidler, D. L. (1984). Moral issues and social policy in science education: Closing the literacy gap. *Science Education, 68*, 411–419.

Zeidler, D. L., & Keefer, M. (2003). The role of moral reasoning and the status of socioscientific issues in science education: Philosophical, psychological and pedagogical considerations. In D. L. Zeidler (Ed.), *The role of moral reasoning on socioscientific issues and discourse in science education* (pp. 7–38). The Netherlands: Kluwer.

Zeidler, D. L., & Sadler, T. D. (2008). The role of moral reasoning in argumentation: Conscience, character and care. In S. Erduran & M. Pilar Jimenez-Aleixandre (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 201–216). The Netherlands: Springer Press.

Zeidler, D. L., Walker, K. A., Ackett, W. A., & Simmons, M. L. (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. *Science Education, 86*, 343–367.

Zeidler, D. L., Sadler, T. D., Simmons, M. L., & Howes, E. V. (2005). Beyond STS: A research-based framework for socioscientific issues education. *Science Education, 89*, 357–377.

Zeidler, D. L., Sadler, T. D., Applebaum, S. & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. *Journal of Research in Science Teaching, 46*, 74–101.

Chapter 9
What's Wrong with Genetic Engineering? Ethics, Socioscientific Issues, and Education

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In "Moral-Ethical Character and Science Education," Michael Mueller and Dana Zeidler ground their ecojustice ethic mostly within a consequentialist theoretical framework. Consequentialism is the philosophical theory that determines the morality of an action by looking at the various consequences or effects that the action produces (Troyer 2003). One does not judge an action as morally defensible or indefensible by critiquing the action in of itself, but rather the good or bad effects that follow. For the authors, it is not the immediate act of biogenetically transforming the species *Danio rerio* into the ornamental, fluorescent-glowing pet fish, "GloFish," that is morally suspect. It is, instead, the various social and environmental consequences and risks that might, and in fact have, ensued from this act. For this response I will primarily focus on the ethics of what is clearly a forceful socioscientific issue – genetically modified organisms (GMOs) – and extend the ethical-educational conversation started by Mueller and Zeidler.

As a socioscientific issue, the authors are more concerned with GloFish as a transgenic species – that is, the fish as it exists, post-genetic modification, outside science's controlled environment – than they are with moral questions concerning the actual practice of genetic engineering. Yet the conceptualization of an ethic that focuses solely on the aftermath of a human action necessitates further development if it does not isolate and examine the action itself, apart from its consequences. As Mueller and Zeidler discuss, ecojustice relies on a diversity of perspectives to provoke the multifaceted dialogue needed for the socioscientific movement to gain momentum in the science classroom. So how can we diversify and broaden our ethical analysis of GMOs in general and of education specifically? I contend that we employ a nonconsequentialist theoretical approach by concerning ourselves with the very act of genetic modification, in addition to the ecological risks or problems of this act. This approach, it seems, will invite another mode of ethical thinking and enliven a discussion that is typically dominated by talk of implications, not of the intrinsic morality of transgenic technology. By the end of this essay, I will have not

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_9,

arrived at a conclusive judgment concerning the morality of genetic manipulation. My primary concern is the enrichment of classroom discourse and how asking certain questions can change us, even though we may not find any clear answers. In effect, this response should be regarded as a thought experiment that illuminates the educational fruitfulness of synthesizing different ethical theories.

Nonconsequentialism and Bioengineering

Is the act of genetic modification intrinsically wrong, regardless of any unwanted environmental or social effects? I believe this question is crucial to ask for at least two reasons. First, it is educative in that it enriches "functional scientific literacy," as defined by Mueller and Zeidler, by invoking "a spectrum of reasoning" to better analyze moral and scientific concepts when "considering our obligations to the life proper and the physical world we inhabit" (pp. 3, 9). And second, inquiry into the inherent morality of genetic manipulation seems lost among eco-educational narratives that mostly deal with the consequences that result from human interaction with the natural world. For these two reasons, let us now turn to the ethics surrounding the immediate practice of biogenetic technology and frame our analysis within a different, yet equally germane, theoretical paradigm.

Opposite of consequentialism stands nonconsequentialism, or deontology, which is a way of thinking about ethics that is chiefly concerned with the intrinsic moral worth of actions. Ultimately, many contemporary nonconsequentialists (Habermas 1990), following Immanuel Kant, aim to judge actions as inherently right or wrong based on the criterion of universality – an action is permissible if everyone could do it without conceptual or practical contradiction. The focus of philosophic inquiry should remain on the action itself, not upon its consequences. While it is the careful mulling over of outcomes that impels utilitarian thinking, it is identifying some sort of moral rules or principles to guide conduct that drives nonconsequentialist thinking. As we will soon see, when we turn a deontological eye toward GMOs, and thus switch our focus from the many threats posed by bioengineering to the very act itself, things become hazier as we are forced to wrestle with ethical problems from a notably different vantage point.

Dichotomous Thinking, Genetic Engineering, and the Inviolability of Nature

In his book *The Frankenstein Syndrome*, Bernard Rollin (1995), philosopher, animal and biomedical scientist, and bioethicist, identifies a number of possible reasons why people are quick to judge genetic engineering as prima facie wrong. He finds that one of the more popular reasons is the nature/culture dichotomy – an "age-old metaphysical dualism" that continues to fuel an erroneous perception amidst the public that bioengineering is fundamentally immoral (p. 40). In continually pitting nature and culture against each other, we are also reinforcing an embedded value judgment, where nature is typically viewed as intrinsically good and sanctified; culture, not so much. Jean-Jacques Rousseau (1762/1979) employs such a dichotomy, demonstrating the ideal of the inviolability of nature when he writes: "Everything is good as it leaves the hands of the Author of things; everything degenerates in the hands of man" (p. 37). For our purposes here, it is science and technology that represent culture, while the species they manipulate through genetic variation represent nature. This binary thinking leads to a value hierarchy: It is not right or good, so it is widely believed, to "mess with Mother Nature," especially with a biogenetic procedure that allows scientists in laboratories to treat life as an assortment of malleable chemicals. But once we take a moment to reflect on what we mean by "nature" and "culture," we find that this divide is not as tidy and clear-cut as it appears, particularly as it relates to the subject of genetic modification.

As the "green" movement becomes more prevalent, individuals are becoming more conscientious with regard to how their daily behaviors and consumption habits impact Earth; yet the fundamental question of whether we should change Earth seems to be answered by nature. Human beings – *Homo sapiens*, a species of great ape, the family Hominidae – are like other nonhuman animals in that, by our nature, we change and have been changed by Nature in order to survive. As Rollin writes, "humans have been altering nature since they crawled out of the primordial ooze; for better or worse, it is what we do, even as fish swim and birds fly" (p. 63). Of course, this does not mean that we have remained intelligent or even commonsensical when altering the natural order of things; the ecological degradations and the prices we might pay for our recklessness are becoming evermore apparent. It is understandable to be resentful with the methods we have employed to transform environments, but the act of transforming nature seems to be morally permissible. When we act ecologically and socially irresponsible, are we acting immoral, per se? For example, our building of roads and bridges, our domestication of animals and plants, or just my breathing at this moment, all result in a change of the natural elements. Human beings choosing reproductive partners is genetic manipulation in some sense, but is this an act of "nature" or "culture"? Culture bleeds into nature; it is indeed becoming nature. It seems unfounded, then, to argue against the genetic manipulation of species because it is unnatural or somehow violates or alters nature. Invoking the principle of the inviolability of nature to oppose genetic engineering is undoubtedly a popular dialogical move, but is it one supported by a convincing philosophical argument?

Some scholars (Smith 2003) disagree with the intrinsic wrongness of genetic engineering, arguing that it is an impossible position to defend philosophically on secular-nonconsequentialist grounds. Deontologists who want to make the case that GMOs are universally immoral because they violate nature have a serious challenge – one that puts them in a thorny situation of either deeming some fundamental, time-tested human practices of other forms of genotype alteration as also inherently immoral, or succumbing to the conclusion that biogenetic alteration is ethically acceptable (albeit regulated, if desired). Kevin R. Smith denotes the crux of this nonconsequentialist dilemma:

> Genetic manipulation entails the deliberate alteration of genetic sequences within the genome. The same fundamental process of sequence alteration occurs as a result of genetic selection, both natural (as with evolution) and artificial (as with selective breeding of domesticated plants and animals). In terms of sequence alteration, the only significant difference between genetic manipulation and genetic selection is that the former process is very much faster than the latter. Thus, an assault on the ethics of transgenesis based on a notion of the intrinsic wrongness of sequence manipulation would be sustainable only as a subset of a much broader assault on all forms of deliberate sequence alteration (DSA)." (p. 326)

In other words, humans have been modifying the genetic sequence of other species for a very long time, and the only difference now with bioengineering is the speed in which we do it. Thus, if we are to agree with the position of the intrinsic wrongness of GMOs, we then are logically obligated – assuming we are to be consistent in our thinking – to also deem it wrong to alter species via selective breeding.

Now, there are philosophers of animal rights (Regan 1983) who contest the selective breeding of sentient nonhuman animals (most do not object to selective breeding of nonsentient plants). However, I venture to presume that most people, without arguing that they are right, do not object to this traditional form of DSA. But what would happen if we were to decide to make the "assault" that Smith indicates above; that is, protest "all forms" of DSA, including selective breeding? Such a conceptual reconfiguration, if actualized, would comprise significant practical ramifications that would not only change the course of our daily lives, but that would also threaten the very survival of our species. It has been the human mastery of selective breeding – that is, modifying the genetic code of other plant and animal species – that has helped us flourish on Earth as *Homo sapiens*.

The point remains, however, that bioengineering is in fact very different from the conventional methods of DSA. Even if we do not concede that genetic engineering is outright immoral, this difference – the rapidity incumbent with biotechnology – should make us view the process of species manipulation in a new way. Is the degree of difference – that is, the reduced amount of time it takes to modify species' genetic sequence to our desired end – enough reason to defend one method of gene alteration but reject the other? If so, what exactly is the appropriate amount of time – a few months, years, or a decade – where moral judgments change from accepting sequence alteration as ethically permissible to rejecting it as ethically reprehensible?

Rollin thinks the rapidity with which we can now change the genomes of other species forces us to examine old questions in a new light. The advantage of conventional sequence alteration is that one "had ample opportunity to observe the untoward effects of one's narrow selection for isolated characteristics" (p. 109). However, with new technologies it is much more difficult to "detect the problematic aspects of what we are doing until after the organism has been widely disseminated" (p. 109). It seems now, given the accelerated pace of genome variation with bioengineering, that we indeed have a new morally relevant characteristic that did not exist with traditional methods of DSA.

Notice how our discussion has led us back to consequential ethics; we have reentered the realm of the "problematic aspects" and unintended effects of biotechnology. This breach into the consequentialist paradigm supports my larger argument (which I will get to soon) about the educational value of emphasizing both ethical theories. For now, I will continue to raise deontological questions not because I have the answers, but because they are fundamental to ask to cultivate the socioscientific reasoning that Mueller and Zeidler describe in their chapter. It is the questions, I believe, that are of educational interest.

Respect for (Human) Persons

In general, nonconsequentialists build their ethic around the principle of the equal respect for persons and violating this principle is another potential rationale for the universal wrongness of bioengineering. The principle postulates that human beings have inherent moral worth because we are rational, responsible, and autonomous beings. As such, persons are to treat each other as moral agents, worthy of respect, as ends in themselves and never as means to an end (Kant 1785/1981). Let us now apply this principle to genetic manipulation.

Similar to the principle of the inviolability of nature, this one too entails disputable overtones and requires some questioning of its basic assertions. What constitutes personhood? Are there degrees of personhood, or is there a line of demarcation that we can draw between "person" and "nonperson"? What does it mean to be a "rational" and "autonomous" being? Are human beings the only "persons?" Prior to the last 30 years, the answers to these questions were fairly straightforward. However, as we better understand the mental, emotional, and social lives of other nonhuman species (especially of other great apes) traditional conceptions of personhood are increasingly being challenged. In fact, some applied ethicists and scientists ascribe personhood, or at least a certain degree of personhood, beyond humanity (Cavalieri and Singer 1994). But for the sake of space and argument, I will assume that the only persons are human beings.

If geneticists are able to conjure up new species by varying the genomes of a plant, a mouse, or a pig, what is to stop them from doing the same with human beings? For many, this seems unethical, perhaps outright terrifying. The manufacturing of human beings in labs defies our sentiments about human dignity and challenges our unique moral place in the world. So how, then, do we conceptually assess this question of human genetic control? To begin, if humans were to become subjects of bioengineering – say, scientists began to clone humans – then this would amount to the violation of the equal respect for persons' principle. Some theological scholars, for example, argue that technologies such as embryonic research and cloning "depersonalize" the human individual by inventing or manufacturing merely "products," not free and dignified human persons (Shannon 2000). Deontologically speaking, it is irrelevant whether biogenetics is used for a good purpose or an evil purpose because the fact remains that human beings – persons – would still be manipulated as objects and tools, mere instruments for some other goal. Hence, scientists would not be honoring the inherent value and self-determination of the human person, which is morally required by nonconsequentialist ethics.

With that said, those who claim that biogenetically growing human beings is fundamentally wrong because it may one day violate personhood, must address the practicality of their position. Relatively all human cultures have a long history of keeping a very rigid and conspicuous human/animal divide, treating nonhuman species very differently than fellow members of our own species. For instance, here in the USA, the vast majority of us deem it natural and acceptable to rear, confine, slaughter, and eat approximately ten billion animals annually. There is little evidence that this will change; and to exclusively base one's case on breaking what at times looks to be an insurmountable human/animal barrier may constitute tenuous reasoning. The point is that advancing the notion that we might someday allow the genetic control of human beings because we do so now with plants and some animals does not hold enough persuasive strength to convince me that genetic modification is prima facie wrong.

Yet again, notice how we have returned to consequentialist thinking by exploring what may come in the future. Even though the consequences that we are predicting – lack of respect for persons – are undesirable for nonconsequential reasons, we are still predicting future outcomes, and this is prototypical consequentialism. It seems, at least in the case of GMOs, that I cannot help but to adjoin these two ethical theories, and in the next section we will look at why this is important for the socioscientific movement in science education.

To end this section, I believe that Mueller and Zeidler are certainly right to focus on the ecological consequences associated with releasing the transgenic species GloFish into the wild. However, I hoped to demonstrate that, for educational purposes, we should not overlook the possibilities in deontological theorizing, which allows for a different moral angle. I have examined bioengineering through a nonconsequential paradigm in order to bring to light some of the broader ethical-educational questions couched in socioscientific issues. Because genetic technology is too significant a matter to go unchecked by a complacent, uneducated public, in what follows I hope to illustrate the educative value of synthesizing the two different ethical theories.

Fusing Two Paradigms

The interplay of both consequentialist and nonconsequentialist theoretical lenses widens the scope of ethical thought and helps generate the multifaceted analysis and discourse that ecojustice requires for the formulation of a "more humanizing science and science education." To this end, students identify the known and potential consequences of their behavior. But in addition, they are in a better position to be cognizant of the inherent moral worth of their actions and also learn how to communicate from, with, and about their raw emotions on important moral issues that arise in their educational experience.

Mueller and Zeidler explain how socioscientific reasoning involves students exercising self-reflection and self-questioning of their most "fundamental beliefs and values." It is highly probable that some students, and educators too, believe that humans should not be in the (big) business of genetically modifying species. Furthermore, some may not be able to articulate or defend the nuances of their convictions or positions with a consistent line of reasoning. This does not mean students' primary feelings and thoughts on important ethical matters are unimportant or unintelligible. In fact, the very opposite is true – these surface intuitions provide the foundation and opportunity for the development of further reflective and argumentative skills. As the authors write, "Under the SSI framework, 'reasoning' is not meant to subjugate emotion, intuition, or other forms of human knowledge and experiences. Reasoning is what we do when we invoke a spectrum of thought." Without marginalizing or dismissing students' "gut" reactions – their intuitive and emotive sources of knowledge – as irrational, irrelevant, or somehow not educable, schools and educators should flesh out *why* students might feel this or that way about biotechnology, which is, to some extent, a pre-consequential conversation.

A central purpose of this paradigmatic fusion is to discern the strengths and weaknesses of each theory. For example, focusing solely on the consequences of behavior, albeit important, should not consume all our energy – this will thwart the pedagogical enterprise of ecojustice ethics through socioscientific issues. Educators and schools are likely to perpetuate the despair often associated with the "ecological crisis" by only focusing on the consequences of students' actions (Mueller 2009). Educationally speaking, it is disparaging to inculcate in children that "your actions will either rescue or annihilate future generations of your species and the Earth." Finger-pointing breeds aversion and will most likely stifle any desire to act environmentally responsible. Educating for ecological intelligence is probably best approached with a close look at the underlying presuppositions and motivations of human conduct, in addition to the careful contemplation of the ramifications of individual action and institutional policy.

Conversely, a weakness of the nonconsequential wrongness position, as in the case of GMOs, is that it can eliminate potential benefits before we even have a good grasp about what the benefits are. Rollin points out how the ubiquitous, almost unquestioned belief in the "inherent wrongness of tampering with the human genome" has hindered forms of genetic research that could "remove, repair, or replace the defective gene at the embryonic level" for sufferers of, for example, cystic fibrosis (p. 65). Assuming we possess the knowledge and technology to reduce the suffering of human persons by eradicating certain diseases before they even take hold, are we not morally obligated to do so? In sum, the socioscientific movement should embrace these two seemingly conflicting paradigms to enrich human moral consciousness and better help students "make value judgments and confront disparities for affected peoples, plants, animals and the environment."

Conclusion

Rollin believes most scientists are not educated: “We do not educate scientists or physicians to be virtuous citizens, we train them in a technocratic way” (p. 31). Notice the distinction he makes between what it means to “educate” and what it means to “train.” Training is merely preparation and instruction, mechanistic and highly controlled. While beneficial for mastering a specific skill-set, training is antithetical to dialogue, to synthesis, to the interdisciplinary approach incumbent upon ecojustice educators in teaching socioscientific literacy. Education, on the other hand, involves questioning, contextual analysis, discernment, and conversation. It furnishes the conceptual and practical conditions that cultivate the faculties of reason and imagination for a deep ethical and aesthetic appreciation for the ecological – that is, the relational – elements of our world. Whether we believe bioengineering is immoral or not, we cannot stop it. That does not mean that we are utterly powerless. Our power is education. The hope for a more humane science lies in our appetite and adeptness to engage in science *education* with the holistic fashion that ecojustice – indeed, that human experience – calls for.

Acknowledgments I thank Bryan R. Warnick for his thoughtful comments on previous drafts of this response.

References

Cavalieri, P., & Singer, P. (1994). *The great ape project: Equality beyond humanity*. New York: St. Martin’s Press.

Habermas, J. (1990). *Moral consciousness and communicative action*. Cambridge: MIT Press.

Kant, I. (1785/1981). *Grounding for the metaphysics of morals*. Indianapolis: Hackett.

Mueller, M. P. (2009). Educational reflections on the “ecological crisis”: Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.

Regan, T. (1983). *The case for animal rights*. Berkeley: University of California Press.

Rollin, B. (1995). *The Frankenstein syndrome: Ethical and social issues in the genetic engineering of animals*. Cambridge: Cambridge University Press.

Rousseau, J. J. (1762/1979). *Emile: or, on education*. New York: Basic Books.

Shannon, T. (2000). *Made in whose image? Genetic engineering and Christian ethics*. Amherst: Prometheus Books.

Smith, K. R. (2003). Animal genetic manipulation: A utilitarian response. In S. J. Armstrong & R. G. Botzler (Eds.), *The animal ethics reader* (pp. 323–331). New York: Routledge.

Troyer, J. (Ed.). (2003). *The classical utilitarians: Bentham and Mill*. Indianapolis: Hackett.

Chapter 10
Action-Based Science Instruction: Service-Learning, Stewardship, and Civic Involvement

Jennifer Ponder and Amy Cox-Peterson

Mueller and Zeidler discuss socioscientific issues (SSI) as they relate to students' everyday lives in the context of environmental, political, social, and ethical issues. In this chapter, we will provide instructional methods and practical applications related to applying SSI within the classroom through action-based science projects. Although any subject can give rise to an action-based project, science is a rich field in which social activism can sprout. Global warming, medical and surgical needs, environmental stewardship, energy awareness, recycling, the aftermath of natural disasters, and, yes, concern for threatened and endangered organisms are just a few connections between science and community action projects. Classroom lessons can be taught and soon forgotten, but the passion, commitment, and emotional expense of an action project ensures its cognitive value and longevity, as well as the preparation of civic-minded individuals who gain problem-solving and decision-making skills for the future.

Decision-making, service, and action within one's community is not usually at the forefront within the K-16 curriculum. In addition, the process of action-based pedagogy and learning is not accessible if teachers and students are not educated about their responsibilities, their role as decision-makers, and the various opportunities to connect community activism with academic content standards. This chapter provides information and examples to encourage the integration of action-based pedagogical strategies into the science classroom. Service-learning, civic involvement, and stewardship are described as three viable action based strategies that can be easily aligned with formal science content standards such as the National Science Education Standards in the USA (National Research Council [NRC] 1996) and the National Science Curriculum Standards in the UK (1999).

Science standards throughout all grade levels indicate that students should engage in activities that lead to questions and investigations. For example, the

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_10,

California science standards proclaim, "scientific progress is made by asking meaningful questions and conducting careful investigations" (California State Board of Education 1998, p. 7). In order for this goal to be attained, students must have the opportunity to identify and consider issues impacting the natural world around them, explore alternative solutions connected to science issues, and work together to learn science content and enact change.

Civic Knowledge, Dispositions, and Skills

It is important to note that citizenship education is often cited as a priority in most school mission statements, so it is interesting to consider how this goal might translate into practice, particularly science practice. It is a challenge, however, for teachers to find curricula to help students understand that civic education is not a list of mechanical skills for a test, but knowledge for further developing and "creating a public" (Postman 1995, p. 18). Patrick (2002) developed a framework that defines components of common education for citizenship in a democracy. We use Patrick's framework to create the following three categories of civic education as related to civic curriculum: (a) civic knowledge, (b) civic dispositions, and (c) civic skills.

If active civic involvement is necessary to promote civic competence, it is crucial that citizens are knowledgeable, for "when participants possess a rich storehouse of knowledge about democracy and social life near and far, their discussions and decisions are more intelligent and their service projects more effective" (Parker 2005, p. 92). With any discussion about knowledge, it is inevitable that the issue of what knowledge should be deemed important will arise. We believe this discussion will depend on the nature of the project and the meaningful connections the students will find as they examine the issue. We argue that natural connections related to science concepts, principles, practices, contexts, integrated with the history of democracy and institutions of representative democratic government (Patrick and Vontz 2001) will emerge through the curricular experience. If this situation is true, then teachers can use the context of an action-based project to expand students' civic and science knowledge.

The second aspect of civic education critical to quality civic curriculum is the development of attitudes and values regarding the roles and responsibilities of citizenship. These civic dispositions are the elements of civic education concerned with the habits and inclinations that summarize an individual's behaviors and values in relation to democracy. According to Parker (2005), these virtues include responsibility, civility, honesty, courage, fairness, and lawfulness. Wynne (1986) emphasizes the importance of civic dispositions by stating that moral values have been dominant in all educational areas throughout history. According to Patrick and Vontz (2001), qualities such as promoting the common good, recognizing and supporting equality for all people, and fostering responsible civic participation are all traits necessary to sustain a representative democracy. By perpetuating and promoting these dispositions through an action-based curriculum, educators can begin to help students move beyond citizenship that focuses on good deeds, and develop the participatory civic skills of deliberation and policy analysis necessary in order to maintain democracy and enact change.

Civic skills, or any skill that empowers students, can influence public policy while holding government representatives accountable. Through action-based projects, teachers can provide students with opportunities to identify, describe, evaluate, analyze, and think critically about issues related to science. More specifically, students should be actively engaged in thoughtful deliberations that encourage the consideration of multiple perspectives before decisions are made. Creating and implementing a plan of action to inform and influence social or scientific change will allow students to apply ecojustice principles and demonstrate valuable civic skills as they participate in civic life beyond the four walls of their classroom (see Patrick and Vontz 2001, for additional information).

Action-Based Strategies

Community service involvement projects breed an atmosphere that promotes motivation, access, and a purpose for learning in school. With service-learning, stewardship, and civic involvement projects, students are actually creating something and making an impact on the community and world in which they live. Such projects also provide opportunities for full participation of the students, teachers, and others beyond the traditional four walls of the classroom. Now we discuss and provide examples of three action-based strategies that can be applied to science instruction and aligned with the science curriculum.

Service-learning involves a learning process where students contribute and provide a service to the community while the community in turn provides a service back to students and schools. This type of project results in reciprocal learning and community partnerships. Specifically, service-learning assignments are ones in which students provide a service and address a community need (Wade 1997) such as gleaning crops and donating them to local food banks. Gleaning is the process of collecting leftover crops in fields. Students can inquire about the type of soil, climate, and other resources needed to grow crops and protect them better. Buchanan, Baldwin, and Rudisill (2002) describe how service-learning differs from traditional community service or field experiences. First, it includes experiences where students learn content while performing community service. Secondly, students apply content to the community setting, reflect on their experiences, and develop relationships with participants or area of study. Third, service is provided "with, rather than for, the community partner" (p. 28) resulting in benefits for all parties. Cumulatively, service-learning provides students with opportunities to learn through active participation in experiences that help the community in some way.

Kaye (2004), known for her expertise in service-learning, outlined essential elements of service-learning projects. These elements include:

- Integrated learning
- Meeting genuine needs
- Youth voice and choice
- Collaborative efforts

- Reciprocity
- Civic responsibility
- Systematic reflection

Examples of essential service-learning elements are described below.

Integrated learning: Connect the project to other areas of the curriculum. For example, students can use language arts skills to write friendly letters to local businesses to elicit support for their project. Or students can calculate the amount of pollution created by a specific number of cars idling in a carpool area of their school each morning.

Meeting genuine needs: Communicate with community organizations and partners related to the project to discover an organization's specific needs before creating a plan of action. For example, students could use questionnaires or conduct interviews to discover how they might support a cause or an organization that supports this cause.

Youth voice and choice: Actively involve students in the decision-making process associated with a service-learning project. Teachers can use deliberation strategies such as structured decision-making to help students consider multiple perspectives and find alternative solutions related to selected issues. Structured decision-making takes place in small groups where students discuss a controversial issue, invite multiple perspectives, and work toward consensus (Guillaume et al. 2007)

Collaborative efforts: Work with local businesses, organizations, and government officials to build partnerships that will further students' cause and help raise awareness for their selected issue. For example, students can elicit support for a project from families, local businesses, government officials, other schools, and members of the community.

Reciprocity: Service-learning is based on the idea that participation in a service activity will strengthen students' learning experiences. At the same time, the in-depth learning that takes place ultimately strengthens the outcomes associated with the service project. For example, students learn about animal cruelty and neglect by working with the local animal shelter. Students use this knowledge to educate the public about animal needs and work with local government officials to pass animal cruelty laws. As a result, the animals and the employees at the shelter benefit from students' service project and their public awareness campaign.

Civic responsibility: Participation in service-learning can increase students' awareness of their role in community issues and improvements, as well as help them understand civic institutions. For example, students can learn about the difference between individual rights and the common good. They can also explore which government official or agency they should contact if they want to propose a change or address an issue in their community or state. This knowledge is meaningful to the students because it confirms that their voices can make a difference.

Systematic reflection: Reflection promotes learning. Reflection should take place before, during, and after service to make explicit connections to learning experiences.

Students can use journals, portfolios, role-play, discussions, or reflection maps to make connections.

The Kids Involved Doing Service (Kids Consortium n.d.) is an organization that works with local communities and schools to identify, research, and figure out how to meet a community's need. Teachers match specific projects to state content standards and help to develop the hands-on interactive learning experiences. The KIDS Consortium has three basic components:

1. *Academic integrity* – Service-learning projects are linked to state content standards. Content is taught through the activities. Students are aware of these standards and focus on them as they are participating in service activities.
2. *Apprentice citizenship* – Students take roles as valuable members of the community and partner with community groups to take action and make a difference. This is important because students learn how they are a part of the larger system that has a voice to enact changes to make their community a better place to live.
3. *Student ownership* – Students are encouraged to make decisions during the learning and problem-solving process. Teachers and community members facilitate the process, but the students actually guide decisions being made. Students are more motivated to lead project activities and continue the project over time if they have a stake in determining the actual project and associated activities.

Stewardship is closely linked to service-learning and includes the call for responsibility to ensure welfare of the world and within world. This can include science topics related to environmental conservation, economic welfare, education, health care, disaster relief, animal welfare, in addition to human rights. Stewardship includes individuals or groups working together to obtain greater peace and sustainability throughout communities everywhere. Stewardship, like place-based education, involves students and teachers focusing on nature-based learning that connects them with their community (Sobel 2004). Stewardship activities require that teachers expand science experiences beyond traditional classroom experiences and help students investigate the world around them. Stewardship and place-based learning include cumulative efforts of individuals or groups which result in positive outcomes for the environment. Stewardship, therefore, is the moral obligation to care for the Earth, its people, animals, and resources so that it may be preserved for future generations. As part of the formal curriculum, teachers, families, and communities can work together to teach the value of stewardship and integrate science content standards with stewardship activities. For example, the Youth Stewardship Program in San Francisco provides free stewardship opportunities for teachers and students. Five field trips to a local park accompanied by lesson plans that connect to California science content standards are provided for participating groups. These lesson plans focus on habitat restoration related to areas such as water and soil or plant adaptation.

Civic Involvement is implemented within science education to encourage active community members. Ketter, Zukin, Andolina, and Jenkins (2002) describe civic involvement as incorporating three different areas: Civic Activities, Electoral Activities, and Having a Political Voice. Civic activities improve the community or help local individuals or groups. Such activities include volunteering time or a service, joining a civic organization, or supporting fund-raising efforts to promote action and change. Electoral activities include voting, persuading others, and volunteering to promote government initiatives or community needs. Having a political voice includes writing or meeting with decision-makers, creating or supporting petitions, and protesting. Keeter et al. also created a list of core indicators of engagement. These areas include:

1. Civic activities – Community problem solving, regular volunteering within the community, active membership within a group, participating in fund-raising efforts, and raising money for a cause or charity.
2. Electoral activities – Regular voting, persuading others to vote or participate, displaying buttons or signs in support of candidates or initiatives, volunteering for candidates or causes.
3. Having a political voice – Contacting political officials or other decision-makers, protesting, boycotting, contacting print or broadcast media, creating or participating in written petitions, and canvassing (going door to door to discuss concerns, causes, or express views).

Although the Ketter et al. (2002) core indicators of civic engagement are created for young Americans, ages 15–25, it is important that teachers in grades K-8 integrate activities that build knowledge, background, and motivation to engage in civic activities. Below you will find specific examples of how fourth and fifth grade students incorporated the three areas of civic activities, electoral activities, and having a political voice into their service-learning project.

Civic activities: A group of fourth and fifth grade students raised over $10,000 to help a local toddler's family pay for a very expensive surgery not covered by the family's insurance plan. The students raised the money by starting a community recycling center at their school site and building partnerships with local businesses.

Electoral activities: The same fourth and fifth graders from the example above conducted research to learn more about the presidential candidates before the 2008 primary election. Since their fund-raising project was related to health care, the students focused on the candidates' proposed health care plans. After learning about specific candidates, the students wrote a letter to the candidate of their choice and expressed their support for proposed policies. An example of a fourth grade student's letter is included below:

Letter to Senator Hillary Clinton

Dear Senator Hillary Clinton,

Here at Good Citizens Elementary School, the fourth and fifth grade combination class has been given a chance to write to a candidate. I picked you because you have many excellent ideas to help us and our world. I love your ideas about Universal Healthcare. Our class has been trying to raise money for a little girl's operation; she has a rare disease called Moebius Syndrome. This disease affects the sixth and seventh cranial nerves, which means she cannot smile or make any other facial expressions. She is only 3 years old and her insurance company thinks of this surgery as plastic surgery, so they won't cover the operation fee.

> Some countries cover the payment when you go to the hospital, so maybe you can change it and make sure everyone has health insurance at a reasonable price. We would really appreciate it if you would come to our school.
>
> Sincerely,
>
> Ayana

Having a political voice: In addition to raising money for the local toddler's surgery costs not covered by insurance, students wanted to know if and how *they* could get involved with changing issues they did not like. After gaining new knowledge about the government and their rights as citizens, the students were eager to take action at the state level. After learning about the Bill of Rights and how a bill becomes a law, they decided to propose an idea for a bill to their California representatives. At first, the students wanted to propose a bill related to health care using the toddler they had been raising money for as an example of social injustice. The students were even interested in challenging the health insurance company that denied the initial claim. However, the students had to shift gears after the toddler's family asked the students not to get involved with the legal aspect of the issue. As a result, the students had to reconsider the focus of the project.

During a brainstorming session about other issues related to the project that could be addressed through public policy, several students brought up issues related to the environmental knowledge they had gained from recycling to raise money for the toddler's surgery. After weeks of discussion, the students agreed to propose a bill related to recycling. The students' proposal suggested that all California schools should be designated as community recycling drop-off centers. Their rationale for this proposal was to make it more convenient for people in every community to recycle while also raising money for each school from the California Redemption Value, a deposit paid on certain recyclable materials at the time of purchase.

Once informed, they wrote letters and spoke publicly to elicit support from local and state government officials as well as other members of the community. A small group of students spoke at a local city council meeting, while the entire class wrote a letter to the California representative from their district. Students also contacted the local media and worked to build a partnership with the local waste management. All of these activities emerged from the students' work on their project, which also led the students to construct their own definition of citizenship.

Action-Based Learning Examples

The issues within a community are endless. An in-depth investigation of these issues can motivate student action and enhance science teaching and learning. Below is a list of sample service-learning, stewardship, and civic involvement activities related to science.

Sample Service-Learning Projects:

1. Third grade students investigate the interactions of organisms in their local forests. The students display their art work to raise awareness for maintaining open space in their own community. They also start a recycling campaign to raise money to promote open-space awareness at various city locations.
2. Middle-schools students work with the school district superintendant's office to identify popular healthy foods among their peers to curtail childhood obesity. They create a slogan, brochures, web site, and posters to promote healthy eating and change food choices at schools in the district.
3. High-school students serve as tour guides at a local museum or nature area. Teams of high-school students lead and facilitate tours for elementary students who visit. They plan activities, discuss the content, and connect the content and activities to the elementary school students' lives and culture.

Sample Stewardship Projects:

1. Students, families, and teachers participate in a painting project within their community. They paint, "Do not litter, drains to Ocean" on the gutters and create informational flyers to residents explaining the new signage. Students use informational books and on-line resources to determine the problems that ocean animals and ecosystems face when trash and other debris drains into ocean or river waters.
2. An elementary school encourages families, students, and teachers to participate in a beach cleanup day once each month. They organize the trash, analyze it, and classify it during classroom activities. The different types of trash are graphed and reported via news articles and morning announcements.
3. Students at Ramirez Middle School promote "No Impact Tuesdays" where students, families, and teachers work to provide as little impact on the environment as possible. Students create posters and newsletters to promote their cause. On Tuesdays, the entire school community works together to use as little water as possible, bring lunches in recyclable containers, use cloth napkins, write on white boards, and use as little electricity as possible. Different classes take turns interviewing other students, calculating the amount of carbon producing resources saved, and writing news articles about how their school is helping to protect their environment.

Sample Civic Involvement Projects:

1. Third grade students investigate the interactions of organisms in their local forests and open spaces within their community. The students locate information about the different plants, animals, and threats to these areas. They write articles and create art work to raise awareness for maintaining open space. They meet with their city council to create ordinances to maintain a specific percentage of open space within their community. The citizens in their city are given the opportunity to vote to approve this action during a local election.

2. After participating in a cleanup event at a local park, sixth grade students observe several cigarette butts around the pond. After conducting research about the harmful effects cigarette butts can have on the animals, they propose a bill to ban smoking in public parks in their city.
3. Seventh grade students investigate the effects of car idling on the environment. They investigate the chemical pollution produced, idling time, and number of gallons of gas burned while cars idle in car pool lines. They work with the School Board in their district to abolish idling while cars are waiting for students in school parking lots and other parts of the school property.

Categories of Citizenship

Civic participation can also be examined through different categories of involvement. Westheimer and Kahne (2002) provide a framework that distinguishes between three different types of participatory citizenship projects. Their ideas are listed in Table 1. Notice that service-learning and stewardship are participatory whereas civic involvement involves justice-oriented activities. For the most part, traditional science curricula and lesson plans target the personally responsible citizen, rather than a participatory or justice-oriented citizen.

Table 1 Types of citizenship participation (Adapted from Westheimer and Kahne 2002, and Cox-Petersen 2010)

Personally responsible	Participatory	Justice oriented
• Acts responsibly in community • Works and pays taxes • Obeys laws • Recycles • Volunteers	• Active member of community organizations • Organizes community efforts to care for those in need • Knows how government agencies work • Knows strategies for accomplishing collective tasks	• Critically assesses social, political, and economic structures to see beyond surface causes • Seeks out and addresses areas of injustice • Knows about democratic social movements and how to effect systemic change
Contribute to a recycling bin at home, work, school	Work with the community to create and organize recycling bins at home, work, and school; monitor the progress of the project	Gather info about why people do not recycle, create a plan to encourage recycling, make public announcement about recycling, and report on the progress of the project
Traditional classroom projects	Service-learning and stewardship projects	Civic involvement projects

There are various ways to begin initiating service-learning, stewardship, and civic involvement projects within science lessons. Example 1 outlines a step-by-step plan that can help students and teachers begin taking action within their community. While planning and implementing these projects, teachers should remember to (a) dedicate a sustained amount of time, possibly the entire school year to the project; (b) encourage participation from groups outside of the school such as families, businesses, and community leaders; (c) connect the action-based activities to the science curriculum; (d) make explicit connections between the science content and the community service and action; and (e) provide ample time for student reflection, discussion, sharing, and making decisions.

Example 1. Steps to Enacting Service-Learning, Stewardship, and Civic Involvement (Ponder and Cox-Petersen 2008)

Take Action and Practice Active Citizenship!

This task will help teachers and students practice active-based strategies. First, select an issue that you and your students are passionate about. Follow the five-step process to action. Use the outline below to format your plan of action.

The tips below (based on steps recommended by Center for Civic Education [2006] and Kielburger and Kielburger [2002]) are helpful when launching an active citizenship project in your classroom:

1. Increase awareness. *Explore current issues in your school/community, state, country, and world. Encourage students to watch the news, read the local newspaper, and search the web to help them identify problems in their immediate environment and report back to the class. Use a four-quadrant chart and create a list of current problems in each category. Encourage students to document the issues by bringing in newspaper clippings or by taking photographs of problems around the community or school (graffiti, litter, etc.). Make a list of the top issues based on students' interests.*
2. Deliberate. *Let the students choose an issue. It will be more meaningful if it comes from their interests. Narrow down the issues that students have generated in an attempt to choose one problem the entire class can attempt to resolve. Follow the steps listed below to narrow down the problems:*

   (a) Ask students to list their top three choices on a small sheet of paper. Tally the results and identify the top three issues selected by the students.
   (b) Send home a letter and ask for parents' support by involving them in a discussion with their child about the issues identified. Ask the parents and the child to discuss each issue at home, select one issue that they think the students can resolve, noting ideas that students can put into action to encourage change, and complete a required form to document their discussion and selected problem.
   (c) Next, write a persuasive paragraph/essay. Ask each student to write a persuasive essay about the issue they selected with their parents and guide students to support their opinions with reasons, examples, and commentary. Encourage them to talk about possible causes, consequences, and solutions to the problem in their essay.

(d) Organize student groups based on common issues and share essays. Have each group plan a presentation to persuade the rest of the class that their issue is the most important to solve.
(e) After all the groups present their essays, create a chart to outline the pros and cons associated with each issue.
(f) Take a final vote and select one issue.

3. Become an expert. *Students should conduct extensive research on the issue before they can take action. To gain a better understanding of the selected issue explore the root cause and examine possible solutions. Make a list of some possible solutions and identify pros and cons associated with each idea. Be sure to use a variety of resources to find out as much as you can about the issue selected.*
4. Devise a plan of action. *Let the students lead the project and make decisions. Encourage students to think outside the box when brainstorming ideas that could possibly impact the selected issue. Also encourage students to build partnerships with groups in the community. Be sure to consider how you and/or your class could elicit support among individuals and groups in the community. Describe a clear and detailed plan of action to address the selected issue. Possible action plans could include writing letters to local businesses or members of the local, state, or federal government, speaking at public forums such as a city council meeting, writing petitions, making posters or brochures, creating a website or blog to raise awareness for the issue, contacting the media, or creating a video documentary using software such as iMovie.*
5. Get busy. *Publicize the issue in your community and beyond to increase awareness and build partnerships. After you and your students implement the project, review and evaluate each action.*

Consider questions such as:

What were the positive aspects of the project?
What were the major obstacles associated with this project? *(Other than time)*
How could you improve the project?
How well did the class work as a team?
What did you learn from this project?
What recommendations do you have for other teachers/students who are thinking about doing a take action project?

Research suggests that service-learning projects, with an emphasis on civic involvement, can help students develop a sense of self-efficacy, enhance academic achievement, and improve social skills and civic mindedness (e.g., Schultz 2008). Facilitating service-learning and action-based experiences in the classroom allows students to actively participate in their community and discover how one person, even a young person, can make a difference and connect science to issues within their community. These projects provide students with the opportunity to examine problems, select issues that are meaningful to them, come up with action plans, and work as a team to attempt to solve problems, all while connecting learning to formal science standards.

The nature of action-based projects allows the science curriculum to evolve and transform beyond its original intent. As a result, students are deeply connected to the material and become key partners in investigating scientific phenomena, enhancing scientific skills, and making a difference in their community. The process of working toward a solution for a meaningful cause often creates opportunities for students to delve into more complex issues and opens the door for science learning for all students.

Current issues such as global warming, recycling, conservation, endangered and extinct species, animal cruelty, genetic cloning, and ethical science research have a direct connection to human lives. How we interact with other species and care for our Earth will impact the lives of future citizens of this planet. Expanding service-learning projects to the science curriculum is one way to encourage students to consider moral ethics related to ecojustice and expand their understanding of the relationships that exist among humans, nonhumans, and the Earth.

In conclusion, action-based projects may have a catalytic ability to motivate students into using democratic skills to question injustice, work to better their surrounding community, and be an advocate for those who do not have a voice (in some cases, even themselves). We concur with Westheimer and Kahne (2004) who encourage teachers' "civic commitment by exposing students to problems in society and by creating opportunities for students to have positive experiences while working toward solutions" (p. 265). Ultimately, action-based projects empower students to initiate change in their community and beyond by applying knowledge and skills obtained through schooling to real-world problems in authentic contexts. The experiences associated with active civic involvement can help students learn an important life lesson: Any one of us can make a difference.

References

Buchanan, A. M., Baldwin, S. C., & Rudisill, M. E. (2002). Service learning as scholarship in teacher education. *Educational Researcher, 31*(5), 28–34.

California State Board of Education. (1998). *California state content standards: Science.* Retrieved December 13, 2009, from http://www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf.

Center for Civic Education. (2006). *Project citizen*. Calabasas: Center for Civic Education.

Cox-Petersen, A. (2010). *Educational partnerships: Connecting schools, families, and the community*. Los Angeles: Sage.

Guillaume, A. M., Yopp, R. H., & Yopp, H. K. (2007). *50 strategies for active teaching: engaging K-12 learners in the classroom*. Upper Saddle River: Prentice Hall.

Kaye, C. B. (2004). *The complete guide to service learning: Proven, practical ways to engage students in civic responsibility, academic curriculum, and social action*. Minneapolis: Free Spirit Publishing.

Ketter, S., Zukin, C., Andolina, M., & Jenkins, K. (2002). *The civic and political health of a nation: A general portrait.* CIRCLE and the Pew Charitable Trusts.

Kielburger, M., & Kielburger, C. (2002). *Take action! A guide to active citizenship*. Hoboken: Wiley.

Kids Consortium. (n.d.). Retrieved December 12, 2009, from http://www.kidsconsortium.org/

National Curriculum. (1999). Key stages 1 & 2 and 3 & 4: Science. Retrieved December 29, 2009, from http://curriculum.qcda.gov.uk/key-stages-1-and-2/subjects/index.aspx.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academies Press.

Parker, W. (2005). *Social studies in the elementary school*. New Jersey: Merrill Prentice Hall.

Patrick, J., & Vontz, T. (2001). Components of education for democratic citizenship in the preparation of social studies teachers. In J. Patrick & R. Leming (Eds.), *Principles and practices of democracy in the education of social studies teachers: Civic learning in teacher education: Volume 1* (pp. 39–64). Bloomington: ERIC.

Patrick, J. (2002). Defining, delivering, and defending a common education for citizenship in a democracy. In J. Patrick, G. Hamot, & R. Leming (Eds.), *Principles and practices of democracy in the education of social studies teachers: Civic learning in teacher education: Volume 2* (pp. 5–21). Bloomington: ERIC.

Ponder, J., & Cox-Petersen, A. M. (2008, January). *Service-learning, Stewardship, and civic involvement: Taking action in science methods courses.* Paper presented at the annual meeting of the Association for Science Teacher Education, St. Louis, MO.

Postman, N. (1995). *The end of education: Redefining the value of school*. New York: Alfred A. Knopf.

Schultz, B. D. (2008). *Spectacular things happen along the way: Lessons from an urban classroom*. New York: Teachers College Press.

Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Barington: Orion Society.

Wade, R. (Ed.). (1997). *Community service-learning: A guide to including service in the public school curriculum*. Albany: State University of New York Press.

Westheimer, J., & Kahne, J. (2002). HYPERLINK "DDpdfs/EducationForAction.pdf" Educating for Democracy. In R. Hayduk & K. Mattson, (2002). *Democracy's Moment: Reforming the American Political System for the 21st Century*. Lanham, MD: Rowman & Littlefield. Chapter 7, 91–107.

Westheimer, J., & Kahne, J. (2004). What kind of citizen? The politics ofeducating for democracy. *American Educational Research Journal, 41*, 237–269.

Wynne, E. (1986). The great tradition in education: Transmitting moral values. *Educational Leadership, 43*(4), 4–9.

Chapter 11
Developing a Sustainable Agricultural Curriculum in Malawi: Reconciling a Colonial Legacy with Indigenous Knowledge and Practices

George E. Glasson

Introduction

A profit motive of the colonial system stole respect of nature from the culture of Africans. Animals were hunted and killed with no thought for the future. Bushes were cleared for tea plantations, and a new system of agriculture [was established] based on monoculture. Arable cropping was introduced which later ensured ecological degradation (cited in Glasson et al. 2006, p. 671).

As I read these pungent words from a Malawian teacher educator during my first visit to Africa in 2003, I was amazed to learn directly from my students about the prevalent ecojustice issues affecting their country. Twenty-four Malawian educators were enrolled in an elementary science methods course that I was teaching in Malawi as part of a Master's degree program to improve primary school education in the country. As a class assignment, students were asked to write about and discuss ecological sustainability issues affecting human and wildlife populations in Malawi. Students discussed the devastating effects of deforestation and the connections to clearing land for growing crops, charcoal burning, soil erosion, water and air pollution, and the loss of animal habitat. Most importantly, students also discussed the loss of indigenous medicines extracted from the barks of trees or plants found in the forest. From these initial classroom experiences, I was most impressed by the passion of the Malawians and their inherent understandings of ecojustice issues affecting their families for generations.

Located in sub-Saharan southeast Africa, Malawi was formally known as Nyasaland and established as a British colony in 1891. Originally occupied by hunters and gatherers, Nyasaland was settled by Bantu tribes along the shores of Lake Nyasa in the sixteenth century and renamed Malawi[1] in 1964 after gaining independence from colonial rule. The Bantu tribes in Nyasaland survived by fishing, hunting,

[1]Malawi was named from Maravi, one of the original Bantu tribes that occupied the area. Lake Nyasa is now known as Lake Malawi and borders the country to the east.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_11,

and engaging in traditional agricultural practices that were passed down through generations. In the 1600s, Portuguese traders introduced maize and other exotic vegetables that are grown in Malawi today. Later in 1859, Scottish explorer Dr. David Livingstone's motto of "Christianity, commerce, and civilization" influenced the establishment of mission schools, tea plantations, and the establishment of a British colonial government. This doctrine provided justification for colonization and exploitation of indigenous people that has resulted in the loss of cultural and biodiversity. Although Malawi was a single-party state between 1964 and 1994 and is now is ruled by a democratically elected government, the legacy and influence of colonialism remains.

This chapter will describe the ecojustice issues that are inherent in the mono-agricultural practice of tea farming that are part of Malawi's colonial legacy. In contrast, research will also be shared that highlights the precolonial indigenous agricultural practices that have been passed down through generations as well as the more hybrid practices of a sustainable farmer that are the result of the confluence of western and African cultures. Drawing on literature from ecojustice education and third space theoretical frameworks, the development of a place-based agricultural curriculum will be discussed that connects community elders practicing sustainable agriculture with a primary school in Malawi.

Farming in Malawi

Tea Plantations

When first encountering the tea plantations in the southern region of Malawi, visitors are astounded by the vast verdant green fields of tea bushes that surround the base of Mt. Mulanje, the third highest mountain in Africa. Located in the most fertile land in the southern African rift valley, the area is blessed with abundant rainfall and mild climate. Water rushes down from the waterfalls and streams from Mt. Mulanje by small villages with clusters of mud brick houses. Villagers grow seasonal crops such as maize, peas, tomatoes, and greens in small plots nestled on the outskirts of the vast fields of tea bushes. Harvesting the tea is done by hand with human labor and then it is sent to a factory for drying and processing. In the factory, drying and curing is fueled entirely using firewood as a fuel source.

One can only imagine the subtropical forest paradise that this area used to be before colonization. Indigenous forests included valuable trees such as ebony and mahogany, and on the higher slopes of Mt. Mulanje, the aromatic mulanje cedar. Other trees produced an abundance of tropical fruits such as mangos, figs, and papaya. The forest was also habitat for many animal species, including monkeys, baboons, lions, elephants, snakes, and tropical birds. Today, cultivated banana and mango trees are found dispersed in small garden plots, however, indigenous trees have been replaced with the exotic eucalyptus (blue gum) and pine trees to provide fuel for tea factories and firewood for cooking in the villages. Woodcarvings of animals from what is left of indigenous trees are sold to tourists, along with aromatic cedar boxes. The government has attempted to regulate and manage the cutting down of indigenous trees for this purpose.

In class discussions with the Malawian educators, we wanted to better understand the ecojustice issues surrounding the tea plantations. The Malawians were very articulate and forthright in describing the equity and environmental issues associated with tea farming. Tea was first planted by the British in 1891 and remains a cash crop for the European landowner that is exported to other countries. However, the Malawians were well aware that the missionaries and European farmers who offered gifts or favors to the village chiefs took the land away from their ancestors. One of the student's fathers in my class was imprisoned for advocating the return of the land to the Malawians. As they are paid very low wages for working in the fields, the rural Malawians benefit very little from the profits of the plantation owners.

Tea farming in Malawi is an example of how globalized market forces influence the economy and ecology of African countries. According to Bowers (2001), ecojustice addresses the causes of poverty at the community level that have been undermined by globalization. The commercialization and control of land by Europeans in Africa have contributed to the loss of African cultural capital and widespread poverty of indigenous people (Boahen 1987). From a postcolonial perspective (Carter 2007), the Malawians in my class were engaged in the process of deconstructing their colonial legacy that influences their lives today. With the advent of democratically elected government in 1994, educated Malawians have become more empowered to speak out about human rights and social issues affecting their country. However, giving voice to their own indigenous knowledge and practices that are still embedded in Malawian culture today is essential for understanding ecojustice issues in the country.

Rural Agricultural Practices

In order to feed their families, the rural farmers must grow crops in overcultivated and drier regions of the country. Trees are cut down and fields are burned to clear land for growing maize and other vegetables. The planting is done during the warm, wet winter season and the harvesting is done only one time a year in the cool, dry, early summer. During planting season and before harvesting, many Malawians struggle to find enough food to feed their families. The typical rural farmer is also dependent on subsidized fertilizer from the government. Although in the short-term crop yield is improved, in the long term synthetic fertilizers contribute to soil depletion. Additionally, many rural Malawian farmers clear their fields by burning. Although efficient in clearing fields, this practice further contributes to soil depletion and erosion.

Collecting firewood for cooking is a daily chore in Malawi, primarily for women and children. Wood is also used to make charcoal by burying burning logs in the soil. Charcoal burning, although banned by the government, contributes greatly to deforestation and air pollution.[2] For the rural Malawian family, there is little alternative but to use wood or charcoal for cooking or to heat homes. Electricity is affordable only by affluent citizens with white-collar jobs. Even then, the supply of electricity is intermittent and sometimes available for only a few hours a day. This lack of supply of electricity is related to damage to hydroelectric turbines due to severe flooding of the Shire River,[3] the excessive growth of plants that clog the turbines, and the continuous breakdown of the country's power transmission network. Thus, access to electricity as an energy source is related not only to achieving affluence or economic wealth, but also to environmental and infrastructure issues. Ecojustice for rural farmers in Malawi would require access to renewable and nonpolluting energy sources.

Indigenous Agricultural Practices

The legacy of colonization and the continued global influence of western agricultural practices have led to a loss of indigenous farming practices that are in many cases more ecologically sustainable than western farming methods. To better understand indigenous farming practices in Malawi, our research team interviewed rural farmers in both their native tribal languages of Chichewa and Chiyao (Glasson et al. 2010). These interviews revealed sustainable practices of rural farmers that were passed down through generations. For example, a traditional farmer along the Shire River grows crops under particular type of acacia species, the msangu tree, to improve crop yield. As one farmer explained, the shedding of tree leaves ((*kulakatika kwa masamba*) replenishes soil fertility (*chajila*). The leaves are buried to quicken decomposition (*kuwola).* Using msangu leaves as a natural fertilizer (*chajila cha chilengedwe*) also improves crop yield. According to the farmer we interviewed, passing down of knowledge of elders (*kusunga misyungu ja achinangolo*) to children is very important in conserving (*kuteteya*) msangu trees. Most notably, these sustainable practices were embedded in the vernacular languages of the community.

These interviews were interpreted in the context of third space theory (Bhabha 1994). Third space theory provides a framework for understanding how the first space or home culture of indigenous people is challenged by encounters in the second space of western culture. Giving voice to indigenous people in traditional languages and discourses in a third space allows for a hybridized exchange of language and ideas. For example, the farmers in these interviews shunned the use unaffordable synthetic fertilizers that eventually depleted the soil in favor of traditional farming practices. Unfortunately, indigenous knowledge is marginalized in the standardized school curriculum in Malawi (Phiri 2008) and the knowledge

[2] Although Malawi is a subtropical country, only 32% of the land is arable and 28% is forested (Ministry of Natural Resources & Environmental Affairs 2002).

[3] The Shire River, home to hundreds of hippos, grazing elephants, and crocodiles along its banks, is the main tributary flowing from Lake Malawi to the Indian Ocean.

and practice of growing sustainable gardens is being lost. Rather than promoting indigenous farming practices, the government is subsidizing western agricultural methods that require the high-input use of fertilizers and pesticides.

Sustainable Hybridized Farming Practices

Our interviews also revealed hybrid practices that blended traditional farming practices with western knowledge (Glasson et al. 2009). The project team visited the organic farm, Freedom Gardens, near Lilongwe, Malawi on several occasions to learn about the sustainable agricultural practices of Dr. Givens Chinkhuntha. Dr. Chinkhuntha was interviewed as he led members of the research team on several tours of his garden to explain how he blended indigenous farming practices with western scientific knowledge to create a sustainable, organic garden.

Dr. Chinkhuntha described his hybridized farming practices that included gravity-fed irrigation, composting, sunken plots, and organic pest control: "[I] realized that the only profession that would give me surety of food sovereignty was farming and so I took my hoes and came to this place where I asked for a piece of land from the chief." The development of his farm was gradual as he developed gravity-fed irrigation techniques to solve problems that arose from working in a flood plain with seasonal rains. Dr. Chinkhuntha explained:

> We had to find a way of dealing with water so that our crops do not get washed down stream during rainy seasons and also have sufficient water to supply to our crops through out the year. ... Water is led to sunken beds through the small channels that you see all along the paths (ridge-ways) that separate the sunken beds. … I borrowed, adapted and adopted this technology from Roman aqueducts but designed to suit the requirements of the terrain and needs for this garden.

Rather than being dependent on a single harvest in which crops are planted only during the rainy season, gravity-fed irrigation allows for maize to be harvested three times a year.

The crops are fertilized exclusively using composted vegetable matter and refuse from the crops on the farm. Dr. Chinkhuntha also elaborated on how maintaining ecological equilibrium in the garden is necessary for controlling pests:

> We also solely rely on biological protection of our crops. Having both plant and animal species in the garden helps with creating ecological equilibrium. We believe that allowing predators to exist in the garden is the best way to control pests. Therefore, we allow them to coexist, which keeps pests checked to reasonable levels. This is clearly illustrated by the relationship between aphids and ladybugs. Chemical sprays tend to kill ladybugs as well and once aphids emerge again, they rapidly multiply to unbearable levels.

According to Dr. Chinkhuntha, microhabitats are created in the sunken plots or beds that are designed for maximizing crop yield:

> The sunken plots, on the other hand, create microhabitats for the crops growing together. Each bed is stocked with a set of crops, which creates a microhabitat that may not be exactly the same as another sunken bed. Through trial and error, experiments and at times using

> knowledge learned from school knowledge has evolved on the best ways to grow crops together, which gives protection from pests and also maintaining soil fertility and texture.

Unlike traditional farmers we previously interviewed, Dr. Chinkhuntha was educated and exposed to western agricultural knowledge. He was purposeful in his decision to farm using low-cost inputs and indigenous ideas and technology; however, his hybridized approach benefitted from two knowledge traditions:

> We use both traditional and western ideas. What I think is that good farmers need to be knowledgeable about what is going on in their farms. Most of people we call farmers fail to do well because they lack knowledge. Some are mere cultivators but lack knowledge about what to do to get what they want from farming, under prevalent conditions in their local places.

Dr. Chinkhuntha was also concerned that educated students abandon farming as an occupation and do not learn about sustainable farming practices in agricultural schools that include both western and indigenous knowledge.

Dr. Chinkhuntha elaborated on how the local community is involved in the production of food and learning about sustainable farming practices at Freedom Gardens:

> The local community provides all the labor requirements for Freedom Gardens. People from the neighborhood come to work for money or food all the time. This arrangement has also acted as education for those who come to work in this garden because I have seen many workers borrowing the science and technology for establishing their own small enterprises both upstream and downstream. So, the villages that surround this place are my main source of labor. In difficult times we are capable of supporting six villages that surround us.

Restoring indigenous knowledge and practices within the local community at Freedom Gardens is a powerful example of revitalization of the commons (Bowers 2007a). Revitalizing the commons involves making choices that are beneficial to the local community, environment, and culture. The organic practices at Freedom Gardens also demonstrate how traditional farming methods can be connected to the larger global society. A variety of crops, such as beans, sugarcane, pineapples, strawberries, citrus fruits, and bananas are sold to the local hotels in Lilongwe (the capital city of Malawi) as well as the international airport. According to Dr. Chinkhuntha, many people come to Freedom Gardens for produce because they do not use chemical fertilizers and pesticides.

In summary, Dr. Chinkhuntha's family practiced sustainability science so that "human needs can be met at the same time the earth's life support systems are conserved" (Carter 2007, p. 166). However, because Malawi is not a country with widespread electricity, energy resources, or economic infrastructure that might be conducive to the successful implementation of western agricultural science taught in schools (Dzama and Osborne 1999), the Chinkhuntha family operated in a third space to make choices that are better for living sustainably. In Dr. Chinkhuntha's case, finding ecojustice requires empowerment by considering knowledge from multiple sources and negotiating what makes sense for practicing sustainable farming and achieving food sovereignty. Many other Malawian farmers, dependent on government subsidies for synthetic fertilizers, accept western agricultural practices that may not be sustainable economically or environmentally. As these farmers continue to interact in the global economy and are exposed to western agricultural methods, hybridized practices and knowledge will continue to emerge as a necessity for survival.

Dr. Chinkhuntha was awarded a doctoral degree by University of Malawi in recognition for his experimentation, observation, knowledge creation, and exemplary practice in the village and to the world at large. His Freedom Gardens are a model of food security and sustainable living needed not only by all poor nations but the world as a whole because of safe ways of producing food. Sadly, shorting after conducting the interviews, Dr. Chinkhuntha passed away. His son, Daniel, however, continued to work with our research team to develop a sustainable agriculture curriculum that was delivered using mobile phone technology.

Developing a Sustainable Agricultural Curriculum

The sustainable farming practices of Dr. Chinkhuntha and his family were used to develop a sustainable agricultural curriculum at a Malawian primary school (Glasson et al. 2008), referred to as the Mobile Malawi Project (www.mmp.soe.vt.edu). As the curriculum included background information and knowledge of the hybridized farming practices of Dr. Chinkhuntha, effort was made to develop lesson plans that were delivered using mobile phone technology. The lessons included information about sustainable agricultural practices from Freedom Gardens such as gravity-fed irrigation, composting, sunken plots, and organic pest control (see sample from lesson in Fig. 1). The gardening activities for the children were designed to employ the use of indigenous tools such as hoes and spades. High-cost inputs such as the use of synthetic fertilizers or herbicides were rejected as unsustainable and were therefore not included in the description of farming practices in the lesson plans.

The lesson plans included instructions for the primary school teacher to ask questions to Daniel, the son of Dr. Chinkhuntha, and to document the progress of the Malawian children in growing a sustainable garden at the school site (see sample lesson on sunken plots in Fig. 2). Smart phones with Internet connectivity were issued to Daniel and a primary school teacher, Timothy Banda.[4] In piloting the curriculum, Timothy was able to use the phone to ask questions for Daniel though text messaging, voice calls, and by sending an e-mail and posting information on a project data website. In return, Daniel was able to answer the questions by also posting an e-mail response on the website. Photos documenting the progress of the sustainable garden that the children were growing were taken using the mobile phone and also uploaded to the project data site.

[4]Dr. Wotchiwe Kalande, a local science and agricultural educator, assisted Timothy with the curriculum and using the smart phone.

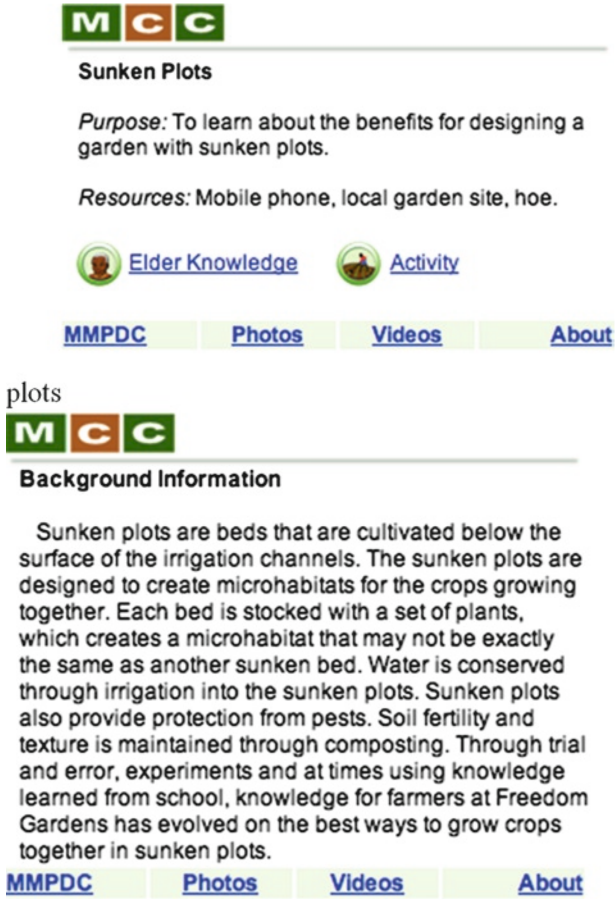
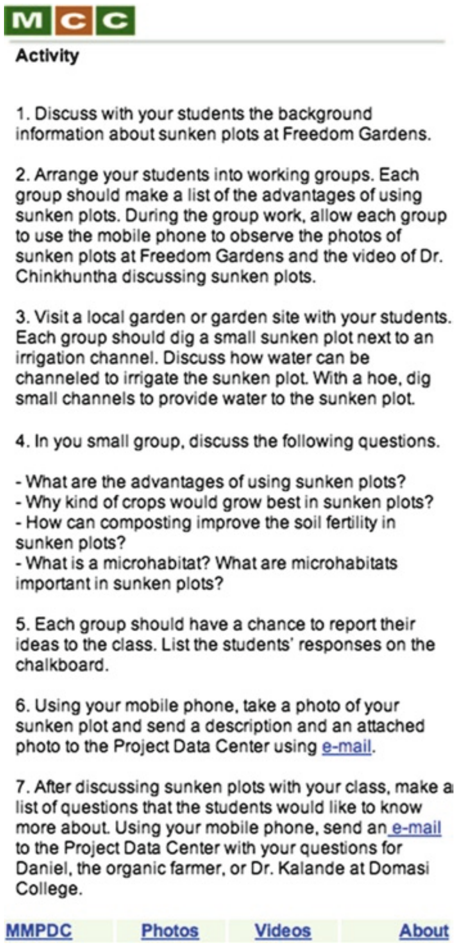


Fig. 1 Elder knowledge about sunken plots

In our initial visit to the primary school in January of 2008 which was located 300 miles south of Freedom Gardens, we noted that there was a stream that would be used as a water supply. The participating teacher, Timothy, showed us the site for a future garden, which at that time, was covered with weeds. The month of January and February in Malawi is the normal warm, wet planting season. As Timothy did not have full access to the curriculum until mid-March, he was essentially planning to grow a garden with his children in June–August 2008, which is normally the cool, dry season in Malawi. Therefore, the use of irrigation and composting for water retention and fertilization were important considerations in his planning.

During March and April of 2008, Daniel and Timothy began communicating using the phone through phone calls and posting questions on the website. Due to initial technical difficulties, Timothy was only able to ask questions using voice communication and text messaging on the phone; however, Daniel posted his responses to Timothy's questions on the project website (see example in Fig. 3).



MCC

Activity

1. Discuss with your students the background information about sunken plots at Freedom Gardens.

2. Arrange your students into working groups. Each group should make a list of the advantages of using sunken plots. During the group work, allow each group to use the mobile phone to observe the photos of sunken plots at Freedom Gardens and the video of Dr. Chinkhuntha discussing sunken plots.

3. Visit a local garden or garden site with your students. Each group should dig a small sunken plot next to an irrigation channel. Discuss how water can be channeled to irrigate the sunken plot. With a hoe, dig small channels to provide water to the sunken plot.

4. In you small group, discuss the following questions.

- What are the advantages of using sunken plots?
- Why kind of crops would grow best in sunken plots?
- How can composting improve the soil fertility in sunken plots?
- What is a microhabitat? What are microhabitats important in sunken plots?

5. Each group should have a chance to report their ideas to the class. List the students' responses on the chalkboard.

6. Using your mobile phone, take a photo of your sunken plot and send a description and an attached photo to the Project Data Center using e-mail.

7. After discussing sunken plots with your class, make a list of questions that the students would like to know more about. Using your mobile phone, send an e-mail to the Project Data Center with your questions for Daniel, the organic farmer, or Dr. Kalande at Domasi College.

MMPDC Photos Videos About

Fig. 2 Sample lesson plan on sunken plots

Most of the initial questions were about methods of composting using the Delia plant and organic pest control. During this time, Timothy was downloading videos and text from Dr. Chinkhunatha's farming practices on his mobile phone. He was also able to access the lesson plans on gravity-fed irrigation, composting, sunken plots, and organic pest control. Timothy was able to purchase tools such as hoes, spades, and watering cans, as well as seeds using project funds.

In July and August of 2008, Timothy posted photos and captions of the progress of the garden (see Fig. 4). In these photos, the use of irrigation was documented. Children were also busy digging ridges for planting corn, weeding the garden, and harvesting the crops. The research and curriculum development team were very excited with the data that was being collected using mobile phones and postings on the project website. Although technical difficulties existed, the project demonstrated that mobile phones were a viable tool for curriculum delivery and communication

Fig. 3 Elder farmer's posts on data collection website

between a sustainable farmer and primary school teacher. Timothy was able to access Daniel's knowledge and experience by accessing the curriculum and asking questions for clarification. The hybridized farming practices of Daniel were used to develop a sustainable agricultural curriculum that was successfully implemented using mobile phone technology. Significantly, the children were able to use this knowledge to grow a sustainable organic garden.

Implications for Developing an Ecojustice Curriculum

Ecojustice education in Africa is based on the premise that rural communities can make unique contributions to the development of curriculum that promotes the learning of sustainable agricultural practices. By drawing on the traditional knowledge

Fig. 4 Examples of primary school teacher posts on data collection website

of sustainable farmers, many environmental problems can be identified and the sustainable practices, passed down through generations, can be included in the curriculum to provide a valuable context for learning sustainability science. These indigenous ideas should be explicitly identified and addressed in the curriculum as important funds of knowledge (i.e., Gonzalez et al. 2005) that are essential for the sustainability of both the environment and culture of African countries. Other examples of ecojustice educational efforts that value indigenous knowledge can be found in various sub-Saharan African countries. For example, Dlodlo (1999) developed a vocabulary for physical science concepts in the indigenous Nguni language, spoken in South Africa, Swaziland, and Zimbabwe. In Kenya, Thompson (2003) identified and categorized the traditional knowledge of snakes in the indigenous Keiyo language and, more recently, Mueller and Bentley (2009) documented an environmental science curriculum in Ghana that was focused on intergenerational knowledge of natural systems.

Although western science that is taught in primary and secondary schools can make valuable contributions to the ecological knowledge and economic development of a community, the validation of indigenous knowledge has been marginalized through the imposition of western science curriculum that is based on a deficit model of learning. This Eurocentric model in African education is often decontextualized from the local culture and rewards success on standardized tests that assess students' understanding of western science concepts. Presently, western science is very influential in the school science curriculum but is largely irrelevant to most Malawian villagers (Glasson et al. 2006). Opportunities exist for science educators to collaborate with people from indigenous cultures to develop culturally relevant curriculum that promotes ecojustice and sustainability.

As culture and worldviews are critical to establishing community identity, it is also important to create a third space when developing ecojustice curriculum to consider indigenous worldviews and lifestyles when connecting with western science. Third space dialogue that promotes reconnection to the local community and place is essential for revitalizing the commons. In the case of the Mobile Malawi Curriculum, the mobile phone technology enhanced the exchange of ideas to create a "cybercommons" (Bowers 2007b) in which information and questions were exchanged freely between a sustainable farmer, the primary school teacher, and children. In this case, mobile phone technology was used to connect intergenerational knowledge with primary school education for the purpose of restoring the cultural and environmental commons. The free exchange of questions and ideas presented an alternative to didactic instruction that promotes consumerism or compliance with western agricultural curriculum. Although Bowers (2007b) cautions against misuse of communication technology for corporate profits, employing mobile phones that is prevalent in the African culture may be important for future curriculum development that promotes intergenerational learning and revitalization of the cultural and environmental commons. Future work that promotes the revitalization of the commons within a third space context should also be inclusive of the indigenous knowledge of elders that may be embedded in vernacular languages of citizens in the community.

Reflections

As a citizen from an affluent western country, I have learned humility and gained much respect for the culture and people of Malawi. From my first encounters with Malawians, I found my students and friends to be incredibly resourceful and open to learning about new ideas that are essential to the survival of their environment and culture. Although widespread poverty still exists amongst the beautiful tea plantations and throughout the country, revitalization of the commons is essential for the Malawians to maintain their sense of place and cultural identity. It was very gratifying to find strong examples of communities reconnecting with their traditional culture through our research and curriculum work related to ecojustice in Malawi. I look with amazement and admiration at the strong sense of caring that the citizens show for each other.

I have also learned that the empowerment of Malawian people requires that they understand how their colonial legacy and continued globalization affects their future livelihood, culture, and sense of identity. The students I worked with were willing to discuss sustainability issues that have affected their families for generations; however, it was only after working as equal partners over time that I was able to gain the trust of Malawians to share these deep-rooted issues associated with colonialism. In my role as a researcher and professor, listening to the voices and ideas of Malawians was essential for developing an understanding of their indigenous knowledge that was essential for developing an ecojustice curriculum. In the process, I realized that I had as much to learn about myself and place in the world as I did about the continuing plight of Africans for a sustainable future.

Although Malawian children are most familiar with their local village life, the opportunity exists through ecojustice education to be connected to the larger global society. Through a place-based and community-centered approach, the Malawians are in the process of developing these connections by valuing their own culture and traditional knowledge while at the same time expanding their understandings of global socioscientific issues. By connecting indigenous agricultural practices to western science concepts, teachers and children will learn to value knowledge and practices that are part of their everyday lives. Although western science has produced many benefits for improving our standard of living, we have much to learn from Africans and their legacy of living sustainably.

References

Bhabha, H. K. (1994). *The location of culture*. London: Routledge.

Boahen, A. A. (1987). *African perspectives on colonialism*. Baltimore: The Johns Hopkins University Press.

Bowers, C. (2001). *Educating for ecojustice and community*. Athens: The University of Georgia Press.

Bowers, C. (2007a). Introducing ecojustice and the revitalization of the commons issues into thinking about environmental education. In D. Zandvliet & D. Fisher (Eds.), *Sustainable communities, sustainable environments: The contributions of science and technology education* (pp. 47–60). Rotterdam: Sense Publishers.

Bowers, C. (2007b). *Critical essays on the enclosure of the cultural commons: The conceptual foundations of today's mis-education*. Digital Library of the Commons. Retrieved July 11, 2009, from http://dlc.dlib.indiana.edu/archive/00004691.

Carter, L. (2007). Sociocultural influences on science education: Innovation for contemporary times. *Science Education, 92*, 165–181.

Dlodlo, T. S. (1999). Science nomenclature in Africa: Physics in Nguni. *Journal of Research in Science Teaching, 36*, 321–331.

Dzama, E. N. N., & Osborne, J. F. (1999). Poor performance in science among African students: An alternative explanation to African worldview thesis. *Journal of Research in Science Teaching, 36*, 387–405.

Glasson, G. E., Frykholm, J., Mhango, N., & Phiri, A. (2006). Understanding the earth systems of Malawi: Ecological sustainability, culture, and place-based education. *Science Education, 90*, 660–680.

Glasson, G. E., Mhango, N., Phiri, A., & Lanier, M. (2010). Sustainability science education in Africa: Negotiating indigenous ways of living with nature in the third space. *International Journal of Science Education, 32*, 125–141.

Glasson, G.E., Evans, M., & Phiri, A. (2008). Connecting community elders and schools in Malawi using mobile phones and web 2.0 technologies. *Proceedings of the National Association for Research in Science Teaching International Conference*, Baltimore, MD.

Glasson, G.E., Phiri, A., Mhango, N. & Lanier, M. (2009, April). Connecting community elders to develop a sustainable agricultural curriculum for primary schools in africa. In E. Abrams (Chair). *The influences of culture and nature on the motivation of Indigenous children to learn science*. Symposium conducted at the annual meeting of National Association for Research in Science Teaching Garden Grove, CA.

Gonzalez, N., Moll, L. C., & Amanti, C. (2005). *Funds of knowledge: Theorizing practices in household, communities, and classrooms*. Mahwah: Lawrence Eribaum.

Mueller, M. P., & Bentley, M. L. (2009). Environmental and science education in developing nations: A Ghanaian approach to renewing and revitalizing the local community and ecosystems. *The Journal of Environmental Education, 40*, 53–63.

Ministry of Natural Resources & Environmental Affairs. (2002). *State of the environment report 2002*. Lilongwe, Malawi: Environmental Affairs Department.

Phiri, A. D. K. (2008). *Exploring the integration of indigenous science in primary school science curriculum.* Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Thompson, N. (2003). Science education researchers as orthographers: Documenting Keiyo (Kenya) knowledge, learning and narratives about snakes. *International Journal of Science Education, 25*, 89–115.

Chapter 12
When Elephants Fight, It Is the Grass That Suffers

Norman Thomson

In his essay summarizing his experiences in learning firsthand about Malawi, Dr. Glasson has identified problems and issues that could be almost every/any country in Africa today that shares a colonial past. His emergent emotions and sensitivity to the people and their situations in the context of eco-injustices have allowed him not only to see Africa through a new lens, but also to connect with the people through third space dialogue. That is, the learning space of two differing cultures or individuals is extended by allowing dialogue and reflection to take place beyond the physical time and space constraints limited by each one's own cultural beliefs and knowledge. The issues, challenges, and solutions to Africa's persistent problems have historically been viewed though a variety of lenses, often from a top-down distant perspective beginning long ago with the illogical partitioning of people and kinships, total insensitivity to the indigenous cultures including languages, and disregard of traditional access to shared resources that had no boundaries or ownership. Colonization also came with different motives and guises: religious, economic, social, political, agricultural, and educational. Jomo Kenyatta (1965), musing over postcolonial rule and its legacy as Kenya's first president, stated that he had not realized as he signed a declaration of nationhood, that the British intent was limited to political independence, but continued economic and social dependence had been established and was to be perpetuated.

Almost 40 years ago, as a young US Peace Corps volunteer asked to teach biology in Uganda, I was provided some wisdom from a young Ugandan history teacher and colleague. Turyahumura cautioned me stating: "First, there are those of you who come here for 6 months and go home and write a book on us because you think you know everything about us, and then there are those of you who come here for 2 years and go home and write a dissertation on us because you think you know all there is to know about one thing in great detail about us, but I challenge you that if you stay for 10 years you will not be able to write a page on us, because we are much more

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_12,

complex than you people seem to think." Unfortunately, after 20 years I found myself reduced to anecdotes and that may be the best I can do in this essay.

In Malawi, Dr. Glasson has found through his work with his Malawian colleagues that when a westerner initially begins working in an African country, we usually enter with some confidence and spirit of giving that we might be able to be of assistance in problem solving. But, in reality it is really our personal experiences that become the journey of learning "humility and gaining respect for the indigenous cultures." It is the in-country efforts of our hosts working at the grassroots levels where change can be realized. And, we realize that we are but a part of the whole village that is necessary to raise the "child" whether nurturing ideas, children, or our own growth as a person.

It has been my experience that there is no such thing as development, but rather it is change that occurs, and it usually has different positive and negative outcomes. Thus, when nations make transitions toward "development," something else is given up or lost. Everything that has been proposed or implemented as a solution to a problem comes with caveats, limitations, and, in some instances, creates or results in even worse unanticipated problems. (I dislike using a reference to "costs" as that places a connotation that something has an intrinsic monetary value.)

Early in colonialism, in order to create a working labor force for exporting resources to the new "homeland," a currency economy was established and was required for paying various taxes. Paper and metal currencies, with inscribed figures of a distant ruler, reminded people to whom homage and thanks should be given during each transaction. The only way to obtain the currency was to work for the colonial rulers in some capacity of servitude. Social and agricultural dependence was introduced using the "fence." Land ownership and exclusionary boundaries restricted the traditional free movement of peoples as colonists partitioned the land. And, signed paper contracts demonstrating ownership were evidence that the Europeans had given up trusting one another's word. Africans soon learned that even their written word could not be trusted either.

A three-tiered educational system prepared Europeans/Whites for government positions and large-scale farming (requiring African office cleaners, laborers, and house servants), Asians for business ownership (requiring African shop cleaners, laborers, and house servants), and the African peasants were to continue producing subsistence quantities of food crops. Africans were prohibited from growing crops and cattle that would compete against the Whites (e.g., coffee, tea, wheat, and hybrid cattle) but were introduced and became dependent upon food crops the Europeans had found in other explorations, such as maize, potatoes, and tomatoes from the Americas, displacing many of their traditional and indigenous nutritional food resources. In business, Asians controlled the cost and access to hoes and sickles required for farming.

Following the African wars for establishing independence (lessons learned from serving the "motherlands" in World War II), indigenous people were able to move on from postcolonial rule – but a new African elite began to fill and maintain roles of established domination. All too often, military coups have masqueraded as reformations for the disposed and frustrated urban and rural "peasant" populations who have never seen benefits of independence. There is a history of African writers' lamentations for loss of cultural values (p'Bitek 1966): Ngugi Wa Thiongo's (1986) concerns that Africa has not yet engaged in "decolonizing the mind" with respect to language use, Batibo's (2005) documentation of language decline and extinction, and Beti's (1957) insight into the disconnects between western schooling and village life.

However, a more perpetual and insidious problem that continues to grow is that sub-Saharan Africa has remained a "basket-case" for food. It is a continent that seems to be unable to provide enough food for its people with cycles of famine and starvation. However, as with other issues, problems concerning food production and distribution are complex: choice of farming methods (e.g., large-scale, high-energy input versus small-scale sustainable/low energy), cash crops (exportation of coffee, tea, flowers versus local consumption of plantain, maize, and millet), changing climate with unpredictable weather (deforestation, drought, flooding, erosion), population increases that have exceeded improved crop production, loss of indigenous crops, the continued over-exploitation and exportation of Africa's natural resources and products (forest, minerals, coastal, endangered species), the dislocation of human resources (brain drain, refugees, genocide), and, of growing international concern, the wholesale long-term loan of millions of hectares/acres of land by countries with monetary resources, who want and need food for their own national consumption (e.g., middle-eastern and Asian countries) – a dangerous form of neocolonialism. And, even when crops are successfully grown and harvested, transportation to markets and externally determined (e.g., the mercantile trade markets of London and Chicago) prices interfere with whether, or not, a crop year is successful. So it goes, that the marginalized peoples of Africa who know their plight and call for ecojustice, sadly state the African proverb that "when the elephants fight, it is the grass that suffers," crying out that someday the elephants should stop.

Sustainable agriculture is being revisited as a viable source of livelihood for rural peoples as a global movement from Malawi to Thailand in the context of the twenty-first century and seems to be offering a new and necessary movement for the world's rural peoples. It has been estimated that it takes 13 cal of fossil fuel to produce 8 cal of maize on Africa's large-scale farms whereas the individual local farmer uses only 1 cal. And, lest the reader forget – in Africa the image of farmer should be a woman as most males have migrated to urban areas in search of secondary employment. However, migration and colonization in Africa preceded the arrival of Europeans. The history of Africa is one of human migrations most likely beginning with the earliest hominids whose very origins were locations in Africa. And, the Bantu peoples now claiming Malawi as their home displaced hunter/gatherers in the sixteenth century and established their own methods of using the natural resources bringing slash-and-burn agriculture, only sustainable because of the low population numbers of people.

Malawi attained independence in 1964 and has depended upon an agricultural-based economy. Realizing that education is a critical necessity for establishing self-sufficiency it was the first sub-Saharan African country to declare free primary education in 1990. Despite these efforts the system has not been able to fulfill its aspirations (Chimombo 2009). Since the introduction of Free Primary Education in 1994/95 many more children have been to school and gender parity in enrollments has been reached at the lower levels. However, levels of resource provision to schools is very low and their distribution uneven. The system has high dropout rates, especially for girls in higher grades, and only small increases in completion rates. Further, the overall performance of pupils has been decreasing significantly. Malawi faces a major task to deliver quality and relevant education.

The country is landlocked and comprises farmers who have limited amounts of land and resources. And, the amount of land for each farmer has diminished with each generation as the population has grown. Recently, the country faced a food crisis in 2005, the result of drought, floods, and a disastrous maize harvest. Huge amounts of food aid, costing more than $100 million, barely averted widespread starvation. The President decided to ignore the consensus advice of the World Bank, the US Agency for International Development, and other developmental agencies (Beardsley 2009). Rather than rely on incentives to boost market efficiencies, he provided smallholders with subsidized inorganic fertilizer (two 50-kg bags per household) and a few kilograms of subsidized seeds. Most farmers opted for using hybrid seed. The increase in national maize production was immediate: the country's maize deficit of a half-million metric tons turned into a maize surplus a year later. By 2007, production had tripled, and Malawi broke its maize harvest record. Production fell back in 2008, when drought struck again, but still met national requirements. The cost of the program was less than half the cost of food aid in 2005.

Yet the Malawi program is not without critics. Proponents of traditional and organic farming fear that providing farmers with inorganic fertilizer will encourage dependency. It could also leave them vulnerable to increases in the price of natural gas, which is consumed in large amounts to make the component chemicals. Inorganic fertilizer promotes emissions of nitrous oxide, a potent greenhouse gas, and it can encourage soil erosion. Moreover, crops grown from hybrid seeds, which are supplied by corporations, may be less resilient than traditional landraces to pests and changes in rainfall patterns. For these reasons, the proliferation of look-alike schemes in Africa is not universally hailed as progress. However, organic farming may not be suited to the nutrient-depleted soils common in Africa. The Freedom Gardens created by Dr. Chinkhuntha has been developed in "reclaimed swampland," but swamplands are also known as "natural wetlands" and these are known to have very fertile soils. The Malawi program of unsustainable solutions could provide time for vulnerable populations, while the infrastructure for more sustainable agriculture is developed through innovations, such as the Freedom Gardens.

The use of real-time technologies for distance communication of farmers, teachers, and students especially interfaced with visualizations is a positive and African way of sharing ideas through real people conversing. It is far superior to using paper documents. However, it should not be forgotten that with the technologies new problems are arising such as electronic wastes (e-waste). A not too far away neighbor of Malawi has problems of ecojustice where coltan is being mined. Coltan is the local Congolese word for columbite-tantalite, a metallic ore comprising Niobium and Tantalum. It is found mainly in the eastern region of the Democratic Republic of Congo (formally Zaire). When refined, coltan becomes a heat-resistant powder, metallic tantalum that has unique properties for storing electrical charge. Coltan is a metal used in cell phones, laptops, and other electronic devices. A worldwide shortage of coltan has driven its price up to nearly US$600 a kilogram providing miners with up to US$200/month compared to a national average of US$10/month. Forests and streams are being destroyed, the bush meat trade is depleting wildlife, large numbers of miners fight over mining rights, and war lords are using the money to buy arms that are being used in the continuous genocide that has killed over three million people and displaced 1.5 million refugees in the Congo over the last 15 years. Coltan is now known as a "blood ore" in what has become known cynically as "guns, money, and cell phones." Thus, positive change for ecojustice in Malawi is in part, contributing to eco-injustice change in Congo. And so, change in Africa continues as the elephants fight.

But, I do not want to end this anecdotal essay with elephants fighting and the grass continuing to suffer. One facet of resources that has not yet been realized in Africa is the continents' lost crop. Today, the 6+ billion people living on earth depend upon only three grains that were developed as food resources 10,000 years ago in the "stone" age!: wheat, maize, and rice. This is a "recipe" for a global disaster if we would consider human extinction, as such, and a major crop failure takes place. Climate change and global warming may certainly qualify as part of such a recipe. The US National Research Council (NRC) in partnership with several other science organizations both in the USA and many African countries have identified over 50,000 plant species indigenous to the continent. Over 1,000 Africans have been asked to identify their favorite grains, fruits, nuts, vegetables, legumes, and other food plants. They have identified over 1,000 grains, up to 3,000 native vegetable roots, stems, leaves, bulbs, and fruits, and thousands of fruits that they know, but have been "lost" through displacement of introduced plant food resources (NRC 1996, 2006, 2008). Populations of people throughout quite vast areas of Africa have continuously used many of the plants, whereas others are only known and used locally. Little is really known about their genetic potentials because the focus of research and development has been on increased productivity of the few introduced species that have become the food staples intolerant to the vicarious African seasons.

However, out of the unpredictable changes associated with rainy seasons has emerged the inspirational story of William Kamkwamba, "the boy who harnessed the wind" (Kamkwabala and Mealer 2009). Kamkwamba was forced to drop out of school because there was no money left for school fees because of the crop failures. But, his quest for knowledge was partially satisfied by a village library where he found a fascinating illustrative textbook on electricity, *Using Energy*. Kamkwamba envisioned building a windmill for generating electricity in his home where he read by candlelight. Using scraps of metal, old tractor fan blades, parts of bicycles, and local wood, and especially his imagination, he built a windmill that could convert wind energy into electrical energy. His accomplishments have brought international attention and recognition and donations to the whole community.

Malawi is a parable for global change. Its story emphasizes, that while internationally, scientists and politicians have focused their attention on the established and easy crops to grow and energy production on a large scale, local people today are revisiting the past, merging it with what they are learning about the potential of sustainable agriculture, and using their imagination and creativity to solve problems on a local scale. Maybe it is also time for Africans to bring their indigenous plants along on this journey and then the elephants may be able to stop fighting.

References

Batibo, H. (2005). *Language decline and death in Africa*. Tonawanda: Multilingual Matters Ltd.
Beardsley, T. (2009). Organisms from molecules to the environment. *BioScience, 59*, 539.
Beti, M. (1957). *Mission to kala*. London: Heinemann.
Chimombo, J. (2009). Changing patterns of access to basic education in Malawi: A story of a mixed bag? *Comparative Education, 45*, 297–231.
Kamkwabala, W., & Mealer, B. (2009). *The boy who harnessed the wind*. New York: HarperCollins.
Kenyatta, J. (1965). *Facing Mt. Kenya*. New York: Random House.
National Research Council. (1996). *Lost crops of Africa: Volume I grains*. Washington, DC: National Academy Press.
National Research Council. (2006). *Lost crops of Africa: Volume II vegetables*. Washington, DC: National Academy Press.
National Research Council. (2008). *Lost crops of Africa: Volume III fruits*. Washington, DC: National Academy Press.
p'Bitek, O. (1966). *Song of Lawino & song of Ocol*. London: Heinemann.
Wa Thiong'o, N. (1986). *Decolonising the mind: The politics of language in African literature*. London: Heinemann.

Chapter 13
Working for Change: Reflections on the Issue of Sustainability and Social Change

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Reading George Glasson's paper, I was transported back to the days when I used to work in a science education reform effort in India. This effort, known as the Hoshangabad Science Teaching Program (HSTP), developed, sustained, and disseminated an innovative inquiry-oriented, place-based framework of science teaching at the middle-school level. It was a collaborative effort that brought people on the ground – the teachers, students, and activists – on a common platform with educators and scientists in universities and research centers – quite like the effort so well-documented by George Glasson. And just like what George Glasson and his intrepid colleagues have initiated in Malawi, HSTP too started small, though in 16 schools and not one, and not recently but way back in 1972. By 2002, the program had grown to cover about 1000 middle schools in Hoshangabad, and 14 other districts of the central state of Madhya Pradesh in India. However, as often happens with reform efforts in education, the program was unceremoniously shut down in 2002, and the schools that had been successfully teaching science through an inquiry and place-based curriculum for decades quietly went back to teaching science the traditional way. Now when I look back at this unique effort in the history of education in India, I find that HSTP was largely successful in developing an alternative way to teach and learn science. However, even after a long run of 30 years, the program's accomplishments in terms of its ability to sustain itself and influence the dominant paradigm in science education were comparatively somewhat muted.

So as I read and marveled at the fascinating account of development of an innovative ecojustice sensitive curriculum in a school in Malawi amidst centuries-long unchecked devastating exploitation and expropriation by globalization and (neo) colonialism, I could not help but wonder about the challenges as well as the opportunities that lay ahead for George Glasson and his wonderful band of colleagues in Malawi as they work ahead to endow some measure of sustainability and wider significance to their effort in one school. In this response to George Glasson'

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_13,

chapter, I begin by placing the effort within the wider context of globalization and counterresponses to it from below. Then I lay out three main challenges that need to be met if we wish to see such efforts become not only sustainable but also important contributors to progressive social change.

The Global Unrest

Communities, especially those on the margins, throughout the world have long realized that changes to their lives, livelihoods, culture, and material circumstances that are triggered and sustained by corporatized globalization from above have rarely worked in their favor (Brecher et al. 2000). Advanced industrial societies are founded upon a technological rationality that legitimates and rationalizes perpetual domination and exploitation of both individual and nature by the productive apparatuses of the society (Marcuse 1964). This exploitation is sustained by transmuting both nature and individual as fungible, commoditized factors of production for the purposes of ever-increasing profits, economic growth, and even social stability[1]. The profound compression of time and space that has occurred with the help of technology in market transactions has helped to phenomenally increase the reach and frequency of market transactions, and hence exploitation, commoditization of nature, and privatization of hitherto public commons in all corners of the world (Harvey 2005). As a result, communities on the margins of global economic order or *ecosystem people* as labeled by Gadgil and Guha (1995) have found themselves expropriated from their commons, displaced from their homes, and deprived of their traditional livelihoods.

Many of these communities have responded to the devastating effects of globalization from above by adapting or *glocalizing* global products and forces for their local contexts and needs (Robertson 1995) as well as by developing their own counterresponses that seek to preserve their livelihoods, communities, and right to live with dignity and hope (Hawken 2008). These efforts range from sustaining and/or developing upon local traditional agricultural practices (Holt-Gimenez 2006) and maintaining and resurrecting traditional indigenous water management systems (Singh 2008) to preserving local indigenous knowledges through school-based reforms (Schroder 2008). The work done by George Glasson and his colleagues in Malawi is one such hope-inspiring example of much-needed "global unrest" that needs to sprout everywhere for ecojustice and against the destructive force of corporatized globalization.

[1]Let me quote (Gellner 2006) here. According to him, "Industrial society is the only society ever to live by and rely on sustained and perpetual growth, on an expected and continuous improvement. … Its favoured mode of social control is universal Danegeld, buying off social aggression with material enhancement; its greatest weakness is its inability to survive any temporary reduction of the social bribery fund, and to weather the loss of legitimacy which befalls it if the cornucopia becomes temporarily jammed and the flow falters" (p. 22).

Insurrection of the Subjugated Knowledges

To me as a researcher and knowledge-worker, Glasson's work is doubly special as it represents what Foucault (1980b) called an *insurrection of subjugated knowledges* against the tyranny of globalizing discourses of science and other avant-garde knowledge systems invested with power and sanctified by prevailing truth regimes. By *subjugated knowledges*, Foucault was referring to "a whole set of knowledges that have been disqualified as inadequate to their task or insufficiently elaborated: naive knowledges, located low down on the hierarchy, beneath the required level of cognition or scientificity" (p. 82). For Foucault (1980a), the role of an intellectual was not to "criticise the ideological contents supposedly linked to science, or to ensure that his own scientific practice is accompanied by a correct ideology," but to critique and change the "political, economic, institutional regime of the production of truth," and to ascertain "the possibility of constituting a new politics of truth" (p. 133). Foucault found that critical scholars have largely performed this role through resurrection of subjugated knowledges. For quite some time, there has been a lively discussion among science educators about the role and space of these "local, discontinuous, disqualified, illegitimate knowledges" (Foucault 1980b, p. 83), within the overall school science framework (McKinley 2005). I would not take any sides here or stake out my position. However, it might be salutary to assert that this insurrection of subjugated knowledges is not opposed to "the contents, methods or concepts of a science, but to the effects of the centralizing powers which are linked to the institution and functioning of an organised scientific discourse within a society such as ours" (Foucault 1980b, p. 84). By engaging in a bottom-up building of an agriculture-based curriculum and then writing about it in the context of ecojustice in this book, I feel George Glasson has been the intellectual that Foucault envisaged.

Sustainability and Social Change

However, I cannot help but think that that might not be enough especially in the context of the overwhelming odds posed by globalization to *ecosystem people* and by a globalized school science discourse to their indigenous knowledge systems. As *campesinos* of Latin American farming communities realized in their struggle to maintain their local sustainable agricultural practices against corporatized agriculture, just preserving local indigenous knowledge systems and practices in one's own local communities is neither sustainable nor sufficient in the long run to withstand the onslaught of global capitalism (Holt-Gimenez 2006). A similar conclusion was reached by Pretty (1999) in her investigation of sustainable agricultural systems in Africa. And when I look back at my experiences in the HSTP program and think about its limitations and widespread impact, I too find that evolving a local response to globalization – in education, agriculture or in any other field – is just the first, albeit necessary, step in the struggle for ecojustice for the oppressed and marginalized. What is also important is to make one's work a part of a wider effort for social change.

Let me explain. It might be that sources of social change are rarely systemic and often spring from out-of-the-way nooks and crannies and interstitial social and territorial spaces (Mann 1986). Thus, impetus for change may come from a small school in Malawi as in George Glasson's work or a village community in India (Singh 2008). But in a scenario where political parties and even states buckle under the might of globalized capitalism, one has to look for alternate, innovative ways to ensure that many little changes can add up to something meaningful in terms of not just withstanding the onslaught of globalization from above but also preserving knowledge and practices that promote justice, peace, and a sustainable existence for all – now and in the future (Brecher et al. 2000). There was a time when votaries for change could think of social change in terms of political mobilization for capturing state power through democratic or revolutionary means. But globalized capitalism has long withered the boundaries and powers of the state. As Appadurai (2000) said, "Global capital in its contemporary form is characterised by strategies of predatory mobility (across both time and space) that have vastly compromised the capacities of actors in single locations even to understand, much less to anticipate or resist, these strategies. Though states (and what we may call 'state fractions') vary in how and whether they are mere instruments of global capital, they have certainly eroded as sites of political, economic, and cultural sovereignty" (p. 16). So, what must a person do if she wishes to see her efforts outlast her involvement and contribute something worthwhile to wider progressive social change?

Well, based on my own experiences in such efforts and a bricolage-like perspective stitched together from varied sources, I can foresee the following four interlinked possibilities:

1. *Working for creating supportive institutional, material, and policy conditions*: There was a brief period in the mid-1990s during which I worked as a social forestry worker in a nongovernment organization, the *Agha Khan Rural Support Program,* which aimed at rejuvenating common property resources, such as village commons, ponds, and groundwater, in rural communities of a draught-prone region in western India. There was a village called *Madargarh* that had about ten acres of common pasture land. The land was severely degraded as it was used by all (for cattle and sheep grazing) and cared for by none. I, along with my colleagues and a few concerned denizens of the village, tried real hard to regenerate the land by planting grass and tree species that local people preferred for grazing and other purposes. However, we failed in terms of long-term sustainability of our efforts.

Looking back, it seems to me that our failure resulted largely because of the following reasons: (a) We could not create village-level institutional mechanisms that could ensure shared protection and sustainable usage. (b) Material circumstances of landless, poorer families did not allow them to stop or limit their dependence on the only source of fodder for their animals[2]. (c) There was little

[2] Richer families could use agriculture residue from their own fields for fodder, and hence were not that dependent upon village commons. Most of them were thus willing to limit their usage of the common land for some initial period during which planted saplings needed extra protection.

policy support from the state for our initiatives. We time and again found that creating supportive institutional, material, and policy conditions for sustainable community ownership and management of common property resources was very arduous, especially in villages where traditional communal institutions and practices have disappeared or weakened on account of centuries of British colonialism and state neglect. The HSTP program too could not sustain itself the moment the state government decided to withdraw institutional and policy-level support to the initiative. Pretty (1999) in her study of sustainable agriculture projects spread over 17 countries of Africa reached similar conclusions. According to her analysis, "sustainable agriculture can deliver large increases in food production in Africa. But spreading these to much larger numbers of farm households will not be easy. It will require substantial policy, institutional and professional reform" (p. 253).

Ecojustice initiatives, whether they pertain to agriculture, education, or in any other field are generally vulnerable to failure as their resistance and adaptive capacities are limited. As a young and naïve forestry worker, it was quite heartbreaking for me to see years of hard work toward developing village-level institutions turn to ashes in little time on account of events that we never expected to matter, such as a change of personnel spearheading the initiative or failure to correctly gauge intra-village feuds and rivalries. Sustainable change is awfully grueling and slow. As Tyack and Cuban (1995) pointed out in their study of school reforms in America, many school reforms have floundered on account of burnout among educational reformers. Thus, for an initiative to become sustainable, not only must one be prepared for the long haul, but also some long-term efforts need to be directed at creating supportive conditions at institutional, policy, as well as material level.

2. *Building horizontal and vertical linkages*: I was much enthused to read in Glasson's chapter about how George Glasson and his colleagues were able to improvise a direct linkage between Freedom Gardens with its rich experience with sustainable agriculture to teachers in a distant school. Such linkages are key to sustainability of reform efforts – a lesson that leaps out when one reads about how Latin American farmers have been able to succeed in generating and spreading sustainable agricultural practices that combine the best of local traditional practices and scientific agroecological know-how. According to Holt-Gimenez (2006), development of extensive farmer-to-farmer knowledge networks has been crucial for Latin American farming communities in their efforts to counter-corporatized and globalized agriculture being thrust upon them by the state as well as transnational corporations. Farmers in this network develop sustainable agricultural practices, and then teach them to other farmers within their community, across regions, and even across national borders. In about a quarter century, this farmer movement has spread across Mexico, Central America and Cuba. In terms of respect and sensitivity toward local people, agricultural knowledge and practices, and also success, this horizontal dissemination of knowledge and practices is in sharp contrast to conventional vertical flow of information

and technologies between agricultural experts in universities, corporations, and government agencies.

However, according to Holt-Gimenez (2006), as a social movement the farmers movement suffers from a key political weakness that has limited its abilities to contribute to a wider social change or even to counter-globalization from above. This weakness lies in the relative absence of vertical networking of the movement with national and transnational advocacy networks working for similar causes. Absence of such linkages hinders this movement's ability to exert political influence for affecting changes on wider structural, policy, and institutional levels. Thus, as George Glasson and his colleagues work to make their efforts sustainable, their work may benefit from initiatives to create and nurture symbiotic linkages with similar efforts on the ground as well as advocacy groups that can project their voice and political heft at wider and higher-level forums from where globalization from above gets directed and inflicted upon hapless communities down below.

3. *Theorizing peaceful and progressive social change*: The national and international linking of ground-level social movements into a global movement against globalization from above has been labeled by scholars as grassroots globalization or globalization from below (Appadurai 2000). This global movement suffers from two closely related weaknesses that reflect rather poorly on efforts made by university and other institution-based scholars to contribute to this movement. First, in my opinion, philosophers, critical theorists, and social scientists have fared rather feebly in their attempts to offer workable and robust theoretical frameworks for understanding and working toward peaceful and progressive social change. There was a time when Marxism offered a framework that one could use to work for progressive change. But the global failure of socialism and the tendency of Marxist-inspired movements to solidify class-based antagonisms and bring about change through violence have served to severely weaken the efficacy of Marxist ideas. Critical and poststructural discourses that arose partly in response to the failure of Marxist perspectives to bring about social change have not served the interests of the oppressed that well either. In their preoccupation with issues that largely pertain to the individual, such as issues of identity, and their focus on discursive and cultural aspects of our lives, they seem to have under-theorized or even ignored the material and structural aspects of our existence. In fact, some scholars, such as Harvey (2005) and Cole (2003), not only doubt that such perspectives can ever be forces for social change and social justice, but even allege that critical discourses are quite compatible with neoliberalism – the governing ideology of the globalization from above.

Second, according to Appadurai (2000), "one of the biggest disadvantages faced by activists working for the poor in fora such as the World Bank, the U.N. system, the WTO, NAFTA, and GATT is their alienation from the vocabulary used by the university-policy nexus (and, in a different way, by corporate ideologues and strategists) to describe global problems, projects, and policies" (p. 17). As Appadurai further argues, "a strong effort to compare, describe and theorize 'globalization from below' could help to close this gap" (p. 17). It would help activists get a clearer picture of the complex subtle ways in which globalization works and what could be "the political, economic and pedagogical benefits of counterglobalization" (p. 17). Appadurai finds that intellectuals have largely been remiss in this effort. It is a work that we urgently need to do. When viewed from this angle, George Glasson's chapter indeed comes across as an admirable attempt to shoulder this responsibility.

4. *Propagating a pedagogy of grassroots globalization*: While reading Glasson's chapter, I could not help but wonder whether Glasson's coworkers in the field were as knowledgeable about the ecojustice aspects and wider import of their work as Glasson definitely is. For people on the ground who are suffering from the effects of corporatized globalization, participation in counterefforts is a direct struggle for their lives, livelihoods, and dignity. As Holt-Gimenez (2006) discovered in his study, the campesinos "were very aware of globalization" (p. 180). However, he also found that their information is "patchy, and their understanding of where and how they might resist is unclear and limited to sustainable farming and migration" (p. 180). Thus, Holt-Gimenez expressed the opinion that the farmer movement in Latin America would benefit if farmers were also able to acquire *structural literacy*, i.e. an understanding of the larger structural, political, and economic conditions undergirding globalization and their sustainable agriculture-related work. In my own work as an educator, I too have found that pre- and in-service teachers are quite knowledgeable about the institutional and structural conditions that influence their work, but are generally lacking in their understanding of the wider social, political, and economic environments that are so instrumental in influencing their conditions and possibilities of work.

However, according to Appadurai (2000), many an intellectual who speaks for the poor and oppressed also lacks, on account of their distance from the dust and grime of daily struggles against globalization, "the means to produce a systematic grasp of the complexities of globalization" (p. 18). Thus, according to Appadurai, what is needed is a "new architecture for producing and sharing knowledge about globalization [which] could provide the foundations of a pedagogy that closes this gap and helps to democratise the flow of knowledge about globalization itself" (p. 18). Expressing hope, Appadurai further says that "this vision of global collaborative teaching and learning about globalization may not resolve the great antinomies of power that characterize this world, but it might help to even the playing field" (p. 18).

A Few Concluding Thoughts

Reading George Glasson's chapter, and writing this response to it has enabled me to reflect upon my own experiences with grassroots efforts in education and social forestry on the much larger canvass of worldwide corporatized globalization and its accompanying countering response of grassroots globalization. We often tend to limit our vision to the immediacy of our work as it is something over which we have some measure of agency and control. As educators and researchers, we feel that even if we are able to influence a few minds, our work would be worthwhile and we are contributing to social change – one person at a time. That certainly may be the case. However, while each of us is doing his/her own little work, the forces of global capitalism are wreaking havoc on entire communities that live on the margins of our societies at a pace and scale that is as awe inspiring as it is repugnant. It is about time we began to think about how our work links and contributes to countering the destructive social change induced by rampant unchecked global capital and contributes to nurturing of practices that enable everyone to live with peace, justice, and dignity.

In this response, I have tried to offer some possibilities that may help us become an important, even if small, part of the emerging solution to the problem of globalization from above. I believe these possibilities manifest themselves in the field of (science) education as much, if not more, as in sustainable agriculture. Global capitalism thrives by isolating and atomizing individuals, families, and communities into manageable, fungible units for exploitation. The need then is to come together in solidarity with the oppressed and on a shared platform of progressive, nonviolent social change and justice.

References

Appadurai, A. (2000). Grassroots globalization and the research imagination. *Public Culture, 12*, 1–19.

Brecher, J., Costello, T., & Smith, B. (2000). *Globalization from below: The power of solidarity*. Cambridge: South End Press.

Cole, M. (2003). Might it be in the practice that it fails to succeed? A Marxist critique of claims for postmodernism and poststructuralism as forces for social change and social justice. *British Journal of Sociology of Education, 24*, 487–500.

Foucault, M. (1980a). Truth and Power. In C. Gordon (Ed.), *Power/knowledge: Selected interviews and other writings 1972–1977* (pp. 109–133). New York: Pantheon Books.

Foucault, M. (1980b). Two Lectures. In C. Gordon (Ed.), *Power/knowledge: Selected interviews and other writings 1972–1977* (pp. 78–108). New York: Pantheon.

Gadgil, M., & Guha, R. (1995). *Ecology and equity: The use and abuse of nature in contemporary India*. New York: Routledge.

Gellner, E. (2006). *Nations and nationalism*. Malden: Blackwell.

Harvey, D. (2005). *A brief history of neoliberalism*. New York: Oxford University Press.

Hawken, P. (2008). *Blessed unrest: How the largest social movement in history is restoring grace, justice, and beauty to the World*. New York: Penguin Books.

Holt-Gimenez, E. (2006). *Campesino a Campesino: Voices from Latin America's farmer to farmer movement for sustainable agriculture*. Oakland: Food First Books.

Mann, M. (1986). *The sources of social power. Volume 1. A history of power from the beginning to AD 1760*. Cambridge: Cambridge University Press.

Marcuse, H. (1964). One-dimensional man: Studies in the ideology of advanced industrial society. Retrieved September 15, 2009, from http://www.marxists.org/reference/archive/marcuse/works/one-dimensional-man/.

McKinley, E. (2005). Locating the global: Culture, language and science education for indigenous students. *International Journal of Science Education, 27*, 227–241.

Pretty, J. (1999). Can sustainable agriculture feed Africa? New evidence on progress, processes and impacts. *Environment, Development and Sustainability, 1*, 253–274.

Robertson, R. (1995). Glocalization: Time–space and homogeneity–heterogeneity. In M. Featherstone, S. M. Lash, & R. Robertson (Eds.), *Global modernities* (pp. 25–44). London: Sage.

Schroder, B. (2008). Developing Intercultural Science Education in Ecuador. *Diaspora, Indigenous, and Minority Education, 2*, 25–43.

Singh, R. (2008). The indigenous knowledge systems of water management in India. In M. M. Q. Mirza, A. U. Ahmad, & Q. K. Ahmad (Eds.), *Interlinking of rivers in India: Issues and concerns* (pp. 235–251). Leiden: CRC Press.

Tyack, D., & Cuban, L. (1995). *Tinkering towards Utopia: A century of public school reforms*. Cambridge: Harvard University Press.

Chapter 14
Questions for Copenhagen: EcoJustice Perspectives and Summary

Deborah J. Tippins and Michael P. Mueller

More than 17 years ago, beginning with the Rio de Janeiro Earth Summit and the Kyoto Summit 13 years later, representatives from both industrialized countries and those with emerging economies began a dialogue centered around the reduction of carbon emissions that are believed to be responsible for the rise in average global temperatures. Economic concerns associated with costs versus benefits dominated the summit conversations. And in the plans to address the reduction in carbon emission, what became known as the Kyoto Protocol was never fully realized.

Fast forward to the present, where world leaders from more than 190 countries recently convened in Copenhagen in December, 2009 to discuss the impact of global climate change on habitats and species, including humans. Amidst the conversations surrounding the very existence of this phenomena, are the immediate questions of what actions are necessary and even realistic. In any sphere of human endeavor, circumstances alter our frames of reference. Different social, political, and ethical situations demand different actions and attitudes. Yet, there remains an inherent value in seeking connections in ostensibly dissimilar perspectives and experiences. The difficult dynamics of listening and learning from the diverse perspectives represented at the Copenhagen summit prompt us to consider the relevance of these discourses in light of the insights shared by the ecojustice scholars in the first section of this book.

Martusewicz, Lupinacci, and Schnakenberg capture our attention by asking us to consider the way in which language frames our patterns of thinking, particularly in terms of root metaphors that distinguish western and non-western ecological understandings. These metaphors reflect the tacit assumptions about the role of language in consciousness that are oftentimes taken for granted. We can see this in Anne Sullivan's work with Helen Keller, which required her to become aware of taken-for-granted assumptions about language in order to connect curriculum with

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_14,

Keller's unique experience. Even the seemingly reasonable assumption that ecologically damaging practices need to be replaced by ecologically sound ones may reflect a tacit set of experiences and a web of dialectical relationships grounded in passionate, personal participation in events. The cultural ecological analysis of these root metaphors advocated by Martisewicz, Lupinacci, and Schnakenberg enables us to consider our assumptions about the very purpose of schooling and the ways in which cultural and environmental commons interact. Malulucci, in her response, reflects on the power of language to create both enclosures and possibilities for inquiry and reflection. She echoes the call for invoking the sacred in determining whether something is moral or valuable. Bentley likewise writes of the importance of our ultimate inability to fully know. In the spirit of what is sacred, these scholars emphasize the need for a science and science education that recognizes the ways in which the cultural and the spiritual are embodied in acts of thinking, inquiry, and knowing. With these thoughts in mind, we are left wondering whether the representatives gathering in Copenhagen will move beyond the constraints of language to create shared understandings and possibilities. Will they invoke the sacred to create a meta-awareness of how the worlds' population, both human and nonhuman, might live their lives "in relation to" others?

In his description of teaching and learning science in the rural Canadian village school of St. Paul's Rivers, and later, in his collaboration with students and other community members to advocate for the Hagan Creek watershed, Roth extends the conversation on ecojustice in science education by reflecting on the difference between education and schooling. The story of his attempts to enact an ecojustice-oriented, place-based curriculum in these rural communities conveys a sense that the concept of relation is fundamental to education. Roth explains that cultural-historical activity theory can shed light on our understanding of education as a way of being "in relation to" the environment in culturally specific and historical ways. In pondering the question of why we should teach science and math if it is not usable in everyday life, Roth characterizes education as a way to introduce his students to modes of being and acting in the world in ways which prepare them to participate in the social life of a community. We suspect that Roth, in his efforts to create meaningful science education experiences, drew inspiration from generations of local knowledge and perhaps, ultimately, learned more than his students. What does Roth's story have to offer the participants in the Copenhagen summit? His story serves as a valuable perspective on the importance of context or diverse systems of meaning in understanding phenomena such as climate change. Once again, we wonder whether participants in the Copenhagen summit will be aware of how their different perceptions of reality will shape the questions they formulate about global climate change. Furthermore, we wonder to what extent participants will affirm the existing environmental knowledge of indigenous communities such as the ones Roth describes.

As Mueller and Zeidler note in their discussion of genetically modified organisms (GMO's) such as Glofish, socioscientific issues are grounded contextually in experiences that can foster moral-ethical reasoning and the development of character as integral components of science teaching and learning. Global climate change, as a socioscientific issue, has value, significance, and the potential to engage students in ethical inquiry. Using the GMO Glofish as an example, Mueller and Zeidler explore the threats to humans and the Earth when the ethical, moral, and socioeconomic dimensions of this organism are not reflected in the science curriculum. This includes a consideration of not only the negative consequences pointed out by Mueller and Zeidler, but also insights gained from studying Glofish that may lead, for example, to a better understanding of gene expression in cancer. Their discussion of GMOs carries with it a concern for the inspirations, assumptions, ethical values, and implications of action that transcend absolute or linear understandings of organisms such as the Glofish, and the impact of its genetic modifications beyond the controlled environment of the classroom. In his response, Rowe extends the dialogue, using a nonconsequentialist argument to suggest that socioscientific inquiry can also provide a context for grappling with larger ethical-educational questions – ones that might consider the moral imperative of environmental practices. Mueller, for example, has written about the role of advertising in the green movement, and the underlying questions of morality that surround this practice. On another level, these authors engage in a discussion that may even point to questions about the processes that separate life from nonlife; as some scientists have already begun to agree that “the best definition of life is the entire Earth” (Kincheloe et al. 1999, p. 74). It may be that for scientists and lay people attending the Copenhagen summit, global climate change, from the perspective of what Mueller and Zeidler describe as functional scientific literacy, can no longer be viewed from purely a cognitive realm. Concern for ecological balance draws on moral, ethical, and spiritual ways of knowing, focusing not only on the consequence of human action, but wrestling with complex questions concerning the morality of these actions.

Going from Copin’ to Hopin’

In the final chapter of this section, George Glasson gives us hope for a vision of the future which embraces practices consistent with ecojustice theory. Glasson provides a deeply personal account of how Dr. Givens Chinkhuntha and his son Daniel used innovations in communications technology (mobile phones) to create a learning network that enabled them to share sustainable hybridized farming practices with teachers such as Timothy, a primary teacher in a distant school. Challenging the legacy of colonization, their Freedom Project illustrates the ways in which communities can become the microcosm through which ecologically sustainable practices are generated. Thomson, in his response, notes that we can approach these projects with humility, as they offer solutions for vulnerable human populations, while some longer-term ideals are being generated and investigated through these national efforts. And finally, Sharma adds that it is now time to think about how this work counters the overarching global capitalist agendas and contributes to nurturing social changes that everyone can live with.

It is simply not enough to articulate an educational vision where ecojustice is at the heart of reform. Our call for educational practices reflecting the premises of ecojustice must take into account the way in which individuals and communities view the purpose of schools and the reasons why a change is needed. It must also reinforce the importance of understanding the place we come from and the ways it has shaped our consciousness. In the section that follows, we will see how a sense of place is an important component of the vibrant schools and communities we envision. Similarly, as representatives come together in Copenhagen, it is imperative for them to think about global climate change in light of new contexts and questions. Throughout the world, people have embraced the notion of "hope" in their desire to see justice and egalitarianism prevail in any decisions made at the "Hope"ehagen summit.

Reference

Kincheloe, J. L., Steinberg, S. R., & Tippins, D. J. (1999). *The stigma of genius: Einstein, consciousness and education*. New York: Peter Lang.

Part II
Place-Based (Science) Education

Chapter 15
Place-Based (Science) Education: Something Is Happening Here

Michiel van Eijck

"Something is happening here" (Sobel 2004, p. 1). This heading decorates the first chapter of what is commonly considered a seminal work on place-based education. Now, more than 5 years later, this statement also holds true for the accounts of place-based education featured in this section. As well, this statement appears to be reflective of the practice of academic research on place-based education.

Place-based education is often defined as a teaching–learning process that centers on what is considered local – usually students' own "place," that is, their immediate schoolyard, neighborhood, town, or community. Although the term "place-based education" was coined by the end of the 1980s, its practices are much older. For instance, in the beginning of the previous century, John Dewey (1915) already proposed to situate student learning in the local environment. Nowadays, place-based education is frequently enacted without flagging it explicitly as such.

In science education, place-based approaches have yielded outcomes that are uncommon in formal education, but which nevertheless reveal gains in scientific literacy. In all the examples featured in this section, we observe how the outcomes of place-based education enter and are beneficial for the community at large, which, by absorbing and "consuming" the products of learning, may undergo sustainable change toward a more positive, environmentally healthy future. In this process, scientific literacy develops as students expand both their control over the commons and tools of production and their room to maneuver in the community.

Not surprisingly, environmental education has recently moved towards more place-based approaches. Originally, environmental education dealt with rather global, abstract environmental concepts, such as those related to ozone depletion, toxic waste, and global warming – concepts that are often poorly understood by students and that bear little effect in regard to students' actions at the local level. In part, place-based education can be considered a particular form of enacting

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_15,

environmental education that emerged from attempts to bring youths closer to their natural environment and the problems affecting these environments. This kind of place-based education, also called "ecological place-based education," is associated not only with going outdoors close to the (sub-) urban environment to learn how the natural and the suburban environment are linked up with each other but also with acting responsibly and ethically in and toward this environment – a prelude to education for ecojustice. However, all too often, the focus of ecological place-based education is on the natural scientific aspects of place – as if nature existed as such independent of the ways in which it figures in the varying experiences of different people. From such a perspective, place-based education is a relatively unproblematic educational approach.

The emphasis on natural science insulates place-based education (unwittingly) from the social conflicts inherent in culture. This accounts for many place-based approaches that do not link natural scientific themes explicitly with critical themes such as urbanization and globalization. This is in part the result of place-based education as a countermovement against those forms of science education in which students often lose their sense of place by focusing on global or abstract issues that bear no tangible relation to place – in fact, science, supposedly valid everywhere in the world, seeks to generate universal and universalized knowledge that is independent of any and every place. There is thus an inherent tension in place-based education, making it a more problematic approach than initially foreseen. On the one hand, a natural scientific approach "dehumanizes" the place and reduces it to its natural scientific characterizations. On the other hand, the very same approaches aim at bringing students closer to the place and away from global, abstract issues.

The problematic nature of place-based education becomes even more clearly articulated once it moves toward urban settings and merges with critical pedagogy. In this regard, place-based education is less associated with the typical natural scientific aspects of the outdoors. Instead, place-based education deals with a complicated amalgam that, besides the natural scientific, involves social, cultural, and political aspects as well. Due to a shift from the natural scientific to the social perspectives on place, place-based education deals with social constructs. The natural scientific aspects of place are rather implicitly featured in describing the inner city material landscapes to which social constructs – of which many are racist myths – are attributed. Such shifts from the natural scientific to the sociocultural reflect the need for a critical pedagogy of place.

Following critical perspectives on place-based education, its problematic nature becomes evident as a matter of the voices by means of which place is articulated. Place, as a social construct, is defined by the perspectives people attribute to it and, in turn, these attributions collectively become the voice by which people are bound up with the places represented. Take a simple map of a place, which is often confused for the place (territory) it denotes. Such a projection of a place, deceptively simple and hence often unquestioned, is already problematic because of the names used. Places are often designated by formal names, which comes across as if this is the only name of the place that matters. However, places often bear local names of indigenous peoples reflecting their century-old relationships with the place. Even more so, the boundaries drawn by the natural sciences between human and nonhuman inhabitants of places are usually taken for granted, but even such boundaries are social constructs.

Following Bakhtin (1981), I understand myself as existing in a material world that I share with others so that – because of my unique position and therefore point of view – there are as many natural worlds and senses of place as there are different people. Indeed, the word "place" derives from ancient Greek word *plateia* (πλατεία, street), which referred to a central place in town for feasts, celebrations, events, and meetings (cf. van Eijck & Roth, in press). *Plateia* is not some position, not an empty space, but an area that becomes significant because of the events, meetings, feasts that "take place" in the place, which thereby comes into existence as place by virtue of the event. All subsequent uses of the word in all languages, e.g., Ger. *platz*, Fr. *place*, Sp. *plaza*, It. *piazza*, refer to locations where people meet and significant events occur. Put shortly, in places, something is happening that matters to folks.

Place-based education concerns the multitude of voices and the narratives they enact in which the material place comes to be refracted and ideologically reflected. These voices collectively *represent* the place – stand for its being, which brings us to identity as one of the key issues currently at stake in place-based education. Because of their own cultural-historically shaped biographies, scholars working on place-based education cannot share the notions of the place of their research participants that are fundamental to understanding the place as it is and hence, as a social construct. Place is not simply a location that we can identify by listening to a particular voice. It is a location unfolding in time where people inhabit, visit, rebuild, make, enjoy, sorrow, describe, and recount, hence live it – it is articulated by a multitude of voices.

In western scientific thought, "the thing is represented as an unknown X to which perceptible properties are attached" (Heidegger 1971, p. 153). This is the case when voices in the natural sciences reduce place by attaching categories for space and time as if they are perceptible properties. This may be problematic for people who are not used to listening to and articulating such voices, which is often the case with indigenous peoples. Hence, place as a lived entity is exactly what makes place-based education so problematic once studied in detail. Its "self" continuously unfolds in time as it is lived by its community – the collective people who live the place – and can neither be grasped by a static identity nor be articulated by a single voice such as the natural scientific.

With an increased interest in place-based approaches in the last 5 years, the problematic nature of place-based education has become even more evident. Several educational studies have recently appeared that illuminate place as a multivoiced and contested entity. As a result of this illumination, the discipline of place-based education is in a process of transition, which is reflected in this section – something is happening. Originally as an approach mainly used in science education in an unproblematized way, it is currently evolving into a scholarly field of study that takes the notion of place as foundational for education. This development is characterized by tensions in current scholarly work and, resulting from these tensions, the pushing and blurring of disciplinary boundaries. Engaging the reader in this challenging process of scholarly development is the aim of this section.

One of the tensions present in this section is between local (place) and global (non-place) knowledge. Place-based education, by nature, deals with local knowledge from the places studied. However, in science education, global, universal knowledge is privileged over those local kinds of knowledges that are bound to places. Here, disciplinary boundaries are disrupted and become porous since exactly the same tension is focused on in studies that deal with the role of indigenous knowledge in science education (e.g., van Eijck and Roth 2007).

The overlap between studies on indigenous knowledge and place-based education is due to another tension as well. This tension concerns place as something we identify with (places in which we dwell up to the extent of indigenousness) in contrast to the way scientists have traditionally generalized the notion of place. When we identify with a place, it becomes part of ourselves and we become part of it, such as is often the case with indigenous peoples and the places they inhabit. This contrasts strongly with the objectification of a place from a scientific perspective, allowing one to compare features of the place with those of any other place on Earth. By doing the latter, however, the place is reduced to universal and non-idiosyncratic measures that are inherently placeless. Although such measures allow the identification of a place, they have little to do with the ways inhabitants identify with the places they inhabit.

Connected to the former is the tension between taking places as living entities that are part of ourselves and which we are part of and care for (subjects) and things in themselves we can study as bystanders in the natural science without being part of or caring for (objects). This tension clearly reflects issues present in ecojustice education since the commons in our environment keep us alive and make us part of (subjects from) the places we inhabit. But it is also connected to the former tension since indigenous knowing is related to taking places as living entities we identify with.

Hence, a focus on these tensions reveals that the boundaries between education for ecojustice, indigenous knowing and learning, and place-based education are in fact blurred and porous. Particularly, this blur and porosity plays through this entire section and in each of the featured chapters. While this section initially features studies in place-based education, one can distinguish several turns where the focus of the text drifts toward indigenous knowledge and education for ecojustice. These turns are of particular interest, since they reveal the pushing and blurring of theoretical boundaries of the existing, once-separated disciplines, yielding more universal themes disrupting boundaries and stretching over disciplines. Taken together, the four chapters in this section show that something is happening in the practice of academic research on place-based education. As such, the ancient notion of place as *plateia* appears to be even reflexive for this entire section. It should be taken as a multivoiced location where people meet and significant events occur.

References

Bakhtin, M. M. (1981). *The dialogic imagination*. (M. Holquist & C. Emerson, Trans.). Austin: University of Texas Press.

Dewey, J. (1915). *The school and society* (Revisedth ed.). Chicago: University of Chicago Press.

Heidegger, M. (1971). *Poetry, language, thought* (A. Hofstadter, Trans.). New York: Harper & Row.

Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Great Barrington: Orion Society.

van Eijck, M. W., & Roth, W.-M. (2007). Keeping the local: Recalibrating the status of science and traditional ecological knowledge (TEK) in education. *Science Education, 91*, 926–947.

van Eijck, M., & Roth, W.-M. (in press). Towards a chronotopic theory of "place" in place-based education. *Cultural Studies of Science Education.* DOI: 10.1007/s11422-010-9278-2.

Chapter 16
Educating-Within-Place: Care, Citizen Science, and EcoJustice

Doug Karrow and Xavier Fazio

Introduction

We bring to the academic debate on place-based education (PBE – science), ecojustice, and indigenous knowledge a distinctly different perspective on the relationship between humans and their world. While contemporary conceptions of place tend to reinforce modern distinctions between subject and object, our conception of place, founded upon *being*, attempts to ameliorate these binary distinctions. Within the literature on PBE a variety of conceptions of place extend influence over the movement. The natural realm, that is, a physical location, orients early conceptions of place. Gradually, the veneer of the cultural realm has extended influence over place to include community. Presently, a sophisticated cultural realm considering complex social and political factors has extended place meaning. The literature review indicates little consideration of place from the ontological perspective. Our work explores the ontological realm through the philosophy of hermeneutic phenomenology – a philosophy premised upon human relationship with the world. Place conceptions inclusive of the ontological and the resulting influence they have on PBE movements have the potential to replace a traditional and prevailing form of knowledge as representation with a view of knowledge as a subspecies of a kind of thoughtful dealing with the world capitalizing on transcendent experiences with nature and our primordial capacity for care.

Accordingly, this chapter demonstrates how a conception of place-based education (PBE) referred to as *educating-within-place* founded upon the ontological realm, is necessary to the potential of citizen science for ecojustice. It consists of the following sections: (a) Introduction, (b) An overview of citizen science and *NatureWatch*, (c) Place meanings and place-based education, (d) The philosophy of Martin Heidegger, and lastly (e) Place-based education and ecojustice.

Subsequent to this introduction, this section provides an overview of citizen science, i.e., *NatureWatch,* a simple ecological monitoring and assessment program.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_16,

Through a series of case studies, we describe how such a program is traditionally implemented within a variety of school contexts.

The next section brings to the fore a discussion of place and education. We begin by examining the ubiquitous nature of *place* meanings helpful to the succeeding discussion on PBE. The focus then shifts to examining PBE as a developing field of practice by considering its definitions, major theorists in the field, theoretical deficiencies, and philosophical influences, building an argument for a conception of place founded upon the ontological realm. We conclude by highlighting *NatureWatch*'s capacity to nurture some conceptions of place while marginalizing others.

In the following section we introduce the philosophy of Martin Heidegger providing a detailed yet assessable overview of his seminal work *Being and Time* (1962). Here we illustrate how his thought around the ontological realm and its relationship with place could inform PBE theory. The last part of this section demonstrates how *care*, as one of humanity's *characters* of being, fundamentally shapes and influences our relationship within the world. We then demonstrate instances during *NatureWatch* implementation where a conception of place founded upon the ontological realm could be nurtured. These examples are drawn from the aforementioned case studies field-testing *NatureWatch* within schools.

In the final section we examine the relationship between PBE theory and ecojustice. After briefly defining ecojustice, we consider how an ontologically enhanced theory of PBE prepares the ground for ecojustice. We synthesize the argument for PBE theory to more adequately consider natural, cultural, *and* ontological realms of experience. Reflecting back on our *NatureWatch* research we reiterate practical pedagogical strategies to invoke the latter of these three realms.

An Overview of Citizen Science and *NatureWatch*

> …citizen science… is a form of science that relates in reflexive ways to the concerns, interests and activities of citizens as they go about their everyday business. (Jenkins 1999, p. 704)

Citizen science is a form of science that relates dynamically "to concerns, interests and activities" of common people engaged in their everyday lives. While there are many examples of citizen science (Mueller and Tippins 2010) influenced by varying degrees of sociopolitical action, the example we focus on is *NatureWatch.*

NatureWatch is a suite of simple on-line ecological monitoring and assessment network (EMAN) programs standardized through a partnership between Environment Canada and Nature Canada. It presently consists of *WormWatch*, *PlantWatch*, *IceWatch*, and *FrogWatch*. People with limited scientific background (*citizen scientists* in the making) can implement these programs effectively and confidently with minimal training.

Participants agree to follow each program's unique protocol for collecting a certain data set, whether identifying frog species by their unique call, collecting and identifying earthworms and their ecology, observing ice-on/ice-off dates on bodies of water, or identifying the flowering dates of specific plants. Collected data sets are recorded, organized, and then entered onto Environment Canada's EMAN database for environmental researchers to interpret and for policymakers to utilize. Participants can expect feedback on their reported data.

Citizen science programs vary in the degree to which they are sociopoliticized. At one end of the spectrum are those programs that are highly prescriptive, carefully defining stakeholders' roles. Citizen scientists are usually recruited only to collect data and have little say in other aspects of program implementation. At the other end of the spectrum are those programs that take a less hierarchical approach to program implementation, where participants equally share various roles. Table 1 delineates various stakeholders' roles using *NatureWatch*. One can see from this that *NatureWatch* tends toward citizen science programs that are more hierarchical and prescriptive. With the exception of community members, namely, students "collecting samples," professional scientists claim responsibility over all other aspects of program implementation.

For 3 years, we have been field-testing *NatureWatch* within public elementary and secondary schools. Our research has evaluated specifics around *NatureWatch* program implementation. Beyond such program didactics, recently, our evaluations have broadened to explore epistemological and ontological dimensions. As marginal participants in the research, we have had the pleasure of observing and recording student involvement with the program throughout various case studies. While such programs excel at doing essentially what they set out to accomplish, namely collecting and monitoring various ecological data, they superficially provide experiences for students to develop ongoing and meaningful relationships with place. We believe, and then argue, that such citizen science programs could be more meaningful for students if they capitalized more consciously on the human relationship with its environment. In making this case, we adopt a different philosophical position, which has implications for matters of epistemology and ontology.

NatureWatch, as it is currently implemented, tends toward teaching students how to identify specific species as indicators of ecological health. In our three case studies, two in elementary schools, and a third within a secondary school, after a day of inservice, teachers introduced students to the program teaching basic skills around species identification, data measuring, recording, and reporting. Sets of data were usually uploaded onto a central database. Without exception, each participating school chose *WormWatch* to implement with their respective classrooms. Teachers unanimously felt this program would be appealing to students as worms are "animals,"

Table 1 *Nature Watch* stakeholders' roles (Wilderman 2007)

Who defines the problem?	*Who designs the study?*	*Who collects the samples?*	*Who analyzes the samples?*	*Who interprets the data?*
Professional scientists	Professional scientists	Community (citizens/ students)	Professional scientists Community (citizens/ students)	Professional scientists

have fascinating life histories, and are readily locatable. Furthermore, because worms require some "scientific" skill in locating and identifying, the program could justify itself as a field trip. Of course, program implementation varied tremendously between schools. One elementary school took a comprehensive integrated curricular approach while others used *NatureWatch* simply as a topic of inquiry within a traditional science course.

WormWatch had students focusing on the ecology of worms. Using various taxonomy charts they were required to identify juveniles, adults, and differentiate between species. Results of these identifications were tabulated on a chart. In most cases, students successfully located worms in a variety of settings, for example, school playground, meadow, deciduous forest, and agricultural field. As well, students were required to observe and record weather and soil conditions, i.e., air temperature and soil type. Within most classrooms implementation occurred over a period of several weeks; three to four visits to the sites usually saturated student interest and attention. Teachers spent much of their time assisting students identifying worm developmental stages and species.

In an effort to explore the relationship between a citizen science program such as *NatureWatch* and PBE, in the next section we explore various meanings of place and how they have influenced PBE theory. Toward the end of this section we highlight those aspects of PBE theory *NatureWatch* currently invokes and hint at others that have been marginalized. These, in turn, are explored in the fourth section where we introduce the philosophy of Martin Heidegger.

Place Meanings and Place-Based Education

Place

> *Place* may be one of the most frequently used words in the English language. It is used variously as a physical location (what places did you visit?), a psychological state (I'm not in a very good place right now.), social status (people should know their place.), the location of something in one's mind (I can't quite place it.), a standard for evaluation (there's a time a place for everything.), and on and on. (Steele 1981, p. 5)

Our intent in what follows is to orient the reader to the broad categories of place meaning, which ultimately inform, in varying degrees, PBE theory. Where possible, we will illustrate our review of the literature by drawing on our example of *NatureWatch*. Despite the various meanings of place hinted at by Steele above, these can be categorized into realms of experience. We recognize, through our own work and thought on the subject the following three realms of experience: *natural, cultural,* and *ontological*. Of course, these are categories of our own construction (Karrow 2006), although others have also recognized them (Sack 1997). Like all "categories," at times they lack neat and tidy distinction. As place-meanings derive from all three, we argue, to become more theoretically and existentially robust PBE must also attend to these realms. Our unique contribution to the discussion arises by considering, in detail, the ontological realm. Considering the ontological realm through the philosophy we posit helps ease binary distinctions between subject and object, and create room for a theory of knowledge posited on care. In what follows, we trace out a rudimentary evolution of thought on the matter of place meanings and categorize these according to the three realms of experience previously noted.

Nespor (2008) highlights two common associations of place that PBE theorists tend to default to. First is the tendency to equate place with *land* or a *natural environment* (Greenwood and Smith 2008), and second is the trend to add to this early definition the veneer of *community* (Theobald 1997). Subsequently, we refer to these as: *place-as-land* or *place-as-community*. Community or "the commons," as Theobald and Bowers refer to it, is "the environment ... available for use by the entire community," encompassing "every aspect of the human/biotic community that has not been monetized or privatized" (p. 2). Referring back to Steele's opening quote, each of these perspectives on place, whether land or community, shares an affinity with the "physical." Such place constitutions are grounded in what we refer to as the *natural realm*. *NatureWatch* illustrates these two meanings of place in that the "places" implicitly examined are ecological spaces where certain indicator species, i.e., worms, are sought after as harbingers of ecological health. We can even see the influence of community as an overlay upon meanings of place derived from land or the environment enacted through the concept of citizen science where the "concerns, interests, and activities" of everyday people are considered reflexively.

A third conception of place addresses a deficiency in the former and overly simplified place-meanings by considering complex issues surrounding class, gender, and race (amongst others). Here we begin to see the influence of the psychological and social dimensions of place alluded to by Steele at the outset of this section. While *place-as-difference* is important and potentially extends PBE and its theoretical base, such an orientation to place is generally described as being grounded within a sociopolitical context (Wollan 2003). Using our nomenclature, place-as-difference is grounded in the *cultural realm*.

Whether place is associated with land and/or community and/or difference grounded by respective natural and cultural realms, what appears to be downplayed in the discussion is a consideration of the *ontological realm*. Fundamentally, there is a deficiency around the meaning of human existence in relation to the world, and as such, we advocate for another conception of *place-as-being*. Adds Casey (1997): "[T]o be at all – to exist in any way – is to be somewhere, and to be somewhere is to be in some kind of place" (p. ix). While Lim and Barton (2006) do begin to acknowledge the importance of an ecological relationship between the student and their learning environment, what they refer to as a "sense of place" within the science classroom (an appropriation of the lifeworld), and their work focuses on how students bring *into* the science classroom their senses of place, our work is distinctly different.

First, our conception of place is also informed by the ontological (being), whereas Lim and Barton, borrowing from Gruenewald (2003) and Lutts (1985) view place "as a complicated, ecological system that includes physical, biological, social, cultural, and political factors with history and psychological state of the person who share the location" (p. 107). Within this definition of place appear the natural and cultural realms; however, little, if any, consideration is given to the ontological realm, barring perhaps the psychological state of people. What's more, we are concerned about this concept of place (the lifeworld, to borrow the language of Husserl) and its foundation, something we examine using the philosophy of Martin Heidegger in the following section. Regardless, the association of place with being within PBE discourse is cursory, despite anticipations by Sack (1997) who alludes to the interrelationship between land, society, and individual in the following way:

> Indeed, the very fact that place combines the unstructured physical space in conjunction with social rules and meaning enables place to draw together the three realms, and makes place constitutive of ourselves as agents. (p. 33)

Again, glimpses of such engagement are partly visible in the *NatureWatch* citizen science program. Our case studies demonstrate that when students are given license to consider nontechnical ways of being with worms, for example, cultivating descriptions of these beings in their environment, vocalizing wonder, awe, or amazement, they surely hold the capacity to discover the meaning of being and in doing so express primordial capacities of care. In the next section, we illustrate in further detail what we have come to appreciate – that place must also be configured according to the ontological realm. We emphasize, place should *not* be understood strictly as referring to that in which something is located – it is not a simple position or location. Rather, place-as-being is *the open region within which entities come to appearance*. Malpas (2006) clarifies between the two notions of place in the following way:

> Rather than the sense of place that is invoked when I give someone my address, or explain where to find a particular book, this latter sense of place is more like that which is at issue in the experience of place as such – whether that be the experience of finding oneself within a particularly striking landscape, of being gathered into the familiarity of friendly surroundings, or of trying to navigate through an unknown countryside or town. (p. 49)

The first sense of place is derivative of the experience (more ontic = real and factual), whereas the second sense of place is more original, embedded still within the sense-making experience (more ontological = an experience of being).

In summary, initially there has been a tendency to associate place with nature, that is, place-as-land or place-as-community. This has slowly given way to complex associations of place with culture, imbued with complex social, political, economic, and historical forces, influencing the manner place has been conceived, that is, place-as-difference. And finally, as we suggest, place envelops meaning through the ontological realm, that is, place-as-being. In doing so, place is conceptualized through the relationship humans experience within their world.

Place-Based Education

Conceptions of place have had a profound impact on PBE theory and practice. At the outset we provide a cursory definition of PBE as a developing field of practice.

Moving on to briefly summarize the works of Theobald (1997), Bowers (2006), Gruenewald (2003), Greenwood (2008), foremost thinkers of PBE, and Nespor (2008), who provides a thorough sociopolitical critique of PBE, we build upon the developing argument that the field of practice is theoretically formative. To further elaborate theory around PBE, an additional entry point, one informed by a branch of philosophy premised upon humanity's relationship with the world is desirable and necessary. The philosophy of *hermeneutic phenomenology* brings to the fore a missing ontological dimension through its relationship *with* place. Furthermore, educating-within-place is what occurs between the discrete categories of place and being prior to their factical differentiation (conceptual categorization)[1]. Hermeneutic phenomenology and the conceptual framework of educating-within-place expand PBE theory by considering the ontological realm in addition to the natural and cultural realms. PBE theory that considers natural, cultural, and ontological realms is more reflective of the phenomenon that exists between humans, their cultures, and their natural environments.

PBE is a developing field of practice that aims to ground learning in local phenomena and students' lived experiences (Smith 2002). More recently, Gruenewald (2003) states that, "place-based educators advocate for a pedagogy that relates directly to student experience of the world, and that improves the quality of life for people and communities" (p. 7). The emphasis within the former definition is on "grounding learning in local phenomena" and "student experience of the world," although what constitutes local phenomena remains unclear. In the latter, notice the shift toward "pedagogy directed toward student experience of the world" *and* "improving the quality for people and community." Over time, definitions have broadened to include social and political features and have moved from learning *to* teaching. To a degree, this reflects changing place-meanings. Recall early conceptions of place-as-land, and more recent definitions expanding this notion of place-as-community, and Nespor's (2008) criticisms of these place conceptions and their limiting effect on PBE theory, namely the notion of place as an *ideal*, dichotomized through binary distinctions. PBE theory is more complex than these conceptions of place lend themselves to. Place-as-difference considers the complexities of power enacted through class, gender, and race. Nespor adds:

> These kinds of networks and circuits [class, gender and race] organize education in relation to place and produce places in different forms. The careful, comparative analyses needed to tease out how the different strategies work and what kinds of "places" they presuppose and create is missing in PBE theory, however, and it does not seem likely to emerge as long as that theory stays wrapped around standard dichotomies and moralizing definitions of place. (p. 482)

To summarize, along with more sophisticated definitions of place, there have come more complex definitions of PBE. The evolutionary tendency has equated place with land, community, and difference; accordingly, PBE initially focused upon

[1]For a detailed description of how the concept *educating-within-place* was conceived see D. D. Karrow (2003).

student lived experience and learning in local phenomena to teaching and student experience of the world with an improvement of people's and communities' lives. Over time PBE has become socially and politically charged. Once again, referring to our *NatureWatch* case studies, such a citizen science program illustrates this tendency. Engaging students in physical environments, un-tampered by economic or political interest (the commons), and having them collect ecological data to assess the fitness of these environments, illustrates a rudimentary form of PBE founded upon place-as-land/community. Depending on the degree to which the citizen science program invokes concernful action around the ecological health of community environments, PBE could reflect a conception of place-as-diversity. However, *NatureWatch*, as we will examine in further detail, falls short of this.

Despite the efforts of Paul Theobald, summarized within his book, *Teaching the Commons: Place, Pride and the Renewal of Community*, Chet Bowers and his on-line book, *Revitalizing the Commons*, and David Gruenewald and his work entitled, *A Critical Pedagogy of Place*, the field of place-based education remains theoretically immature (Nespor 2008). Gruenewald (2003) elaborates: "Place-based education, in its diverse incarnations, is currently less a pedagogy per se and more an alternative methodology that lacks a coherent theoretical framework" (p. 3). What is common to these approaches is an emphasis on *place* or "context" and *education* or "the value of learning" as separate entities brought together through deliberate practice or pedagogy. They differ in the manner they approach PBE; pedagogical enactments striving to relate place objects with learning subjects.

Theobald's work situates PBE in a sporadic history of the critical junctures at which the commons, arenas with strong borders controlled by dense networks of intradependencies (the necessary relations within place) have been undermined (Nespor 2008). Beginning with the ancient Greeks he intermittently traces the history of the commons noting its deviation over time while arguing for its maintenance by schools directed toward promoting community (Theobald 1997). Oriented slightly differently, although borrowing the idea of "the commons," Bowers (2006) advocates for the preservation of the "commons," again in his owns words, "the environment…available for use by the entire community," encompassing "every aspect of the human/biotic community that ha[s] not been monetized or privatized," by ways that schools and other institutions can help "resist their further destruction" (p. 2). In an effort to move beyond mere "technique," Gruenewald (2003) begins to theorize the movement through what he refers to as a *critical pedagogy of place* – an effort to conjoin critical theory with PBE and thus move the field of practice in a direction inclusive of socially critical and ecological dimensions through what he terms *decolonization* and *rehabitation*. Despite inherent problems with such an attempt to theorize PBE, namely "it represents abstract context-free thinking, as well as a rationalist approach to change and progress" (Stevenson 2008, p. 356), the collective approaches of Theobald, Bowers, and Gruenewald are problematic because they tend to moralize and emphasize dualities, as previously noted. As place is idealized through some historical allusion to "the commons" and our present condition as "the fall" from this ideal, a strong moralizing sentiment is expressed. What is more, place tends to be defined in terms of regions with boundaries obscuring critical questions about how places are constituted and connected to one another (Nespor 2008).

Regardless of these approaches to PBE and the arguments tabled for one over the other, they represent attempts, with varying degrees of success at establishing a theoretical foundation for PBE. While Gruenewald's philosophy is informed by Freirean critical theory, a deconstructivist member of philosophical poststructuralism, and Theobald's philosophical roots remains obscure (Stevenson 2008), Bowers' philosophical roots are more eclectic. Central to his philosophy, notes Mueller (2009), "is the premise that cultural knowledge and language carry forward root metaphors that encode and reproduce cultural ways of knowing and human relationship with the Earth's natural environments" (p. 1034). Primarily informed by a variety of postmodern philosophers, namely critical theorists, his work is heavily influenced by Gregory Bateson.

Our philosophical entry point is somewhat different; the philosophical forefather of the deconstructive movement – *hermeneutic phenomenology*. While deconstructionism is primarily oriented toward the ethical and political (Moran 2000), hermeneutic phenomenology tends toward the ontological, human existence, or as metaphysical philosophers refer to it, *being*.[2] Furthermore, hermeneutic phenomenology, as a body of philosophy, should be of great interest to those attempting to understand, "themselves as part of the studies of the interaction between man and world" (Wollan 2003, p. 38), and in this sense, it is an appropriate philosophy for approaching the interrelated phenomenon of place, being, and education. What is more, it is our contention that such a philosophical position has the potential to contribute further to the theory of PBE.

The connection between place and being is essential, as we shall argue. And our distinct approach to this contribution aims at illustrating this connection. As Malpas (2006) observes, "*place* and *being* are inextricably bound together in a way that does not allow one to be seen as an 'effect' of the other, rather being emerges only in and through place," and vice versa (p. 6, our emphasis). As we discovered previously, whereas earlier PBE movements focused upon learning about the environment, namely, "the land," successive PBE movements have shifted this focus to include "the community," and contemporary PBE movements emphasize "difference" with a sociopolitical imperative, we are interested in the interrelationship between place and being. Whereas previous movements' concerns stem from human displacements from nature, and more recently culture, our argument issues from a concern over ontology, or being. Wary of the tendency to repeat the foibles of our contemporaries, we do not subscribe to an *ideal* notion of place or being

[2] In its upper case form "Being" is distinctly different from its lower case form, "being." Being (capitalized form) "is not a being, a God, an absolute unconditional ground or a total presence, but is simply the living web within which all relations emerge" (Bigwood 1993, p. 3). Whereas being *is* existence, Being refers to the primordial existence of our being. In other words, Being is, "that which gathers particular beings together into a way of being and courses through them in their coming to appearance (p. 146).

lamenting some arbitrary "fall from grace." There is no moralizing tendency behind our argument. Rather we delve into the meaning of human existence and its relation with place as we currently experience it. Before concluding this section, it is necessary to introduce our conception of PBE. Although we have already argued for a conception of place-as-being, we articulate how this might relate to education.

Meanings of place-as-land, place-as-community, or place-as-diversity share a commonality. They each approach the *object* of place from the standpoint of a *subject*, an irresistible modern habit. We wish, through our conception of PBE to dissolve this tendency by advocating for a blurring of the object/subject distinction. This is accomplished, we believe, in a couple of ways. First, our philosophical position, hermeneutic phenomenology, is premised upon erasing subject/object dichotomies. Second, the language we choose to "name" our conception of PBE is distinctly different. "Educating-within-place" appears hyphenated in an effort to convey a sense of ongoingness, intimacy, imbeddedness, the active, inevitable, evocation of the possible. Also, we hedge against using the word "education" as a noun as if something has occurred opting instead for "educating" as a verb, in an effort to convey the sense as described previously. Conveying a sense of the education's dynamism Fox (1983) adds: "Education is *ek-static*, a movement beyond what already is, a reaching out to the new life around us in a way that keeps open the possibility 'that people of this precious Earth ... may live' " (p. 9). Our use of language, in this way, may seem strange and peculiar; however, it is not without precedence. Speaking of the unusual character of Heidegger's language, of some influence on us, Abram (1997) notes: "[H]e [Heidegger] is trying to avoid the use of nouns, of nominative forms that would freeze the temporal flux" (p. 212). All in all, educating-within-place is the conceptual structure reflecting the continual, ongoing, intermingling, and complex phenomenon between place, being, and educating.[3] It is not something *acted* upon a place, rather something that occurs *within* place.

NatureWatch and Place-Based Education

To this point, we have introduced *NatureWatch* as an example of a citizen science program, explored various meanings of place and their influence upon PBE theory, and advocated for a conception of place-as-being to foreground the ontological realm within PBE theory. We now wish to illustrate the degree to which *NatureWatch,* as it is typically implemented, reflects aspects of current PBE theory. We recognize that in its existing form, *NatureWatch* does instill rudimentary experiences around place. There are, however, other place experiences of the ontological

[3]Our intent within this chapter is not to provide an account of the derivation of educating-within-place, but to elaborate theory around PBE by considering ontological realms. For a more detailed account of its origin, see D. D. Karrow (2003).

order that remain marginalized. We will return to these marginalized experiences after considering Martin Heidegger's philosophy in section four.

What allusions to PBE theory are invoked by *NatureWatch* as it presently exists? That *NatureWatch* has the capacity to invoke place-as-land/community is certainly obvious. This usually amounts to educating students in physical places outside the domain of the classroom. These physical places are broadly construed and may include everything from natural to cultural settings. *NatureWatch* certainly provides students with opportunities to work in more natural settings situated within their local communities. In our three case studies, which included two schools situated within suburban settings and a third in a highly urbanized setting, students got outside collecting worms. In some instances, collecting sites were the school grounds, or adjacent natural spaces, such as a farmer's field or a deciduous forest. In the urban secondary school, students visited a section of the Niagara Escarpment to collect their worms. Either way, students were outside, within a different "place" implementing the *WormWatch* program.

As to whether *WormWatch* invokes place-as-difference, the sociopolitical dimension theorized by Gruenewald, in our experience, is doubtful. As the program is highly controlled with stakeholders' roles carefully prescribed, students and their teachers had little or no opportunity to examine larger issues stemming from collected data. For instance, in several cases, teachers expressed concern over the lack of worms discovered on school sites. They posed questions about this, that is, the health of student's play/work environments, but that is as far as their inquiries went. *WormWatch* did not provide opportunities to invoke a *critical pedagogy of place* to borrow from Guenewald, although it certainly has the potential to do this should Environment Canada choose to embrace such an approach to citizen science, or should teachers feel they have the license to do so (Karrow and Fazio 2010 submitted).

In bringing this section to a close, a few general observations are in order. With regard to the various *WormWatch* case studies the prevailing attitude toward any relationship between the student and his/her environment is distinct. Because of the manner in which the program is conceived, structured, and implemented, students assume the position of a detached, objective, and impartial "scientist." Students have little or no opportunity to develop a sustainable and meaningful relationship with their local environment. They, as "subjects" rove about visited environments observing worm "objects." The type of knowledge privileged throughout these field-collecting exercises is scientific-technical knowledge. Students are educated into acts of "correct" identification, as per the premise of the program, with the teacher acting as the arbiter of that knowledge. Interestingly, student buy-in seemed to taper off during successive site visits. For instance, within elementary schools, during the third or fourth visit to a site through the course of a month, students spent more time digging and backfilling while pursuing various other off-task behaviors, than assessing basic ecological conditions. Frequently, one or two students ended up with the tedious task of classifying the worms, no easy task even for the casual zoologist, while the balance of the group (4–6 students) milled around. Furthermore, several teachers indicated that the implied value of the program hinged upon students' correct identification of worm specimens. The validity of data was a common concern for many teachers often burdened by students' repeated requests for assurance during worm identification, data recording, and database inputting. Because the program conveys a scientific-technical premise, teachers' attention is drawn toward this and their perception of the program is skewed in this fashion. While these observations of the nature of student and teacher participation are generally consistent with the *WormWatch* program objectives, if the focus remains on scientific-technical knowledge, much is missed. Opportunities to reveal that which is marginalized by such knowledge will be further explored when we introduce Martin Heidegger's philosophy in the next section.

The Philosophy of Martin Heidegger

The Phenomenological Movement

Little of Heidegger's work has been considered alongside PBE theory largely because it has only recently been translated, remains dense and impenetrable, and unsettles the traditional course of philosophy most are familiar with. On top of this, is the undeniable association Heidegger had with the German socialist movement leading up to and during World War II, and his reluctance afterward, to repudiate the regime or his actions. Yet, despite these shortcomings and detractions, Heidegger's work offers us a distinctly different concept of place – one that we refer to as place-as-being.

This section begins by situating Heidegger's work as a response to the limitations, as he saw them, to western philosophy. We then provide a summary of his work, in relation to place, through his monumental book *Being and Time* (BT) (1962). The section culminates by acknowledging *care* as one of human being's characters of being suggesting that an essential task of education might be, "to inspire a psychology of awe" – "To *care* about Being as such" (Irwin 2002, p. 203).

To understand Heidegger's contribution to western philosophy, one must be acquainted with his predecessor and mentor Edmund Husserl, the father of phenomenology. Husserl was deeply concerned about the direction western philosophy and its disciplines, mathematics and the sciences, were taking, namely, consistently overlooking our ordinary, everyday experience of the world around us. This compelled him to inaugurate the philosophical discipline of phenomenology, which during the early 1900s, was motivated by his infamous dictum, "back to the things themselves." This has become a rallying call for philosophy to focus its attention on how things become apparent to our everyday consciousness. Unlike its contemporary disciplines, phenomenology would not attempt to *explain* phenomena, as science and mathematics attempt to, but rather it would *describe* "as closely as possible the way the world makes itself evident to awareness, the ways things first arise in our direct, sensorial experience" (p. 35). In the case of *NatureWatch*, in addition to satisfying program objectives, this might also involve having participants (students) describe worms using a variety of mediums. They could photograph them, draw, poeticize, or narrate their experiences *with* worms and their ecology. In the words of another great phenomenologist, Merleau-Ponty (1962):

> All my knowledge of the world, even my scientific knowledge, is gained from my own particular point of view, or from some experience of the world without which the symbols of science would be meaningless. The whole universe of science is build upon the world a directly experienced, and if we want to subject science itself to rigorous scrutiny and arrive at a precise assessment of its meaning and scope, we must being to reawakening the basic experience of the world, of which science is the second-order expression..... To return to the things themselves is to return to that world which precedes knowledge, of which knowledge always *speaks* and in relation to which every scientific schematization is an abstract and derivative sign-language, as is geography in relation to the countryside in which we have learnt beforehand what a forest, a prairie or a river is. (p. viii–ix)

Heidegger broke with Husserl's original view of phenomenology seeking allegiance with the ancient Greeks, namely Aristotle. As such, phenomenology was to be understood in terms of the Greek understanding of *phenomenon* and *logos* – in other words, "letting what is to be seen show itself in a manner in which it shows itself" (Moran 2000, p. 228), or as Wollan (2003) comments: "Heidegger therefore sees the aim of phenomenology as looking for the 'hidden ground and meaning' of what ordinarily shows up in the world" (p. 33). Things show themselves (appear) in various ways depending on the modes of access we have to them, that is, history, tradition, and increasingly through technology. In our *NatureWatch* case studies this took on the form of "revealing worms" through a scientific frame of reference. Students were directed by the program to engage with worms by collecting data. An aside: today data commonly means *information* – facts or statistics collected together for comparison, analysis, reasoning, or calculation. In the seventeenth century, data meant *something given*. Construing knowledge through the act of giving something – a gift, perhaps? – is radically different from the contemporary knowledge metaphor founded on social constructivism where knowledge is "constructed." Regardless, striving to think the nature of phenomenology differently, Heidegger, in contrast to Husserl, realized that some things do not always show themselves as they are, so phenomenology could not be simply description, rather it seeks *meaning* which is, on occasion, hidden by the entity's mode of appearing. Entities can be such things as birds, wind, laptops, books, and in our *NatureWatch* case studies, worms. They "appear" (come to presence or come to be) in various ways, but increasingly so through the enframing capacity of science, and even more so technology. The students we observed primarily engaged with worms as they "appeared" through the interpretive stance of science, namely, data collection. In this way, Heidegger's view of phenomenology departs from that of Husserl's. Furthermore, because the understood model for seeking meaning is interpretation of a text (up to that time), phenomenology became linked with hermeneutics (interpretation) and in this way radicalized phenomenology as *hermeneutic phenomenology* – "how things appear *or* [our emphasis] are covered up must be explicitly studied" (p. 229). Accordingly, providing opportunities for students to engage with worms in other ways beyond strict data collecting activities becomes a priority as it nurtures and respects the relationship they have with their lifeworld – what Heidegger proclaimed as Being-in-the-world.

Hermeneutic phenomenology is the structure Heidegger uses repeatedly and iteratively to clarify the general character of our understanding of any phenomenon. It consists of three broadly construed levels:

First, an entity or phenomenon is grasped globally and hence without detailed articulation.

Second, the "Being" of that entity, or the different possible ways in which it can show itself, is laid out.

Third, the "meaning" of that Being, or the ground upon which the entity shows itself in those various ways, is highlighted and described (Parker 2005).

So in terms of *NatureWatch*, again, in addition to satisfying program objectives, in what other ways might this ontological realm be invoked? As we have seen, Heidegger's approach to phenomenology broke with Husserlian tradition – so simple and "pure" student descriptions of phenomena will not suffice. In addition, students would be required to *interpret* their descriptions, perhaps a more complex task. Nonetheless, students could take their previously suggested descriptions of worm ecology and interpret these beyond the interpretive (rational-scientific) framework demanded by the *NatureWatch* program. Of course, part of this exercise would be to point to (explicitly, or implicitly) the overly utilitarian nature of *NatureWatch*. One could conceivably reap the benefits of engaging with worms for other reasons, that is, spiritual, historical, aesthetic, and emotional. Furthermore, students could explore other interpretations of worms, and provide their own. This of course, would have to be carefully modeled by teachers supporting the cause, yet passionate too about its outcomes.

In summary, Heidegger's view of philosophy was that it *was not* something "to be applied *to* life, but rather comes *out* of life and is lived as a *part* of life"; an important and salient distinction (Malpas 2006, p. 41). Citizen science programs, such as *NatureWatch* could espouse such a philosophy with simple yet effective reorientations by teachers during program implementation. Let us examine these in greater detail in what follows.

Heidegger's Being and Time

> Unless we go back to the world, space cannot be conceived. (Heidegger 1962, p. 148)

Being and Time is a monumental undertaking to critique the foundations of western metaphysical thinking. Metaphysics is that branch of philosophy concerned about *the nature of Being* and *what it means to be*. Over the course of history, metaphysicians have answered these questions in different ways, and it was Heidegger who again expressed interest in revisiting the question: What is the meaning of Being? Seemingly a simple question, yet through his attempt to answer the question, he radicalized philosophy, and more specifically phenomenology. Heidegger was compelled to do this because Being is a universal concept, and because it continues to remain concealed (Wollan 2003).

The question of *the meaning of Being* is central to Heidegger's thought. Although he is also interested in the being of entities in numerous forms, he is more concerned about the being of their surrounding context, and ultimately the Being of the world as a whole (Inwood 1997). The question of the meaning of this Being and its relation to knowledge and science founded on such questions as "What can we know?" and "What are the foundations of sciences?" radically challenged the conventional epistemology of the time favoring a disinterested, objective inquirer. Suspicious of such an epistemology, Wollan (2003) paraphrases Heidegger as follows:

> It is an interested human being, situated in a particular place and a particular time, with many other relations and attitudes to many other things than the object of its sciences. As well, he suggested knowing is not the first relation we adopt for things in the world. As a physical and cultural being the human is always placed within a deeper understanding of what it means to know something than that which in an aggressive way claims to have a direct contact with the world itself. Through human social practice is conveyed not just a hidden understanding of what it is, for example, to be a person, but an understanding of what it is to be at all. (p. 33)

And it is this "hidden understanding" of the meaning of Being that perplexes Heidegger and becomes the project of his philosophical investigation over the course of his career. He is not thinking of Being as something that *is,* rather Being is something that makes itself apparent to us, a "clearing" opened by our shared and practical lifeworld (Heidegger 1962). For students interacting with worms in their local environments, this might involve, through their previous experiences describing worm ecology (beyond the scientific framework), discovering other meanings for worms beyond data objects. Learning experiences could be structured for them to discover the role worms (as Darwin described them – *the Earth's ploughs*) play in revitalizing the soil, or the mystery behind their hermaphroditic reproductive abilities, or the fact they did not exist in North America prior to colonization, and so forth. An emphasis on the fact that we could not exist without the presence and activity of worms would surely instill wonder and awe; the impression that these beings, their environment, and our relationship with them is remarkable.

Heidegger begins by considering human begins, as they are capable and compelled in the first place to pose the question about Being, so he naturally begins his inquiry there. To distinguish between the Being of all beings, and the Being of human being, Heidegger conjures the word *Dasein*, with various translations proffered: "being here" or "being there," existence, human being, and so on. Adds Wollan (2003):

> Dasein is Heidegger's way of referring both to human being and to the type of Being human's have. … Dasein is essentially in the world, not simply in the sense that it occupies a place in the world together with other things, but in the sense that it continually interprets and engages with other entities and the context in which they lie, the environment or the world around us. Dasein is at the centre of the world, drawing together its threads. (p. 34)

Regardless, *Dasein* is distinctly human being's Being, or as Moran (2000) notes, "the specific mode of Being of humans" (p. 238). Furthermore, Dasein is not a specific entity that realizes itself through rational, logical-theoretical thinking, although Heidegger does recognize that consciousness exists, he deliberately tries to downplay the foundational significance of mental states.

The balance of the work within BT is spent analyzing human existence through an enquiry into the Being of Dasein (human being's Being). The analysis shows that Dasein has a fundamental structure of Being-in-the-world, "being with things and with others, in such a way that its whole existence is structured by care" (Moran 2000, p. 238), one of several basic features of Dasein's Being known as existentials. We even caught glimpses of this prestructure as students interacted with their worms. Observing secondary students express concern or anxiety over severing worms inadvertently while digging for them, was both surprising yet reassuring. There are many more existentials beyond care and there is a connection and a time structure linking them together in entirety. As well, they are not apparent on their own, but observable through people's concrete existence or social practice. Adds Wollan (2003):

> The existentials are totally decisive for comprehending what Heidegger means by Dasein's Being-in-the-World because they are the basis for and make possible the individual human's concrete existence. The existentials are not separable from each other and equally involved in our discloure of the world and ourselves, they are in Heidegger's term "equiprimordial." The existentials appear strange to us, because of the tendency in the human manner of being to overlook their existential basis; *things* [our emphasis] appear to be closer to us than the existentials.

Phenomenological analysis seeks to prove the existence of these existentials in light of their genuine expression. Let us examine the existential of care more closely, as it becomes a focus for what follows in the remaining section where we make the case for it as a precondition for ecojustice.

Heidegger comes to the conclusion that care is the fundamental structure behind Dasein's Being-in-the-World through the influence of Kierkegaard's work on death and anxiety, "Dasein's Being is Being-towards-death" (Moran 2000, p. 240). As human beings are each directed toward death, human nature is radically finite. Anxiety, one of many moods (also existential), is our unique capacity to sense death, or that a certain nothingness or groundlessness beseeches us. It reveals to us a certain homelessness and our only way to understand this is to turn away from it. It thus serves to demonstrate to us that we are caught up in a structure of care about the world; we are not indifferent to it (consider the reaction of the secondary students previously described). Adds Inwood (1997): "[C]are is correlative to the significance of the world. Only if Dasein is care can it dwell in a significant world, and only if it dwells in a significant world can Dasein be care" (p. 59). The anxiety experience refers to something we already know; that the human existence is entirely guided by the principle of care. As such, we experience that our Being is realized and guided by the care of to be (Wollan 2003). Just as the scientist might investigate or search and presume neutrality, we see that beneath this neutrality there is the mood, the concern of the scientist to discover, to reveal new ideas or theories and to attempt to level off temporal aspects.

The existential of care is also expressed through Dasein's spacial character. Although beyond the scope of this work (see Wollan 2003), an analysis of Dasein through spacial existentials reveals Dasein's spatiality. Dasein is "in" the world in the sense that it deals with other entities with concern and familiarity. This character of Being-in makes possible Dasein's spatiality. This is illustrated through two existentials Heidegger (1962) refers to as "de-serverance" and "directionality."

De-severence refers to a "constitutive state of Dasein's Being, making the farness vanish, making the remoteness of something disappear, bringing it close" (Wollan 2003, p. 37). Through this existential, a second makes itself apparent – directionality. "Every bringing close has already taken in advance a direction towards a region out of which what is de-severed brings itself close, so that one can come across it with regard to its place" (p. 37). And here we come full circle to discover the relationship being has with place. As Casey (1997) adds: "[W]hen closeness is realized by the conjoining of circumspective concern with directionality, *place results* (p. 248, our emphasis). As students experience worms, engaging with them through the existentials of care, de-severance, and directionality, through the Being of their humanity (Dasein), place is created.

NatureWatch and Heidegger's Philosophy

Let us again consider, in what ways *NatureWatch* could capitalize upon this basic existential of care. We saw evidence of this fundamental structure repeatedly during our case studies and salient episodes with teachers attempting to foreground such experiences. PBE theory, which includes place-as-being through the concept of educating-within-place, attempts to replace a traditional form of knowledge as representation with a view of knowledge as a subspecies of a kind of concernful dealing with the world. In what follows, we shift our attention from a theory of truth conceived as judgment toward a theory of truth based on revelation. Recall, this all presumes a conception of place-as-being, or an appreciation for place as that which is *revealed* (appears).

To begin, we noticed that students generally looked forward to field-collecting experiences. Field trips were usually met with great anticipation and excitement. Once on-site, for the most part, students were touching earthworms, describing how they felt, pressing down upon the earth to leverage their shovels, feeling the soil with their hands as they located/sorted worms, discovering unknown invertebrates/vertebrates, looking up to the sky to assess rudimentary weather conditions, gaining an appreciation for their ecology and habitats, and so on. We even witnessed Grade 10 students comment, "we never knew worms existed underneath the school yard!" It could be said, these students were forging a *relationship* with worms and the local environs. In her landmark study in the 1950s reviewing the autobiographies of 300 European geniuses, Edith Cobb noted that many of these people described similar experiences during childhood.

> [T]he study of the child in nature, culture and society reveals that there is a special period... of childhood, approximately from five or six to eleven or twelve, between the strivings of animal infancy and the storms of adolescence – when the natural world is experienced in

> some highly evocative way, producing in the child a sense of some profound continuity with natural processes. … [T]hese writers say they return in memory in order to renew the power and impulse to create at its very course, a course which they describe as the experience of emerging not only into the light of consciousness but into a living sense of a *dynamic relationship* [our emphasis] with the outer world. (Cobb 1959, as cited in Sobel 2008, p. 16)

Intrigue, excitement, curiosity, revulsion, wonder, and awe were common emotional responses from the students, and sometimes their teachers. Students began to express what Malpas (2006) observes when he states: "Returning to place is thus not returning to any one place, but a returning to the openness and indeterminacy of the world – a returning, also, to the experience of *wonder*" (Malpas 2006. p. 310). Place-as-being provides for such a return, to the place where Being as such can be a matter for human being. To experience the mystery, the joy and awe of discovering that Being has possibility beyond that which tends to be revealed through dominant means, namely, science and/or technology (Heidegger 1977) is worthwhile. Such an emotional connection is the prelude to an intimate relationship. Once such a relationship begins, other nontechnical forms of engagement may follow. Students, as a foundation to their Being-in-the-World, demonstrate *care*, by gently touching their worms, rehydrating them as they dry in the air, re-placing them in their home and covering the soil carefully upon them, or acquiring empathetic understandings about their precarious fates. In a creative writing activity, teachers had students in one class write letters from the point of view of a worm relative whose cousin had been eaten by a Robin (a very common North American bird that is adept at eating worms). In another class, students assumed the role of the Robin, and prepared a thoughtful response. In and of themselves, these activities do not guarantee learning to value the world and its many species, but at least they begin to interrogate prevailing assumptions and demonstrate that such engagements with nature, beyond the instrumental, are possible, desirable, and worthwhile. Instead of students amassing data, as we previously suggested, perhaps their connection with nature could be nurtured through empathetic understandings or engaging with nature along aesthetic lines.

Until these points are considered, the type of educational experiences programs such as *NatureWatch* offer will fall short of bringing the types of lifelong understandings, attitudes, and behaviors vital to restoring a healthy relationship with our Earth. In closing, David Sobel captures the relationship we posit between such transcendent experiences with nature and our primordial capacity for care.

> [O]nce you've felt at one with the natural world, it will powerfully compel you to environmental ethics and behaviour. It follows that if we want to develop environmental values, we should try to optimize the opportunity for transcendent nature experiences in middle childhood. (Sobel 2008, p. 18)

Summarizing this section we wish to highlight a few points before moving on to the final section. First, Dasein's Being-in-the-World is a unique and peculiar phenomenological problem of interest to those examining the relationship between humans and their environment. Such a perspective is useful to those elaborating PBE theory. As we illustrated within the previous section, predominant meanings of place-as-land/community, or place-as-difference, each contribute elements to PBE theory, but unless the ontological realm is considered such theory remains callow.

Bringing a conception of place-as-being to PBE theory through the concept of educating-within-place is more integrative, holistic, and reflective of the phenomenon of Being of human being, a Being fundamentally structured by care; a precondition for ecojustice. While such philosophy may seem obtuse at times, we have also indicated moments or opportunities where *NatureWatch*, despite its predilection toward the natural realm of experience, could draw too upon the ontological realm through the support and guidance of the teacher providing educational experiences around the discovery of the mystery of Being. Many of these capacities already exist within students. The challenge for science teachers, educators, and researchers is to make apparent the interpretive structure of science, and in doing so, provide other opportunities for students to experience the more natural world in ways that de-marginalize all epistemologies, including those of a more ontological structure.

Place-Based Education and EcoJustice

Before tackling the question, "what is the relationship between PBE and ecojustice?" we need an adequate understanding of ecojustice. Ecojustice is a moral and conceptual framework for understanding the goals of social and ecological justice. In Mueller's (2009) words: "Ecojustice is an emerging perspective that addresses the confluence of social and environmental injustice, oppression for humans and nature, and ecological degradation" (p. 1033). The aim of ecojustice is to develop an understanding of the tensions between cultures and the needs of the Earth's ecosystems. Tensions may include intergenerational knowledge and skills, beliefs and values, expectations and narratives. The philosophy behind ecojustice is founded on the role language plays in highlighting or downplaying particular cultural metaphors that influence our perceptions, attitudes, understandings, and beliefs about nature and society. Within schooling education contexts, imbedded metaphors of the dominant discourse are implicit within curricula, the myriad theories informing pedagogical practice and learning, even the physical character of classrooms and schools, that is, the manner classrooms are physically structured, the division of the day into managed increments, and so forth. These metaphors are part of the complex and interconnected cultural narrative that shape the ways students frame their relationships with other people and the Earth's natural places, among other things.

Returning to the opening question of this section, in its present formative state, PBE theory is remarkably similar to the aims and goals of ecojustice. The sociopolitically oriented works of Theobald, Bowers, and Greenwood although primarily oriented by place-as-diversity, aim to bring about social and ecological justice, the same goals of ecojustice. Of course, the extent of the similarity rests in the meaning of place adopted by PBE theory. Those motivated more so by the cultural realm will find compatibilities with the moral and conceptual framework provided by ecojustice. While those motivated to provide place-based educative experience from the natural realm will have superficial ties with ecojustice, as such, PBE experiences strive only to relocate learners in environments outside the classroom.

In a way, this is a sorting of philosophical lineage. The philosophy of hermeneutic phenomenology, which attempts to sift through the meanings of possible Being, illuminates or deconstructs the essential foundation of an entities' or phenomenon's Being. In answering the question, "what is the meaning of Being?" we create a space within the lives of all people, students in particular, to discover the mystery, awe, and wonder of Being itself. Is this not a necessary foundation for ecojustice?

While the project of hermeneutic phenomenology makes no claim at revealing cultural metaphors and the stories carrying them forward, ontic structures or objects, it does examine the precondition of these structures, their unique Beingness. All of Heidegger's thought can be construed as an attempt to articulate this place of being. *The task of philosophy is the task of thinking in an attempt to recover that original "giving" of being, that original happening of "place."* Thinking is thus essentially a form of returning home – a homecoming of sorts. In a way, hermeneutic phenomenology and the critically oriented philosophies framing ecojustice share a common lineage. They each claim to "deconstruct" current "realities" promoted either through interpretive frameworks or language. We might add that language is one of many tools maintaining and bolstering the interpretive framework at play. Ecojustice may be a micro-deconstructive process focusing intently upon language, concepts, metaphors, cultural narratives, and so on, whereas hermeneutic phenomenology tackles the orienting interpretive framework creating a space for other interpretive possibilities.

In sum, we see the relationship between PBE theory and ecojustice as follows. Hermeneutic phenomenology prepares the ground for what ecojustice accomplishes. And it does so in a way that reveals to all of us the nature of being human, human beings' relationship with the Earth, and the Earth as the ground for the being of human being. With this in place, the moral fortitude so necessary to compel great acts of social and ecological justice is revealed.

PBE theory that considers the ontological is founded upon our unique and foundational capacity for care. Such a thoughtful dealing with the world, when given opportunities to be revealed within citizen science programs such as *NatureWatch*, allows students to experience what surely must be the primary aim of educating – to experience the awe of Being in this world. Within more concrete settings this translates into teachers providing opportunities for students to *describe* experiences and *interpret* these descriptions using the various forms of disciplinary representation schools capitulate. Furthermore, it necessitates the pedagogical responsibility on the part of teachers to provide opportunities for students to express, nurture, and to let flourish our foundational capacity for care – care for care's sake. When we care and are given the message that caring is important, fertile ground is prepared for an ethic of social and environmental responsibility. Rekindling the mystery around Being through an affiliation within place is absolutely critical to successive moral and ethical judgments – capacities necessary to prompt civic engagement. Ultimately, this is the ground upon which ecojustice thrives; a ground fortified by the ontological realm of experience.

Acknowledgments The authors wish to thank Michiel van Eijck for his astute editorial advice, and Michael Mueller and Deborah Tippins for their invitation to contribute to this collected work.

References

Abram, D. (1997). *The spell of the sensuous*. New York: Vintage Books.

Bigwood, C. (1993). *Earth muse: Feminism, nature and art*. Philadelphia: Temple University Press.

Bowers, C. (2006). *Transforming environmental education: Making the cultural and environmental commons the focus of educational reform*. Retrieved May 24, 2009, from http://cabowers.net

Casey, E. (1997). *The fate of place: A philosophical history*. Berkeley, CA: University of California Press.

Cobb, E. (1959). The ecology of imagination in childhood. *Daedalus, 88*, 537–548.

Fox, M. (1983). *Original blessing*. Santa Fe: Bear & Company.

Greenwood, D., & Smith, G. (Eds.). (2008). *Place-based education in the global age*. Mahwah: Lawrence Erlbaum.

Gruenewald, D. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*, 3–12.

Heidegger, M. (1962). *Being and time*. (J. Macquarrie & E. Robinson, Trans.). New York: Harper & Row.

Heidegger, M. (1977). The question concerning technology. In W. Lovitt (Ed.), *The question concerning technology and other essays* (pp. 3–35). New York: Harper & Row.

Inwood, M. (1997). Heidegger, A Very Short Introduction. Oxford: Oxford University Press.

Irwin, F. R. (2002). Heidegger and Nietzsche: Nihilism and the question of value in relation to education. In M. A. Peters (Ed.), *Heidegger, education and modernity* (pp. 47–63). Lanham: Rowman & Littlefield.

Jenkins, E. (1999). School science, citizenship and the public understanding of science. *International Journal of Science Education, 21*, 703–710.

Karrow, D. D. (2003). Place, metaphysics and technology: Place-based science education. *Proceedings of the Seventh International History, Philosophy and Science Teaching Conference (IHPST),* Winnipeg, Canada, *7,* 418–435.

Karrow, D. D. (2006). *Educating-within-place: Metaphysics beyond Technicity*. Unpublished doctoral dissertation. The Ontario Institute for Studies in Education of the University of Toronto, Ontario.

Karrow, D. D., & Fazio, X. (2010). *NatureWatch*, schools and environmental education practice. *Canadian Journal for Science, Mathematics, and Technology Education*. Submitted.

Lim, M., & Calabrese-Barton, A. (2006). Science learning and a sense of place in a urban middle school. *Cultural Studies of Science Education, 1*, 107–142.

Lutts, R. H. (1985). Place, home, and story in environmental education. *Journal of Environmental Education, 17*, 37–41.

Malpas, J. (2006). *Heidegger's topology: Being, place, world*. Cambridge, MA: MIT Press.

Merleau-Ponty, M. (1962). *Phenomenology of perception*. (C. Smith, Trans.). London: Routledge & Kegan Paul.

Moran, D. (2000). *Introduction to phenomenology*. New York: Routledge.

Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.

Mueller, M. P., & Tippins, D. J. (2010). Citizen science, ecojustice, and science education: Rethinking an education from nowhere. In B. J. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education*. New York: Springer.

Nespor, J. (2008). Education and place: A review essay. *Educational Theory, 58*, 475–489.

Parker, M. (2005). *The philosophical grounding of hermeneutic phenomenology*. Retrieved March 25, 2005, from http://www.mathcs.duq.edu/~packer/IR/IRphil.html

Sack, R. D. (1997). *Homo Geographicus*. Baltimore: The John Hopkins University Press.

Smith, G. (2002). Place-based education: Learning to be where we are. *Phi Delta Kappan, 83*, 584–594.

Sobel, D. (2008). "Appareled in celestial light": Transcendent nature experiences in childhood. *Encounter: Education for Meaning and Social Justice, 21*(4), 14–19.

Steele, F. (1981). *The sense of place*. Boston: CBI Publishing.

Stevenson, B. (2008). A critical pedagogy of place and the critical places(s) of pedagogy. *Environmental Education Research, 14*, 353–360.

Theobald, P. (1997). *Teaching the commons: Place, pride and the renewal of community*. Boulder: Westview.

Wilderman, C. C. (2007). Citizen science toolkit. Cornell Lab of Ornithology. Retrieved June 17, 2008, from http://www.birds.cornell.edu

Wollan, G. (2003). Heidegger's philosophy of space and place. *Norwegian Journal of Geography, 57*, 31–39.

Chapter 17
Invoking the Ontological Realm of Place: A Dialogic Response

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In this response to Doug Karrow and Xavier Fazio's chapter "Educating-Within-Place: Care, Citizen Science, and Ecojustice," we further discuss key issues presented by the authors, especially regarding the ontological realm of place. To begin, we introduce ourselves as science educators from diverse backgrounds in terms of our experiences with place-based education. Using the NING social networking website as a discussion platform, we draw on our experiences, things presented in the chapter, and our expanding thoughts to engage in a discussion about what educating-in-place means to us as science educators and researchers.

Introduction

Miyoun: Having interests and been engaged both in science education and environmental education, I often face tensions and conflicts when in pursuit of both. "Place" offers a basis and direction for me to continue: Place offers/becomes pedagogical contexts where science education and environmental education can be pursued and explored together and can become synergistic.

Sheliza: My relationship with PBE is very recent and continuously evolving. I immersed myself in PBE research last year, using visual imagery to connect students from an urban Toronto cityscape to science in their community. As I continue to work within the field, I find that while PBE has a long tradition within environmental education, it is limited in its use within science education. Recent research offers much possibility and it is a progressive time for PBE in science education. As a result, my experience with PBE is developing both practically and theoretically.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_17,

Jen: I have many years of teaching in place-conscious ways; however, I have just recently come across place-based education as a theoretical (for research) and pedagogical (for teaching) framework. Intellectually, it has been exciting for me to pursue this strand of research and pedagogy because it allows me to merge my interests in science teaching and learning, informal science education, and most importantly, sociocultural considerations of how people learn and connect with places.

Defining "Place"

Jen: Karrow and Fazio's description of project *WormWatch* reminds me of the "placelessness" inherent in many science education initiatives. Like big box stores, these initiatives are designed to be enacted in any geographical school/space without any consideration of place. According to Karrow and Fazio, a project like *WormWatch* would be richer if the ontological realm of place was considered in the planning and implementation of the activities. They discuss Heidegger's notion of Dasein or being-in-the-world in relation to care, "we are caught up in a structure of care about the world; we are not indifferent to it." This makes me ask the question: What presupposes place? What are the conditions that must exist in order for place to exist and how is this relevant to thinking about PBE? While I agree with the authors that "unless the ontological realm is considered such theory remains callow," I think we need to press this idea a little more – why is this the case? Are there other realms of place that we are not considering as well?

Sheliza: I am sure many would argue that there are no definitive conditions that "must exist in order for place to exist." However, if we are to entertain the proposition that Karrow and Fazio advocate for, that is the consideration of an ontological realm in PBE, perhaps we could assume that place comes to "exist" or "be" because of the relationships humans (or nature) have with it. Place is theorized as a human-created system of exchanges between culture and nature, or human beings and land, or communities and environment. If place could be theorized as a part of a social-exchange process, then an emphasis could be placed on how the relationships with context create realities, meaning, and knowledge. Is it possible that this is how place comes to being? Are localities or geographical and physical areas simply spaces that are universal or global, until direct and personal interactions award them meaning? Does that meaning then transform that space into a place? Discourses about place versus space theorize place as a locality of difference, suggesting that the uniqueness and personal realities of a space makes it a place. Doreen Massey stated that the "local" is frequently invoked as the source of differentiation such that place is posited as one of the grounds through which identity is rooted and developed (Massey 2004, p. 7). It seems that we must consider how people define place, since their place will be inextricably linked to them in intimate and personal ways, and thus how our students are likely to describe their place (which will have influenced their sense of being) when they engage in place-based approaches in their classrooms.

Miyoun: I agree Sheliza when you say place is inextricably linked to human beings in intimate and personal ways. It is essential. It happens to everyone and it happens in unique ways for each individual. “To be is to be in a place,” as Casey (1996b) pointed out. If we reflect on this sentiment, we might conclude that we cannot exist without being in a place. When, considering the essential yet personal nature of “human relationship” with “place,” we need to pay attention to how the place comes to “exist” or “be” in this relationship and what kinds of relationships we have with place.

Relph (1976) explained human relationships with a place using two opposing attitudes of authentic and inauthentic. While not advocating binary views on human relationship with place, I think his ideas offer us the conceptual guidance to reflect on our attitude toward human relationship with a place. An authentic attitude would nurture a “profound relationship” with a place, and it “comes from a full awareness of places for what they are as products of man’s intentions and the meaningful settings for human activities, or from a profound and unselfconscious identity with place” (p. 64). Through understanding and reflection, a person can develop a considerable intensity of association and strong sense of responsibility for the place. On the other hand, inauthentic attitude involves “no awareness of the deep and symbolic significances of places and no appreciation of their identities” (p.82). It is a utilitarian attitude, which keeps a superficial relationship with a very limited (or lack of) identification or emotional attachment to a place. As Relph (1976) noted, this attitude of placelessness is becoming dominant and as Jen pointed out it is common in science education.

According to Relph, “awareness” matters for one to develop an authentic relationship with a place. I think that awareness comes from one’s realization and meaning-making of the ontological realm of their place as Karrow and Fazio argued. I believe place-based education could benefit from making students’ relationships with a place more explicit, focusing on the kinds of relationship students could develop with a place and thus acknowledging the ontological realm of a place.

Sheliza: Interesting point Miyoun, I am intrigued by your comment in regards to the “inauthentic” conceptualization of place. It speaks to place as utilitarian, superficial, and lacking an appreciation of identity. This reminds me of literature in cultural and political studies which comment disapprovingly of place as being this universalist notion that actually represses the diverse and meaningful identities that people have with place,

> The logics of universalism and, more recently, modernization and globalization have sought to represent localised identities as historical, regressive characteristics, and have worked to undermine the old allegiances of place and community. … Difference and particularity will not be wished away by the language of universal rights or international brotherhood; nor are they fully repressed. (Carter et al. 1993, p. ix)

In the latter half of the quote, Carter et al. reassert the ways in which local differentiation within communities is not to be “wished away.” Instead, difference supports the development of new communities of interest and belief. This is believed to be transformative for communities, especially since localized identities are usually repressed by ruling relations (such as institutions of schooling) and undermined, such that the traditional ties that communities might have with their land/environment are diluted with universalist notions. I believe this notion is mirrored in the science classroom, as students’ diverse/cultural/personal understandings of science and how it exists in their place, is avoided or ignored in conventional science classrooms. Science educators are expected to stick to a regimented ideal of science as dictated by the curriculum. Drawing on place might be seen as deviating from the "script" of science schooling. So, I agree with Miyoun that making students' relationships with place more explicit will draw in the differentiation of localized identities that could make place "authentic" and learning more motivating.

Miyoun: Classrooms tend to mirror or reflect what happens outside and thus tensions arise in classrooms. For example, when curriculum tries to universalize and decontextualize learning from students' place identities, students respond by critiquing, disengaging, or resisting. What I have learned from students is that, as Carter (1993) said, contextualized and unique localized identities cannot and will not be "wished away." I think this is a critical and practical question for any PBE effort: How are we making sure to acknowledge, invite, and even capitalize localized identities or place identities of our students as part of our PBE efforts?

Jen: Miyoun, this is an important question if we are thinking about PBE from a critical perspective, that is, how could we use PBE to create an equitable science learning experience for all? This reminds me of Keith's story, Kozoll and Osborne's (2006) narrative of the Jamaican American preservice teacher. They describe him as a "success story for science education" (p. 2) because unlike many minority students, "Keith found a place in science," where he was able to develop a love for and an identity with the subject and this provided him with a lens with which to view his world (Kozoll and Osborne 2006, p. 162). His experiences of observing ants, gardening with his mother, and catching anoles enabled him to give context to what he learned in school. According to the authors, Keith found that the science he learned in school (high school and college) not only connected to what he did as a child, but also helped to deepen his sense of wonder and knowledge about the natural world.

However, the sad part of the story is that Keith's schooling did not facilitate this connection, but rather served to separate his science learning experiences from the context in which he learned much of his science. Keith's interest in science started from his experiences of science-in-a-place and as a child these experiences were not separate from his interactions with family and friends, in other words not separate from his lifeworld. While he was able to contextualize his experiences with science in school, it did not seem to go the other way, where his sense-of-place was deliberately brought into his school science experiences. Keith was left to make those connections on his own or rather extract his science-rich connections from his informal, holistic learning experiences. This makes me wonder how much richer a science learning history Keith would have had if his school science experiences allowed him to bring his own ontology to bear in the classroom. While he was able to create an identity around science, did science allow him to maintain prior identities, perhaps including his sense of traditional ecological knowledge? Keith came into his high school and college science classes with a rich understanding of the natural world, but in my opinion, left with a more fragmented, dualistic view of the world.

Miyoun: That situation is one of the major concerns in science education that we have. When science education fails to make connections between students' lifeworlds and science, students have difficulties in finding purposes and meanings in science education (I have to say this is a separate question from gaining proficiency in test scores). Students are left with fragmented or compartmentalized views of the world and science. I am not saying students fail to find purpose or make meanings. On the contrary I believe a lot of students do so (as Keith did in the article Jen mentioned). But my point is that the burden of doing so lies with the students since most often science schooling is not designed to nor pays attention to making those connections.

I believe the place-based approach has a lot to offer for science education, especially this challenge in science education since PBE attempts to foreground students' place in its educational pursuit. Of course we are up against the dominant culture of schooling, which frames (or diminishes) education to be dichotonomous acts between object and subject and marginalizes "place" and students' local identities. However, students' identities, what we can call place identities in this context, will not be "wished away." Thus, when students' place identities are in conflict with the demands or expectations of schooling, they work against each other, and students will have to resist, disengage from, or compartmentalize learning. In other words, when schooling aligns with their place identities, meaningful and purposeful learning can occur. I think what Karrow and Fazio advocate, explicit consideration to the ontological realm, is a first step for PBE to acknowledge and address in the connection between students' lifeworlds and educational attempts.

Sheliza: What strikes me here is the "burden" Miyoun describes, of having connections between science and place lie on the shoulders of the students. I find that facilitating or supporting place-based connections that nurture science identities or traditional ecological knowledge is incredibly difficult for science educators to do in everyday schooling. There are a myriad of dominant or ruling relations that form the conventions of science instruction. In this sense, one view is that teaching science is often teacher-centered, curriculum-focused, and founded upon school-based practices contained within the four walls of the classroom. The other view assumes an effort to teach science that is learner-centered, environmentally/ecologically focused, and community or place-based so as to reach beyond the boundaries of schooling, which does not seem as accessible with the dominant relations. Perhaps a balance between the two views is needed.

Karrow and Fazio advocate for an ontological PBE as a means of possibly addressing the connection between students and place. Further research is still needed to investigate how easily it can be adopted into a teacher's philosophical and pedagogical practices in the science classroom. For this reason, I am keen to see the field of research grow in PBE with science education, and witness some of the enacted pedagogies that successfully work in the science classroom to nurture science identities and place-based affinities.

Miyoun: Toward the end of their chapter, Karrow and Fazio argued, "PBE theory that considers the ontological is founded upon our unique and foundational capacity for care." While they did not fully explain what they meant by care or how it would come about, I think they raise an interesting question on "foundational capacity for care" as grounds for ecojustice. They offer a connection on how PBE, with consideration of the ontological realm, could support ecojustice theory and education, providing that explicit opportunities for students to express their ontology with and in a place (to describe and interpret) would "nurture and let flourish foundational capacity for care."

Jen: Miyoun, I also had similar questions when I read that section, but I surmise that care is an aspect of ontology; as one cares for and/or protects what one knows. However, care – what it means to care for something – has many philosophical considerations and can take on different meanings when in reference to ecojustice. Mike Mueller and Deborah Tippins (2010) urge researchers to "listen to and value the local narratives, many of which may embody emotional, aesthetic or even spiritual qualities." They use the term "heartfelt" to describe the types of discussions they convey. It is in these affective connections to place where an ethic of care is evident and where people make deeper connections to place and the flora and fauna within it. Situating this within ecojustice philosophy, people will be motivated to become better informed about local environmental issues, thus able to make decisions that are both viable and beneficial to their communities.

Educating-Within-Place: Localization of Learning

Miyoun: As Karrow and Fazio challenge object–subject dichotomies (what they call "irresistible modern habit"), they propose educating-within-place as a conceptual structure to explore relationships between place, being, and educating beyond the typified dichotomies. As it has been problematized during our conversation, PBE practices may end up defeating the purpose of PBE itself, and behind those PBE practices there may exist the subject object dichotomy. In these efforts, place is treated as "object" (whether it is viewed as a natural realm, community, or diversity, as Karrow and Fazio described) and students are considered as subjects that conduct the "study" of the object rather single dimensionally. When PBE is carried out/practiced based on this simplistic object–subject dichotomy, what is being neglected or ignored is essential connections and relationships between students and place (i.e., what is the nature of the relationships and how are the relationships being developed and nurtured), thus failing to provide authentic PBE experiences and defeating the purpose of taking up place-based approaches. In other words, these PBE efforts tend to focus on "what" is in a place, yet limited attention is being paid to "how" or in what ways students nurture relationships and connections with and in a place. I think PBE should not be limited to just about "what" students would learn about their place but should pay attention to "how" students interact with and experience their place, in ways which nurture them to develop connected understanding, empathy, and care.

How PBE efforts tend to focus on "what" of place seems to reflect the current educational climate, which has deprioritized the importance of place to accommodate the push toward standardization and universalization of "what" students need to know and how they can best demonstrate that knowledge (Sanger 1998). The result is that regardless of where students live, students tend to get "anywhere and anytime" education that seems to have lost its intimate and unique connection with the local community (Sobel 1996). "Educating-within-place," by bringing our attention to the ontological nature of our very being that is the inseparable nature of human relationship with a place, could help PBE to challenge the object subject dichotonomous perspective and move toward "here and now" education.

Jen: This separation between the "what" and "how" of a place reinforces the Cartesian dualism that Ladislaus Semali and Joe Kincheloe (1999) often denounce, "this western modernist way of producing knowledge and constructing reality… [seeks] to produce not local but translocal knowledge" (p. 28). They describe this process as "Cartesian reductionism," where problems are broken into separate components, described and categorized, and questions of context are dismissed. This reminds me of museum displays that aim to present a comprehensive view of biodiversity. In such exhibits, flora and fauna are presented in such a way that completely removes them from their context in what Kahn (1995) describes as heterotopias – combinations of different places as though they are one. They are listed with their scientific pedigree (evolutionary relationships) and their geographical ranges; however, oft missing is their role in their given ecosystems – their relationships to other living things and their natural environment – nor are there any hints about how they are known by local/indigenous people who share their ecosystems. There seems to be no room for the ontological realm in science. This is the same situation that we re/create for ourselves and for our students if we consistently approach PBE and environmental education (for that matter) from this dichotomous perspective. This issue raises a question about the relationship between PBE and environmental education and as they are both commonly enacted, there is very little difference. I think we all agree that the ontological realm is an important yet often missing aspect that makes PBE a meaningful pedagogy in science education and in other disciplines. I also think that environmental education, if approached with PBE methodologies and enacted with PBE pedagogies that center on peoples' connections with places, is PBE as it is truly meant to be.

Sheliza: Karrow and Fazio describe how meanings of place are usually based on place as an object discussed or studied from the standpoint of a subject (as if by some "irresistible modern habit" we reflect on place in this manner). In this sense, perhaps more so for science educators, I began to think that as teachers try to get through a lesson that requires them to be more "place conscious," their efforts may go against PBE. This is assumed because if we define place as an object, and the students/teachers together as subjects educating themselves or reflecting upon place, then we see "educating" as an action. In this sense, the act of educating probably is unmindful of the ontological realm because we are educating ourselves *about* place but not *in* place. Should we say that students are educating *in* a place rather than students are educating *about a* place? Would that small change invoke the ontological realm during place-based moments? Karrow and Fazio state that they wish (through their conception of PBE) to blur the object/subject distinction by positioning PBE as "educating-within-place" in order to convey a sense of ongoingness, intimacy, embeddedness, the active, inevitable, evocation of the possible. This draws in the "here" and "now" approach to PBE that Miyoun describes earlier.

Edward Casey notes, "to live is to live locally and to know is first of all to know the place one is in" (1996a, p. 18). To know the place one is in does not simply mean to study it, but to be in it. Perhaps to live in the "here" and "now" evokes the ontological realm, thus to live is to connect and relate to and grow *in* a place that becomes reshaped and redefined in personal ways. This serves our growth as a person and shapes our identity and our sense of being or existing in place. In a related quote, Arif Dirlik says, "place consciousness … is integral to human existence" (1998, p. 8). Here, an awareness of place aims to blur that object/subject dichotomy. Thus, place is not a single-dimensional object, but it is a multidimensional entity to experience and connect with.

Invoking the Ontological in Place-Based Education

Sheliza: Karrow and Fazio draw attention to the varied representations of place-based education in order to emphasize the theoretically formative or immature (Nespor 2008) nature of the field of practice (examples cited by Karrow and Fazio include, *Teaching the Commons: Place, Pride and the Renewal of Community* by Paul Theobald [1997], *Revitalizing the Commons* by Chet Bowers [2006], and *A Critical Pedagogy of Place* by David Gruenewald [2003]). To further the argument, Karrow and Fazio reference Gruenewald (2003) who states that "place-based education, in its diverse incarnations, is currently less a pedagogy per se and more an alternative methodology that lacks a coherent theoretical framework." (p. 3).

This is a rather moot point in the field and I grapple with this: How do we conceptualize PBE? I offer two possibilities: the first possibility assumes that we apply PBE as a methodology for teaching science. In this case, we need to embrace a more prescriptive analogy for PBE, where a set of steps or rigorous methods are needed to conduct and implement place-based practices in schooling. While this may make PBE seem more accessible to science educators due to the ease of gathering and following resources, we must be wary of "globalizing" approaches that are meant to be local and contextualized. The second possibility is to conceptualize PBE as a pedagogy, such that we embrace a more evolutionary and formative conceptualization. In this case, learning and knowledge is socially constructed within place.

My impression is that in order to invoke an ontological realm, as Karrow and Fazio argue for in PBE, we must allow PBE to evolve based on the experiences and relationships humans have with place. Thus, invoking the ontological realm will influence pedagogical practices, but it may do little for rigid methodological practices. Maybe this is the difference between outdoor education and place-based education. Do most outdoor education programs mirror *NatureWatch*, in that it is "simple … standardized" (p. 16) as opposed to what scholars advocate for PBE (for example, a critical pedagogy, sociopolitical and phenomenological … and of course now, ontological?)

Jen: Sheliza, your discussion about pedagogy and methodology has important implications for making PBE accessible to educator-practitioners. As researchers, we often focus on the theoretical realms of what we believe to be effective pedagogical practices with little consideration to the “nuts and bolts” of the actual implementation, that is, we sometimes fail to make explicit the connection between methodology and pedagogy – the “why” and the “how.” Gruenewald (2003) warns that standardizing or scripting PBE would defeat the purpose of place-based teaching and learning as, “practices must emerge from the particular attributes of a place” (p. 644). In contrast, Pauline Chinn’s (2006) idea of “establishing a personal connection and acquiring the tools to study one’s lifeplace can lead to transformative teaching and learning in science” is a useful heuristic for thinking about merging theory and practice when it comes to PBE. Coming from an experiential education/informal science background, I value experience as a way of learning to teach. I believe that developing activities and practices in teacher education that allow educators to develop tools to study places would enable educators to develop place-conscious practices that would hopefully become a part of their personal teaching philosophies. The key is making the sense-making of these experiences obvious through the process of reflection. This would bring to consciousness the ontological “experience-of-being” realm and render this conscious awareness a resource on which to build future activities. Malpas (1999) mentions:

> Understanding an agent, understanding oneself, as engaged in some activity is a matter of both understanding the agent as standing in certain causal and spatial relations to objects and of grasping the agent as having certain relevant attitudes – notable certain relevant beliefs and desires – about the objects concerned. (p. 95)

Reflecting on experience brings about this understanding of the teacher/agent in relation to her place and, with guidance of a place-conscious facilitator, enables teachers to think about how she could create similar experiences for their students (transference), even in the face of a standardized curriculum. These experiences could help them to realize the social embeddedness of notions of place, because as the cliché goes, to know oneself is to understand others.

And to respond to your question about outdoor education programs, I think that many of them intend to be place-based. If they are enacted in a local context, they usually focus on understanding the local natural environment. However, they may not be place-based in the pedagogical sense that we speak of – they may not consider dimensions other than the pure ecological aspect of a place. They become more of a methodology – a specific approach to teaching without the theoretical underpinnings. This factor is heightened if the programs are designed to be “exported” to other contexts. In this case, the programs become scripted and more disconnected from the context in which they are to be enacted.

Sheliza: Jen, in regards to less consideration to the actual implementation of PBE, are you proposing that a balance between methodological practices and pedagogical practices are needed? I suggested above that PBE as methodology would be too prescriptive and standardized, and that PBE as a pedagogy would be evolving and formative. I guess I was thinking as a researcher and not as an educator and I guess I advocated for PBE as pedagogy because I thought it would make for a type of teaching that was not standardized/simple but personal and connected to local place (the type of science education that Karrow and Fazio call for when they emphasize invoking the ontological realm).

But your comment opens my understanding and makes me realize that in order to make PBE accessible to educators we *do* need to address how it is implemented in practice. This may mean developing some habits of mind to support educators and offer guidance in facilitating PBE in their classrooms. Maybe we need some activities (that are a little structured) in order to allow educators to develop tools to study places and maybe this would impart some consciousness to place that would affect their personal teaching philosophies. So, how do we create this balance without defeating the purpose of PBE? I like the notion of having place-conscious facilitators. What would their role be? How do researchers support them? How would place-conscious facilitators create experiences for their students in the face of standardized curriculum? Would we assume that place-conscious facilitators are concerned with the methods of applying PBE in a classroom and that their role is to facilitate that method? How can the science educator be both a place-conscious facilitator and a teacher who draws on experience and evokes the ontological realm?

At least one understanding has come out of this metalogue for me – that is, that PBE as methodology may be equally important as PBE as pedagogy. I no longer think that one will defeat the purpose of PBE or the other, but if balanced appropriately it might offer science educators the necessary support to apply PBE in their classrooms.

Principles of Place-Based Science Education

Miyoun: I agree with Jen's points on teacher education in PBE. The discussion made me think about how it responds to Sheliza's question on methodology and pedagogy and proposes a valuable direction for PBE. If we think about where PBE is going or needs to be heading, I personally believe this focus on teacher education offers a great potential for PBE to overcome the current challenges it faces. I think what Jen has proposed (for example, sense-making of individuals' own ontological realm through the process of self-reflection) is a great way to foster healthy, dynamic interactions and development of pedagogy and methodology in PBE.

This reminded me of a study that asked a group of preservice science teachers to write about their memories of place and its implications for their teaching (Howes 2009). The reflective writing seems to have pushed the teachers to make sense of their own relationships with and in a place, and furthermore, to integrate their awareness and consciousness into their teaching (such as sense of connection, peace, and care). This study showed the potential of reflective writing as a teacher education tool to guide teachers into pedagogical sense-making of PBE. I think when educators give explicit attention to the ontological realm of their own being-in-place and make sense of it within their pedagogy, they will be ready to bring pedagogy and available tools together into their practices of PBE.

Jen: Writing provides a powerful, reflective tool for getting educators to think about their own relationships with place. When I was an experiential educator, we did an ice-breaker called, "describe the home where you grew up" (a talking activity that could easily be turned into a writing activity). It was always interesting to hear people begin by describing the physical space and inevitably the discussions would lead to narratives of activities, people, sensations, and so on – all experiences that make it a place called home. This would lead to discussions about place in learning – making the classroom a place for learning, the role of community (as a place and/or cooperative) in teaching and learning. I could see using such an activity – talking or writing – to make participants more aware of their "being-in-place and making sense of it within their pedagogy" as you stated, Miyoun. Malpas (1999) makes this connection between narrative and being: "[I]t is largely through narrative, in fact, that we are able to project our lives from the past and present into the future, and, in doing so, we are also able to explore and map out possibilities for future action" (p. 94). I love this quote because it really speaks to the importance of bringing to awareness our experiences of being in our "lifestories," and especially for educators, providing the space for reflective discussion about what it means for their teaching philosophies and corresponding pedagogies.

Clifford Knapp (2008) developed a teacher education course, "Integrating Community Resources in Curriculum and Instruction," that uses principles of PBE and experiential education structures to help students learn how to find, investigate, and integrate local resources into their curricula. He lists design principles for this approach:

- The surrounding phenomena provide the foundation for interdisciplinary curriculum development and contain ecological, multigenerational, and multicultural dimensions.
- Students and teachers are encouraged to cross the boundaries between the school and the community and become involved in a variety of constructive ways.
- Learners are expected to become creators of knowledge as well as consumers of knowledge, and their questions and concerns play central roles in this process. They are assessed on the basis of how this knowledge contributes to the community's well-being and sustainability.

Given our discussion, while these are good tenets, I think it would be stronger if the following design principle was added: Throughout the course, personal narratives and reflections will be used to encourage learners to make sense of their own relationships with and in a place, both in their histories and their experiences during the course.

Sheliza: I think Knapp's principles are useful in that they mirror curriculum reform that advocates for science, technology, society, and environment (collectively referred to as STSE in Ontario curriculum, but known in other areas of science education research and practice as science, technology, and society [STS]). (But see how this notion connects with what was described in an earlier chapter by Mueller and Zeidler on the limitations of STS.) For me, Knapp's principles trigger another important aspect to our discussions on place and PBE; that is, its position in science education.

At the moment, science education calls for an understanding of the complex hybridity of STSE. For example, the STSE framework is believed to illuminate various particulars such as (i) appreciating the societal impact and somewhat culturally determined nature of scientific and technological change; (ii) recognizing that decisions about science and technology may be taken in pursuit of particular interests, linked to the distribution of wealth and power, and may yield benefits to some at the expense of others; (iii) establishing one's own perspectives and position on issues (based on moral values and decency); and (iv) willingness to take action and work for the sake of good intentions (Hodson 1998, p. 655). Further still, more current literature goes so far as to suggest a reconceptualization of STSE such that it centers around the environment renaming it as E-STS (Blades 2006), where taking up the E-STS approach as a core principle for science education might fuel a wave of "pedagogical possibilities toward a rising tide of social justice" (p. 657). This draws attention to the ways in which place-based pedagogies might pursue the type of learning that science education calls for.

In our discussions about place-based approaches, it is important not to lose sight of PBE for the teaching and learning of science education. We must be cognizant of its purposes for science education: What is it for? Who is it for? If we assume an STSE framework for the teaching and learning of science education, then might we conclude that place-based practices might serve as a useful pedagogy or methodology for enacting the type of science education that is expected (e.g., a science education that is sustainable, activist, environmental, moral, community-referenced, and all the other descriptors of an STSE framework)?

Jen: The National Science Education Standards (National Research Council [NRC] 1996) cite the goal of science education as educating students to (i) experience the richness and excitement of knowing about and understanding the natural world; (ii) use appropriate scientific processes and principles in making personal decisions; (iii) engage intelligently in public discourse and debate about matters of scientific and technological concern; and (iv) increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers. These goals, they note, "define a scientifically literate society." While these goals are germane for individual advancement in science knowledge and application, there is very little about the importance of collective science literacy and this is where the community-referenced descriptors (unlike Ontario's STSE framework) would be of more relevance (interestingly, an electronic search of the NRC document for the word "sustainability" turned up naught).

I believe that a definition of a scientifically literate *society* should include collective-referenced (such as "societal impact") notions of environmental sustainability and environmental equity, especially in a nation that aims to be truly democratic. These collective-referenced notions would invoke a sense of social responsibility and would afford room, within the standards, for enacting science education with a PBE framework.

Miyoun: I think the collective is an important point to propose as a meaning and goal of science education. Often when collective meaning is concerned, it is discussed within an economic development context and not within an ecological or sustainability context. A PBE and sustainability concern could broaden collective purposes and goals for science education in society.

Enacting Place-Based Education

We agree that invoking the ontological realm in PBE would allow for richer science teaching and learning experiences that are contextualized and relevant to the lives of students and teachers. We also recognize that although projects like *WormWatch* and standards-based education are beneficial in that they offer salient guidelines for enacting content-rich and process-oriented science education, they fail to incorporate what students know about and how they understand the *place* where the curriculum is enacted. To summarize our discussion, we present the following key points that we believe are important in conceptualizing truly place-relevant/place-conscious science education experiences:

- We must be wary of "globalizing" approaches that are meant to be local and contextualized.
- PBE as a methodology is as equally important as PBE as pedagogy. If balanced appropriately, it might offer science educators the necessary framework to apply PBE in their classrooms.
- Teacher education and professional development for PBE should integrate activities that allow educators to make sense of their own relationships with and in a place and experience the tools to bring this place-consciousness into their teaching.
- Place-based science education should work to make student's relationships with place more explicit, focusing on the kinds of relationships students develop with and in a place, thus acknowledging the ontological realm of place.
- With consideration of the ontological realm, PBE can foster "foundational capacity for care" in students which becomes essential grounds for ecojustice and education for ecojustice.

References

Blades, D. W. (2006). Levinas and an ethics for science education. *Educational Philosophy and Theory, 38*, 647–664.

Bowers, C. (2006). *Transforming environmental education: Making the cultural and environmental commons the focus of educational reform*. Eugene: Ecojustice Press.

Carter, E., Donald, J., & Squires, J. (Eds.). (1993). *Space and place: Theories of identity and location*. London: Lawrence and Wishart.

Casey, E. (1996a). How to get from space to place in a fairly short stretch of time. In S. Field & K. Basso (Eds.), *Senses of place* (pp. 14–51). Santa Fe: School of American Research.

Casey, E. S. (1996b). Between geography and philosophy: What does it mean to be in the place-world? *Annals of the Association of American Geographers, 91*, 683–693.

Chinn, P. (2006). Preparing teachers for culturally diverse students: Developing cultural literacy through cultural immersion, cultural translators and communities of practice. *Cultural Studies of Science Education*, *1*, 367–402.

Dirlik, A. (1998). Globalism and the politics of place. *Development, 41*(2), 7–13.

Gruenewald, D. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*, 3–12.

Hodson, D. (1998). *Teaching and Learning Science: Towards a Personalized Approach*. Buckingham: Open University Press.
Howes, E. (2009, October). *Developing an environmental sense of place for science teacher education.* Paper presented at the Research Symposium of the North American Association for Environmental Education, Portland, OR.
Kahn, M. (1995). Heterotopic dissonance in the museum representation of Pacific Island Cultures. *American Anthropologist, New Series, 97*, 324–338.
Knapp, C. E. (2008). Place-based curricular and pedagogical models: My adventures in teachin through community contexts. In D. A. Gruenewald & G. A. Smith (Eds.), *Place-based education in the global age* (pp. 5–27). New York: Lawrence Erlbaum.
Kozoll, R. H., & Osborne, M. D. (2006). Developing a deeper involvement with science: Keith's story. *Cultural Studies of Science Education, 1*, 1871–1510.
Malpas, J. E. (1999). *Place and experience*. New York: Cambridge University Press.
Massey, D. (2004). Geographies of Responsibility. *Geografiska Annaler, 86 B*(1), 5–18.
Mueller, M.P., & Tippins, D.J. (2010). Citizen science, ecojustice, and science education: Rethinking an education from nowhere. In B.J. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education* (pp. 00–00). New York: Springer.
National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.
Nespor, J. (2008). Education and place: A review essay. *Educational Theory, 58*, 475–489.
Relph, E. (1976). *Place and placelessness*. London: Pion Limited.
Sanger, M. (1998). Sense of place and education. *Journal of Environmental Education, 29*, 4–8.
Semali, L., & Kincheloe, J. (1999). What is indigenous knowledge and why should we study it? In L. Semali & J. Kincheloe (Eds.), *What is indigenous knowledge? Voices from the academy*. New York: Falmer Press.
Sobel, D. (1996). *Beyond ecophobia*. Great Barrington: Orion Society.
Theobald, P. (1997). *Teaching the commons: Place, pride and the renewal of community*. Boulder: Westview.

Chapter 18
A Case Study of David, a Native Hawaiian Science Teacher: Cultural Historical Activity Theory and Implications for Teacher Education

Pauline W.U. Chinn and David D. Maika‘i Hana‘ike

Introduction

> I use my indigenous status to promote a positive role model for my students. I allow my role as a teacher to mix with my strong image of myself as a kanaka maoli and I share that blending with my students. (David D. Maika‘i Hana‘ike)

For school-aged children from marginalized groups, cultural differences including language, ethnicity, class, and religion increase the distance between their cultural historical worlds and the cultural historical world of mainstream instruction and assessment. In the USA, studies of mathematics and science teaching suggest that these students are doubly disadvantaged. Stigler and Hiebert's (1999) book, *The Teaching Gap*, compared Trends in International Mathematics and Science Study (TIMSS) performance of US mathematics and science students to students in 40 nations and analyzed videotapes of classroom mathematics instruction in the USA, Japan, and Germany. Findings of significant differences in teaching across cultures but small differences within cultures led them to conclude that teaching is a cultural activity and that, despite US teachers agreeing with reform efforts, there was little evidence of change. They concluded: "Our students *are* (sic) being shortchanged. They could be learning much more and much more deeply than they are now" (p. 5).

Indigenous people are especially ill-served by the dominant culture of teaching in the USA. Tharp's (1989) research in Native Hawaiian and Navajo classrooms identified ineffective instruction as contributing to academic underperformance of indigenous students:

> Not only language but all instruction should be contextualized in the child's experience, previous knowledge, and schemata (p. 355). … In the absence of school/cultural compatibilities, the relationship between teacher and child becomes the ground for struggle … absorb[ing] all of the energy that should be directed toward learning academic skills. (p. 356)

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_18,

These findings underscore the urgent need for culturally competent teachers. But Hawaii's new teachers, many from out of state, often work in rural schools with high proportions of Native Hawaiian children. These schools tend to have less experienced teachers, higher proportions of uncertified teachers, and higher rates of teacher turnover. Compared to peers, Native Hawaiian children, 26% of public school students statewide, are far more likely to be in No Child Left Behind restructuring schools and in special education programs (18 versus 11%) but less likely to be in college (14% versus 23% expected) (*Ka Huaka'i* 2005, Kamehameha Schools 2005). Community-based, culturally relevant resources exist, but even being born and raised in Hawaii does not ensure that teachers will acquire culture-science content knowledge and culturally responsive teaching strategies. The marginalization of indigenous knowledge and culture has a long history in Hawaii, perpetuated by American missionaries and businessmen who constructed a stereotype of Hawaiians as primitive, sensual, and hedonistic (Chinn 1999). One of my (Chinn) Asian American graduate students recently used the word "primitive" in his writing about Hawaiians. Though set in quotes, it reveals the life in this stereotype and the writer's familiarity with historical power–knowledge relationships.

The persistence of stereotypes that marginalize certain groups suggests the need to study effective teachers and the experiences they draw upon to address complex issues of race, culture, language, and power in their schools and communities. The following collaboratively developed case study of David Hana'ike, a Native Hawaiian science teacher, illustrates the way a teacher connects his lived experiences to instruction, educational reform, and his own professional development. It seeks points of entry into the question: "How does a science teacher become an effective instructor of low-achieving, culturally marginalized students?"

The coauthors David Hana'ike and Pauline Chinn taught secondary science at the same middle school at different times and have known each other for more than 20 years. For over 10 years, Pauline taught students from David's middle school in her high-school science classes. Melissa, one of these students, began this inquiry when she sought evidence for the rumor that students from David's middle school did better in high-school science classes than peers from a nearby school with similar demographics. Melissa's study found students in all classes from David's school evaluated their middle-school science experiences more positively (analysis of means) than peers from the nearby school even though students from both schools in Honors Biology had statistically identical grades (Chinn 1997). Three years later, David's study for his master's degree replicated Melissa's finding for Honors Biology students and also found that Physical Science students from his school had statistically significantly higher grades than their peers from the other school.

Cultural historical activity theory (CHAT) provides a theoretical perspective on David's development of teaching expertise through his lifelong participation in and active establishment of activity networks connecting school learning to students, place, culture, and science.

Literature Review

The persistence of educational inequity suggests the need to focus on effective teachers, their professional development, and strategies they employ to address complex issues of race, culture, language, and power. Loucks-Horsley, Stiles, and Hewson (1996) describe effective professional development programs as providing situated, collegial, sustained, and transdisciplinary learning that

- Develops sensitivity to the diverse learning needs of individuals and people of different cultures, languages, races, and gender (p. 1)
- Supports students' construction of science knowledge by "doing science and mathematics, by investigating for themselves and building their own understanding, as opposed to being required to memorize what is 'already known'" (p. 2)

Such an approach requires teachers to develop experiential knowledge about their diverse students' lives, cultures, and communities.

Cultural Historical Activity Theory (CHAT), a theory of human development rooted in dialectical materialism, provides an analytical framework to understand and potentially address issues of marginalization and underrepresentation in science education. Beginning with Vygotsky's key insight in the 1920s that all intrasubjective processes that appear to be individualistic begin as intersubjective processes situated in material and social settings, Vygotsky, A.N. Leont'ev, and others developed a theory of human development, learning, and self nested in historical and cultural contexts. Originating in biological views of activity, which recognized that living things are part of systems connecting them to their environment and other living things, activity theory began to be applied to human development and cultural change.

Leont'ev (1981) extended Vygotsky's insight into a materialist theory of self when he proposed that human subjectivity develops out of each person's unique complex of material and social experiences: "[T]he activity of separate individuals depends on their place in society, on the conditions that fall to their lot, and on idiosyncratic, individual factors (p. 47). … [S]ociety produces the activity of the individuals it forms" (p. 48).

Engestrom (1999) adapted Vgotsky's central concepts of externalization/internalization into a view of learning as an expansive cycle:

> [T]he expansive cycle of an activity system begin with an almost exclusive emphasis on internalization, on socializing and training the novices to become competent members of the activity as it is routinely carried out. Creative externalization occurs first in the form of discrete individual innovations. As the disruptions and contradictions of the activity become more demanding, internalization increasingly takes on the form of critical self reflection – and externalization, a search for solutions, increases. Externalization reaches its peak when a new model for the activity is designed and implemented. (pp. 33–34)

Working within CHAT, Stetsenko and Arievitch (2004) extended Leont'ev's theorizing of human subjectivity with the notion of an embodied, socially situated self able to learn and consider new activities:

> These processes of 'doing' the self … include the ways by which people respond to challenges and conflicts in their lives, how they internalize, interpret and also further develop the sociocultural rules and standards of what it takes to be a human being. Thus, the self is highly dependent on the existing array and accessibility of cultural resources as well as highly susceptible to issues of power and contestation. (p. 494)

Lave and Wenger (1991) and Cole (1996) expanded CHAT to include cross-cultural considerations. Lave and Wenger's (1991) research across diverse occupations and cultures showed learning begins as situated peripheral participation in a community of practice and develops through increasing responsibility and use of more sophisticated tools. In their view, new selves and identities develop in association with the new complex of tools, practices, meanings, and knowledge. Recognizing that individuals are located within activity systems with different mediating systems, rules, tools, and values provides a conceptual framework for understanding the underrepresentation of minorities in science as difficulties of articulation between and among different cultural activity systems. Though school and home communities value the goal of school success for all children, tensions and contradictions within and across each system may interfere with desired outcomes.

Capper and Williams (2004) view contradictions "as potential springboards for learning, innovation and development." They identify four sources of contradictions in education:

- *Within* components of an activity system (e.g., changes in curriculum and pedagogy)
- *Between* components of an activity system (e.g., between teachers and administrators)
- *Between activity systems* (e.g., between schools and homes)
- *Historical disturbance* (i.e., establishing science content standards)

The history of members of an organization plays an important role in its ability to address contradiction and disturbance. If teachers, students, and parents in the activity systems connecting school and home successfully respond to these disturbances and contradictions, its members are viewed as learning. Learners in an increasingly technological, multicultural, and globalized world potentially are able to develop multiple identities and literacies as they participate in diverse activity systems. Processes of active negotiation, contestation, and ongoing construction of identity develop a concurrent personal sense of agency. Bandura (1989) describes personal agency as emergent, interacting with environmental, cognitive, affective, and personal factors and powerfully affected by people's beliefs about self-efficacy, the "capabilities to exercise control over events that affect their lives (p. 1). … The more efficacious people judge themselves to be, the wider the range of career options they consider appropriate and the better they prepare themselves educationally for different occupational pursuits" (pp. 4–5).

Gee (1992) holds that learning to use the relevant communication strategies and activities related to particular social groups is a condition of acceptance as a member. "If you have no access to the social practice, you don't get in the Discourse, you don't have it" (p. 114). Gee (2004) views differences between "academic varieties of language connected to content areas" (p. 19) and vernacular language of home and community as barriers to knowledge. He thinks science education should provide students with situated experiences so they "see acquiring a scientific variety of language as a gain … because they recognize and understand the sorts of socially situated identities and activities that recruit the specialist language [and] value these identities and activities" (p. 93).

Initial science identities are not always grounded in school-based activities though access to science communities is largely institutionally controlled. Paul Coleman, a Native Hawaiian astronomer at the University of Hawaii, revealed in a recent lecture that he decided to become a physicist when he was 7 because his favorite comic book superhero, Spiderman, was a college physics student. Imagined worlds can provide identities that become real through participation in activity systems that prepare a child who desires to be a physicist with the tools and Discourse of physicists.

Viewing Schooling in Hawaii from a CHAT Perspective

A view of learning as situated, expansive, and agentic, yet embedded in historical and sociocultural contexts suggests the perspectives of indigenous elders and learners can yield insight into cultural ways of learning. Meyer's (1998) synthesis of interviews with Native Hawaiian elders on indigenous ways of learning and knowing identified the centrality of place, practice, and cultural context: "Sites of practice, where the product, process and context were Hawaiian – **that** (sic) was where both information and practice synergized and strengthened the threads of cultural continuity" (p. 143). Similarly, Kawakami and Aton's (2000) study found authentic, personalized, experience-based learning a critical factor for Native Hawaiian students. In contrast, conventional school science as taught and learned as a body of culture-free content and principles obscures its own historical roots as it excludes cultural perspectives relating knowledge to place, practices, and nature (Aikenhead and Ogawa 2007).

Gee, a sociolinguist, views learning as apprenticeship in the meaning-making and social practices of groups with recognized Discourses, or "ways of displaying membership in a particular social group or social network" (1992, p. 106). He criticized schools that "do not offer … full and meaningful apprenticeships to minority and lower socioeconomic children" (p. 150). The importance of apprenticeship in acquisition of disciplinary Discourses supports the immersion of science teachers as learners in authentic activity networks to develop multiple literacies spanning culture, science, and pedagogy. Teachers who understand the relationships among power, discourse, and identity recognize the importance of teaching from a cultural asset versus cultural deficit position. These teachers are especially critical to the success of marginalized students as "the challenge of minority socialization entails learning to manage life in multiple worlds" (Stanton-Salazar 1997, p. 33).

Expert teachers demonstrate pedagogical content knowledge, a concept proposed by Shulman (1986) that incorporates diverse and situated knowledge of content, students, curricula, and pedagogy in effective teaching. Shulman (cited by Sparks 1992) commented on the complex nature of teacher expertise:

> We have observed repeatedly how critical the mastery of content and pedagogy is for the development of teachers, over and above their ability to manage a class. We have seen how

> teachers falter for lack of a clear analogy or explanation, for want of a way to connect a Shakespearean text or a Darwinian concept to the experiences of California or Michigan adolescents.

From a CHAT perspective, learning is not a simple matter of an individual processing sensory input but the far more complex processing of a socially situated self-processing input mediated by experiences, meanings, and tools. The fundamental concepts of socially situated learning and division of labor foreshadow the highly differentiated activities, tools, and knowledge of educational systems that mirror the division of labor in society. These concepts provide powerful lenses for seeing and interpreting the impact of uneven distribution of activities, expertise, and associated social capital in schools and society as contributing to different subjectivities.

Given the diverse literacies students bring to school, how can teachers from different backgrounds become sensitized to literacies that lie outside their experience? How do teachers translate awareness of cultural difference into practices that produce student academic success? In the following section, I (Chinn) describe how my minority middle-school students connected race and student identity and relate a minority woman engineer's experiences with teachers, peers, and family.

Identity Formation, Schooling, and Multiple Literacies

Gee's (2001) view of socially situated identity leads to his proposal that individuals may be considered to have four aspects of identity, each socially defined and value-laden: N-identity determined by biological or natural traits, I-identity determined by institutions, D-identity based on participation in discourse of particular groups, and A-identity based on self-selected affiliations. The following stories suggest how identities are reproduced within and across cultures through day-to-day interactions among people of unequal power and status.

I (Chinn) grew up in Hawaii, a neocolonial society that categorized people by gender, race, economic status, and language. In my highly tracked public schools, few of my ethnically diverse elementary classmates remained my classmates through high school. Over time, the range of ethnicities declined until all except one were White and Asian. Six months in India sensitized me to the ways social class, caste, and gender affected opportunities in all aspects of life. I returned to Hawaii to teach in a low-income middle school. As my low track Filipino and Pacific Islander students and I walked past a classroom and glanced in, with a single comment, "all [Asians], mus' be smart class" a student showed he "read" the academic level of a class using a single variable, ethnicity (Chinn 2005). Unspoken was the corollary that those not belonging to this ethnic group were not smart.

Years later, a Native Hawaiian/Filipino engineering student said she thought this process began (Chinn 1999) with elementary teachers' ability and behavioral groupings. As a well-behaved student who spoke Standard English, she was placed with "rowdy" children who looked like, but did not behave or speak like her. She persisted in college track mathematics and science classes despite peers and teachers' race-related, demeaning comments. She thinks teachers' ability groupings in the early years created persistent cliques in which institutional, discourse, and affinity identities were crafted. She had two groups of friends with different educational backgrounds, but did not feel she belonged with either group. Living in multiple worlds and performing different identities in different social settings emerges as a strategy enabling the most underrepresented individuals – female, Polynesian scientists – to navigate between and within professional and community activity systems (Chinn 1998).

Seeing the power of teachers to construct identities for children (low achievers, G/T, SPED) who then internalize them as their own identities motivated my transition from classroom teaching to teacher education. Teachers needed knowledge and strategies to move away from practices that reinforced ethnic and academic stereotypes that advantaged some and disadvantaged others.

Introducing David

I met David through our participation in an environmental education cohort in the 1980s. In the 1990s I began to hear about David as an agent of change as a high-school science teacher receiving students from his middle school. I had heard students and teachers say that students from his school's science program were better prepared for high-school science than students from other middle schools. Since 1993, students from his middle school had taken 3 years of science and his department's science fair activities, fund-raising, and annual 7th and 8th grade neighbor island science trips were well-known among science teachers at other schools. My student Melissa decided to explore student views and grades (Chinn 1997). Her study of Honors Biology classes showed students from David's school rated their science learning significantly higher than peers from a school with similar demographics even though their grades were statistically identical.

After I moved to the University and David entered the M.Ed. program, he decided to take up Melissa's study and extend it by evaluating his school's science programs, his practices, and student outcomes after they entered high school. His principal, state science specialists, university faculty, and colleagues already recognized David as an effective teacher. David was in the cadre of public school science teachers tasked with developing K-12 science performance standards and had been to American Samoa to share his culture, place, and standards-based middle-school curricula. He co-taught a place- and culture-based curriculum development course with me. A few years after receiving his master degree in secondary science education, David completed a master's degree in administration and became a principal. He currently is a personnel officer.

Methodology

Cultural historical activity theory implies the use of qualitative methods that enable participants to explore and reflect on experiences they identify as contributing to agency and decision-making. Research methods in this co-constructed case study include numerous face-to-face, telephone, and e-mail interviews with David spanning nearly a decade, videotapes of classroom lessons, a student teacher's comments from his observation/participation in David's class, David's writings about his teaching philosophy and practices, and measures of 9th grade student academic achievement, attitudes, and science learning from his master's degree (Hana'ike 2000).

David's personal voice appears in extensive quotes from e-mail and personal interviews while his activities as an educator and researcher are based on videotaped activities, peer observations, and the coauthor's familiarity with his setting, colleagues, and students as a former teacher in David's school. Since the first version of the paper was written several years ago when David was in his administrator preparation program, our informal interviews have explored questions that lay outside our 20-year relationship. Who were the sources of his cultural practices and values? When and why did he begin to integrate his cultural knowledge into his teaching? Our conversations focus on the idiosyncrasies of human development, the agentic self, and contradictions and tensions within and across activity systems that may impede or provide opportunities for learning and change.

Results

Genealogy of Learning

David grew up in an ethnically diverse, semi-rural community on windward Oahu, graduated from a private school for students of Hawaiian ethnicity, and majored in biology at a West Coast college. His story shows the importance of genealogy, a remembering and honoring of key persons and relationships that is fundamental in Hawaiian culture. Despite knowing David for over 20 years, I did not know how significant genealogy in all its forms was until he mentioned in an e-mail that he provided his personal genealogy of learning to use computers in applying successfully to a Hawaiian foundation for a computer for his aunt's research. This was a practical outcome of his statement "if you did not know your genealogy, you don't have rights." In the section below, David explores the role of family members, mentors, and key experiences in learning and professional growth.

> My name is David D. Maika'i Hana'ike. I am the fourth child of six children. My parents are both college educated and attended the University of Oregon. My mother majored in mathematics and my father in psychology and English. My father was in graduate school when he married my mother. They lived in Oregon close to family (my mother's side, French, English), where two of my siblings were born. With the death of his mother, my dad brought his family back to Hawai'i to live with his father to watch over him. Our family settled in Kane'ohe on the Windward side of O'ahu where we were often in the bay fishing, crabbing, swimming and kayaking. We were too far from the recreation centers, and the ocean afforded much of our entertainment and natural history.
>
> Our educational heritage came from my mother and my father. My maternal grandmother was a teacher and a principal in small schools in Oregon. My paternal grandmother went through normal school and taught for a while. My paternal grandfather was a minister and

a teacher in the public school system. The connection between educators and ministers was strong in the 1900s. My father's paternal great-grandfather went to Lahainaluna Seminary School where he was ordained a minister and doubled as the Assistant Principal.

My mother stayed home during my childhood, and did not work until all of her children were graduated from college. Throughout my elementary years, my mother was a strong factor in my excellence in education, being home everyday to assist in our studies in math and science. My father's expertise in language arts was extremely beneficial in my studies of reading and writing. Nightly review of my writing was commonplace in our household. My father made sure that all work was done before television was allowed. There was little left unattended when it came to education in our household.

I attended [a public elementary school] and later [a private school for Native Hawaiians] from grade seven to twelve. My course work led me into the gifted/talented track, and I excelled in mathematics and science. I attended _____ High School in Hinsdale, Illinois as an exchange student sponsored by [both schools]. Being chosen to travel abroad was my family's way to broaden my educational experience. I went on to Willamette University in Salem, Oregon and majored in Biology/Pre-Med. Throughout my four years at Willamette, I was fortunate to have strong influences promoting success in my life. An alumna of Willamette University and a retired school teacher and principal, my grandmother mentored me through some tough times while away from Hawai'i.

How Did You Develop Your Cultural Knowledge?

I asked David this question when I noticed his genealogy of early learning completely omitted Hawaiian cultural knowledge. He told me that his parents stressed high academic performance and that his Hawaiian-Chinese father told him to keep his cultural and school knowledge separate. David said he learned cultural uses of plants while staying with his paternal grandfather and Chinese step-grandmother after school. He was *punahele*, their favorite, as the first grandchild born after the family returned from Oregon.

Though the 1970s were a time of cultural awakening and indigenous activism, David's formal education, even in a high school dedicated to Native Hawaiians did not provide opportunities to study Hawaiian culture or language. He said he received his Hawaiian middle name when he was 18 and had developed enough so his Hawaiian grandfather could give a middle name that would fit him as an adult. David received the name Maikaʻi, a word with multiple meanings. Maikaʻi means "good" in terms of moral character as well as good health and good appearance, beautiful. The name also connected him to his maternal grandmother's Maui lineage. His grandfather's name thus gave him a worthy and meaningful Hawaiian name to live up to.

But only after returning to Hawaii after college and seeing his high-school peers engaged in language and cultural activities, did he actively begin learning about his culture. He attended community college classes to learn Hawaiian language and studied hula. He kept his cultural learning apart from his professional life until teaching provided opportunities to view indigenous culture as a resource for learning and a source of professional identity. Even there, his indigeneity took several years to enter his instruction and become an integral component of his identity and practices as a Hawaiian science teacher.

Becoming a Science Teacher

David’s premed biology degree prepared him for his first position as a contact lens optician, but staff reduction and comments from friends that he would be a great teacher led to a career change. When he reviewed the section below, he commented on his lack of preparation for working with culturally diverse students. Because his teacher preparation program did not provide strategies to reach the “rascals” with behavior issues, he drew upon his own learning experiences and his growing knowledge of Hawaiian practices, places, and natural history to develop an instructional toolkit of learning activities to share with colleagues. Experienced mentors, including his maternal grandmother advised him to put aside “foolish lesson plans” in favor of pedagogies supporting relationship building and engaging all students in learning.

> My move into education came about due to staff reduction in the eye department of my hospital. That was the turning point in my genealogy of being an educator in the DOE. Even after graduating from the University of Hawai‘i with a Professional Diploma in 1985, I returned every Christmas to Salem, Oregon for several years to be with my grandmother and learn about her passion for education. She was critical in [developing] my thinking skills, as she was a veteran teacher with similar relationship skills that I had. Our conversations over my first couple of years as a teacher assisted my ability to work stronger and wiser with relationship building with my students. I would have to say that my grandmother was as important an influence on my success in education as were my parents.
>
> My first year of teaching I had three levels of students (grades 7, 8, and 9) both math and science. My math students were Z level (lowest) and English Second Language Learners (ESLL). Much of what I had to work with prompted me to draw on my knowledge base from Willamette University. I did quite a bit of direct instruction and a lot of drill with my ESLL, and constant bombardment of quizzes to remind the student that I meant business. I [also] did a lot of rewarding of good work with words of kindness. My students knew how I wanted them to act. My greatest moments were [when] my hardest classes came back and cried as they left for high school. When I [reminded them] they were so *kolohe* (rascally) during our first quarter they cried more and claimed that they truly loved me, the work we all accomplished and that I truly respected them [and treated them with] kindness.
>
> Taking the kindness method out into the field and doing small group studies was Dr. George Walker’s approach to discussing things with his UH students. Judy and I often were seen falling behind on our hikes because students got so involved that they wanted to find their own examples of what I was talking about. And they were almost always successful.
>
> My education mentors within the public school system here in Hawai’i are numerous. My coordinating teacher at Kailua High School, Amy W was a tough individual who did not fool around with foolish lesson plans. Her “no nonsense” approach to curriculum design and inquiry lessons was instrumental in forging my philosophy on education. The efforts of Edith W. and Judith I. at Kawananakoa during my first year of teaching also made a lasting impression on the value of long hours and thorough unit plans. Both took me under their wings and helped me to develop strong ideas about the education of all students, from those with challenges to the most gifted of students.
>
> During my 16 years at Kawananakoa, I worked side by side with two great mentors, Edith and Judy. Together we ruffled a few feathers promoting science education and requesting increases in years of science. The crowning jewel of our efforts was to become the first public middle school to offer a mandatory 3 year science curriculum based on general science and natural history. In addition, we created the curriculum to get the

> students out into the field where real science was easily observed. Projects included bioremediation systems, visits to Kawainui Marsh and working with renowned scientists, graduate students, and retired teachers from my high school.

Activity Networks as Resources for Curriculum Development

David's engagement in cross-institutional, cross-scale, intergenerational activity networks was intended to gain knowledge to translate into school programs. He viewed curriculum development as transdisciplinary and collaborative:

> I was fortunate in working with many experts in the field of education, oceanography, and Hawaiiana. My connections and collaborative efforts began to branch from those early years in the mid-1980s. A sharing between levels helped me to grow and allowed my systems to learn from each other. No one level was left out of the learning process and the ties only got stronger.
>
> We used our connections in our family of educators to branch into field trips to Ka'ena Point State Park, Hawai'i Volcanoes National Park, Space Camp (Alabama) and Cape Canaveral. All trips were tightly woven into what we were teaching, and were educational as well as entertaining. Hiking the lava flows, going up to Mauna Kea at night to see Halley's comet, seeing all the endemic and indigenous plants from the mountain to the sea assisted us in teaching the idea of sustainability and natural resource management. We had students send post cards to their families to share their daily experiences. It was our way to keep the knowledge flow going from generation to generation, thus keeping the ties in the family lines connected through the education their children were receiving.
>
> My mentors were not limited to the classroom. I have had strong and lasting relationships with numerous educators in the upper levels of the DOE and the University of Hawai'i. During my summers I was the instructor of the Blue Water Marine Laboratory based at the Waikiki Aquarium. My work at BWML was used in my classes at Kawananakoa, and vice versa. Dr. Carol H., former Education Director, Waikiki Aquarium was influential in my efforts to connect environmental education and oceanography to the DOE curriculum. I would not be complete in describing my educational history if I didn't describe my relationship with my former principal, Mr. A. [that] reaped many rewards for our school. I believe that Mr. A saw in me the ability to work with any organization, and the work ethic to complete a task with all the "bases covered."

Classroom Observations: Learning Discourses of School and Science

Videotapes of David's classes show that he provided his students with a socially structured environment with high expectations for social and academic performance. He required students to address him by his complete four-syllable Hawaiian surname, preceded by the title Mr. This formal mode of address contrasted to the common practice I observed in both private and public schools of students simply calling their teachers Mister or Miss, sometimes followed by the initial of the teacher's surname. If students wished to be acknowledged they had to address him appropriately before being recognized. David consistently modeled how he should be addressed

("Excuse me, Mr. Hanaʻike") and how others should be treated. Requiring his students to master middle-class social skills prepared them for positive relationships with teachers and other adults. David explicitly connected this to social advancement and economic opportunity. Direct instruction of targeted social skills was justified by the importance of proper speech and behavior in the workplace.

After a few months, social expectations were internalized by most students with infractions policed by peers. Students' social and academic actions appeared exemplary to visitors unaware of the effort and practice that led to an orderly learning environment. A preservice student reported he found it hard to believe students were selected by their below-grade-level reading scores based on his observations of similar students at other schools. He noted that in a 50 min lesson on energy, David provided a reading, defined key vocabulary, and connected the topic to students' lives through their familiarity with cars. The reading was followed by a discussion, quiz, and a group activity to build marshmallow–toothpick molecular models. Groups named and sketched methane, ethanol, and propane, and other hydrocarbon molecules, employing appropriate terms. After receiving David's approval, students dismantled their "molecules" and ate the marshmallows.

David said he provided his students with the same content as gifted and talented students with instructional differences. To build reading and comprehension skills, he presented key vocabulary and assigned short-content readings followed by quizzes consisting of four multiple-choice questions. Students went up as soon as they finished to check their papers but did not receive correct answers. They could take their papers to be rechecked four times. Though this allowed a perfect score, the high visibility of the checking process increased students' motivation to perform well. The activity was low stakes relative to grades but high stakes socially as peers assessed each other's reading competence.

Role of Culture in Science Learning: Modeling Multiple Identities

As an adult to strongly identify himself as Hawaiian, culture and place-based learning are deeply meaningful to David. He believes his students, whether Hawaiian or not enjoy learning when it is relevant to their own everyday experiences and familiar places. *Moʻolelo*, stories; *oli*, chants; and sayings, *ʻolelo noʻeau*, learned in his Hawaiian language and hula classes were especially relevant during field trips, providing students with multidimensional understandings of place and teaching respectful relationships between humans and nature.

> Many trips with my students to the island of Hawaiʻi allowed me and my colleagues to strengthen our ability to work with students outside of the classroom. Being in "the field" gives a teacher the ability to work towards developing strong bonds of "mentorship" with alienated students. Using the indigenous culture of our islands has allowed my students to see their *ʻāina* (land) through the eyes of a native practitioner who also happens to be their teacher.
>
> Indigenous practices also help students to appreciate how specific routines we take for granted were "life or death" issues on an isolated island ecosystem, conservation of resources and planting practices to name two. Many chants and proverbs hold secrets for

> the relationships of the *kanaka maoli* (Native Hawaiians) and their connection to their ocean, their land, and all the living organisms that share it with them.

David believes that being a Hawaiian science teacher increases his ability to be a role model for underrepresented minority students. His modeling of indigeneity extended to extracurricular activities connecting indigenous and school identities. After teaching for 4 years, during which time he and his colleagues succeeded in establishing Hawaii's first mandatory 3-year middle-school science program, he started a hula *hālau* (school; literally, a branch from which many leaves grow) at the school.

> I use my indigenous status to promote a positive role model for my students. I allow my role as a teacher to mix with my strong image of myself as a *kanaka maoli* and I share that blending with my students. I often try to connect to the ethnic background into my teaching. I am always looking for ethnic and social relevance to my lessons, and try to assure my students that this connection allows them to learn more about themselves and where they came from.
>
> To give balance to my life and express my love of flora and fauna I incorporated that knowledge with the arts. I founded a *hula hālau* with the assistance of a life long friend and *kumu hula* (hula master). The hālau was named *Kei Ka Nani o Wahi'ika'ahu'ula* (How glorious is Wahi'ika'ahu'ula) after Princess Abigail Campbell Kawananakoa, wife of Prince David Kawananakoa (the namesake of our school). Using my lineage connected to the Kawananakoa family we received a grant from Kekaulike Kawananakoa who was greatly touched by our honoring of her grandmother. We returned our aloha by participating in the State Hula Competition using *ipu heke* and *palapalai* fern collected on the slopes of Wai'anae. Our young middle school ladies performed a hula honoring Puna entitled *Ke Ha'a La Puna* where my family originated. Our young ladies received a first place award and were jubilant considering they were only 5 girls performing against many larger private school hālau.

Evaluating Outcomes of a Reformed Middle-School Science Program

For his master's research (Hana'ike 2000), David compared 92 students who had attended the reformed middle-school science program with 86 students from an intermediate school about a mile away serving a similar population. David studied high-school students enrolled in Honors Biology (stanines 7–9) and Physical Science classes (stanines 1–6). He collected grades and student surveys evaluating their prior science programs. Like Melissa, he found Honors Biology students from both schools had statistically identical first through third quarter grades. But his school's Physical Science students significantly outperformed peers each quarter and traditionally underrepresented students enrolled in Honors Biology at higher rates. Students from the reformed program were also twice as likely to report teachers as their most important motivation to learn and gave higher ratings to their learning of science content and processes.

David included a case study of a disruptive student with a record for theft and possession of a controlled substance to illustrate student change through teacher mentoring. David nominated the student to be a homeroom representative and accreditation team member (over colleagues' objections), and became the primary liaison with the family. Colleagues reported that the student began using phrases learned in David's class when issues of behavior arose. Improved academic performance culminated in a video project on ocean thermal energy conversion David held up as a standard of excellence. Ultimately, the student asked David and another teacher to write letters of recommendation to a private, selective school. David complied after the student agreed to strengthen his academic skills by repeating the eighth grade in his new school.

Becoming a School Administrator: Translating Skills/Values/Knowledge Across Activity Systems

David mapped his transition from teacher to administrator onto professional networks and experiences that began in the classroom and extended into the wider school and educational community. His accomplishments, strong educational values, and a clear vision of his future role as an administrator were sources of agency and self-efficacy as he planned his next professional step:

> I believe that education is life, and that it is a dynamic learning process. I have been an active member of the leadership team at my middle school, and have been involved in the development of curriculum, organizational policies, facilitative processes and accreditation reports. Throughout these times, I have been able to give my insights into the development of instructional action plans, appropriate standards-based teaching practices, and assist others through mentoring relationships. My work has left the box of the teacher and has entered the community, as I have advised, counseled and sought services for students of "at-risk" backgrounds through the development of a hālau (school for study of hula) and the integration of the arts, academics and guidance practices. I believe that my experiences as a teacher and advisor, as well as my compassion will make me an ardent and passionate force that can lead a committed school community to higher levels of student success and achievement.

Thoughts on Culturally Responsive Professional Development

David's personal experiences as a Native Hawaiian studying his own culture in the company of elders lead him to be cautious as he recommends that teachers learn in small groups from indigenous elders. His concerns of knowledge appropriation and misrepresentation express long-standing distrust between indigenous and dominant cultures.

> Mentoring by educators on a small group basis is the best method. My training with my cousin from the University of Hawaii has allowed me a wondrous opportunity to sit one on one and mutually share our *mana'o* (thoughts, ideas). This can be done with many of the *kupuna* in the education profession, as well as the church system.
>
> What becomes the issue is whether their knowledge will continue in a healthy fashion and not be adulterated for personal use. That is their biggest fear, that their knowledge will be used by individuals for profit and not educational purposes. For that reason, small intimate groups closely reviewed seem to be the best method. I hope to

> take some this *mana'o* (wisdom) with me as I work with teachers to assist them in their efforts to bridge what is expected in our standards to what is relevant to cultural connections to our island state.

Discussion

David's story reveals a complex and unique socially situated self that continually develops and evolves as he resolves contradictions within and among indigenous, science, and school activity systems. David's story of a lifetime of learning illustrates how participating in and making connections among multilevel activity systems develops multiple literacies, socially situated self-efficacy, and an increasingly agentic self. His culturally diverse family, schooling, community experiences, and grounding in indigenous culture provided him with knowledge and tools for effective instruction of academically at risk, culturally diverse students.

David acknowledges his mentors and a school community that embraced change, took risks, and engaged in professional development as cultural change oriented to improving student achievement. David described his school's reformed science programs as learner-centered, hands-on, reading–writing intensive, and inclusive of special education students and second language learners of English. He expected his students to use language associated with the Discourse of science and to be able to connect their learning to their lives. His lesson on hydrocarbon fuels demonstrated "connecting learnings" in its explicit connections "among knowledge, skills, and ideas across lessons … and across in-school and out of school applications" (Langer 2001, p. 857).

David's career path suggests the importance of diverse school, community, and professional experiences for development of culture and place-based pedagogical content knowledge. Becoming knowledgeable about the cultural ways of groups different from one's own is referred to as "border-crossing" by Wellman (1999) who employs the concept to understand ethnic identity formation and Aikenhead (1998) who refers to indigenous students crossing cultural borders between home and western school science. By externalizing knowledge through teacher and student talk and actions, David modeled and expected his students to enact academic and social literacies.

David's commitment to developing place and culture-based science curricula is the professional extension of his personal desire to know more about Hawaii and to live and teach his Hawaiian cultural heritage. His focus on relationship building and co-learning by teachers and students is a reflection of his own experiences and cultural values. Coursework during his sabbatical focused on the natural history of Hawaii in order to develop place-based curricula involving students in increasingly sophisticated culture-science, inquiry-oriented activities.

David's study showed that his school's reformed middle-school science program was especially beneficial to students most at risk of academic failure. Educative student–teacher interactions in multiple contexts were the basis for students' views of teachers as a primary factor in motivation to learn. Collegiality, restructuring curriculum to be connected to students' lives and communities, and holding high social and academic expectations led to measurably higher student satisfaction and academic outcomes. By expecting success, being an ethnic role model, and providing challenging opportunities for students to master academic discourses, David helped students develop identities as successful learners.

Implications for Teacher Education and Professional Development

This paper asked the question: "How does a science teacher become an effective instructor of underrepresented, low-achieving, racially marginalized students?"

David's genealogy of learning is a narrative of supportive mentors and participation in multiple activity systems (Discourses) in which he develops professional and personal competence. David becomes increasingly agentic, establishing activity systems that enable students to develop skills and knowledge supportive of success in school and community. Through this process, David's expectations that students engage appropriately in societal, school, and content area Discourses supported positive shifts in their institutional (I), Discourse (D), and affiliation (A) identities (Gee 2001). These shifts are seen most clearly in the disruptive student whose institutional I-identity changed from *controlled substance/disruptive thief* to *student government representative-school accreditation team member*, whose discourse D-identity changed from *poor in science* to *outstanding in science*, and whose affiliation A-identity changed from *potential gang member* to *private school student*. Finally, David's study suggests developing a Discourse-identity as a successful middle-school science student carries over into high-school science activity systems.

Clearly, teachers need more than a conceptual toolkit to develop knowledge of effective sociocultural contexts and instructional practices for culturally different and marginalized students. This case study suggests that pre- and inservice science teachers would benefit from situated, cross-cultural, and transdisciplinary learning activities associated with sustained teacher collaboration. Collaborative, culturally responsive, place-based learning communities led by experienced members with long-standing, stable relationships support the development of pedagogical content knowledge that enables teachers to address the discontinuities within and across home–school activity systems. David is still in contact with students from his early teaching days who now are parents and business owners.

Nelson (2007) identifies sociocultural factors, that is, disarticulation among home/school/community activity systems embodied in the lack of minority mentors and role models as contributing to the underrepresentation of minority Science–Technology–Engineering–Mathematics (STEM) students. Science teachers such as David, who identify themselves as members of indigenous groups, are critical to establishing multilevel activity systems inclusive of science, school, and indigenous communities. Historical distrust between indigenous and dominant groups underscores the importance of preparing science teachers with knowledge and practices for culturally responsive teaching. A goal of equitable education for all students guides the respectful teaching and learning of indigenous culture ensuring that "knowledge will continue in a healthy fashion and not [be] adulterated for personal use."

Conclusion

David brings his understanding of teaching and learning as relational and collaborative to program planning and curriculum development. Teachers who have been mentored by David tell me they carry on what they have learned and I see them work with their student teachers as he worked with them. David is a transdisciplinary literacy expert, helping both students and junior colleagues learn and practice the skills and knowledge they need to be successful in academic, professional, and community settings.

David's administrative experiences and growing knowledge of social systems is now leading him to consider transitioning into another activity system:

> I will always be a student and a teacher. That has to be the central core belief of all teachers. I have been debating whether I would continue in my studies and get my PhD. If I do, I believe it would be more in Curriculum & Instruction, and not in Education Administration.

David is considering doctoral studies focused on preparing teachers to work across culturally diverse activity systems. His assessment of his own formidable set of skills and experiences, his assessment of his ability to enter new activity systems, and his ability to draw upon a network of colleagues in the academy suggest the agentic, networked nature of self, simultaneously a historical product and a creator of history. If he does that, I know he will not be alone, but accompanied by a host of mentors, some providing guidance across diverse cultures, places, and generations, others like me still part of the present.

References

Aikenhead, G. S. (1998). Border crossing: Culture, school science, and assimilation of students. In D. A. Roberts & L. Ostman (Eds.), *Problems of meaning in science curriculum* (pp. 86–100). New York: Teachers College Press.

Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education, 2*, 539–620.

Bandura, A. (1989, September). Human agency in social cognitive theory. *American Psychologist.* Retrieved May 15, 2008, from http://www.des.emory.edu/mfp

Capper, P., & Williams, B. (2004) Enhancing Evaluation using systems concepts. American Evaluation Association. Retrieved on April 16, 2009, from http://users.actrix.co.nz/bobwill

Chinn, P. (1997). Teacher-student action research: Answering Melissa's question. *Teaching and Change, 5*, 99–115.

Chinn, P. (1998). Isabella Aiona Abbott and the education of minorities and females. *Teaching Education, 10*, 155–167.

Chinn, P. (1999). Multiple worlds/Mismatched meanings: Minority women scientists and engineers. *Journal of Research in Science Teaching, 36*, 621–636.

Chinn, P. (2005). Eh, mus' be smart class: Race, social class, language, and access to academic resources. In A. Rodriguez & R. Kitchen (Eds.), *Preparing Mathematics and Science Teachers for Diverse Classrooms: Promising Strategies for Transformative Pedagogy* (pp. 159–182). New York: Routledge.

Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge: Harvard University Press.

Engestrom, Y. (1999). Activity Theory and individual and social transformation. In Y. Engestrom, R. Miettinen, & R.-L. Punamaki (Eds.), *Perspectives on activity theory* (pp. 19–38). New York: Cambridge University Press.

Gee, J. P. (1992). *The social mind: Language, ideology and social practice*. New York: Bergin & Garvey.

Gee, J. P. (2001). Identity as an analytic lens for research in education. In W. G. Secada (Ed.), *Review of research in education, 25* (pp. 99–125). Washington, DC: American Educational Research Association.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. New York: Routledge.

Hana‘ike, D. D. M. (2000). *A study of the effectiveness of a multicultural middle school science program on the transition of "at-risk" students to a high school science program*. Unpublished master's thesis, University of Hawai‘i at Mānoa.

Kamehameha Schools. (2005). Ka Huaka‘i: 2005 Native Hawaiian educational assessment. Retrieved November 3, 2009, from http://hawaiidigitallibrary.org/elib/cgi-bin/library?c=nhea&l=en

Kawakami, A.J., & Aton, K.K. (2000). Ke A'o Hawai'i (critical elements for Hawaiian learning): perceptions of successful Hawaiian educators. Pacific Educational Research Journal, *11(1)*, 53–66.

Langer, J. A. (2001). Beating the odds: Teaching middle and high school students to read and write well. *American Educational Research Journal, 38*, 837–880.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

Leont'ev, A. N. (1981). The problem of activity in psychology. In J. Wertsch (Ed.), *The concept of activity in Soviet psychology* (pp. 37–71). Armonk: Sharpe.

Loucks-Horsley, S., Stiles, K., & Hewson, P. (1996, May). *Principles of effective professional development for mathematics and science education: A synthesis of standards* (NISE Brief, 1, 1-6). Retrieved June 9, 2008, from http://www.wcer.wisc.edu/archive/nise

Meyer, M. (1998). Native Hawaiian epistemology. *Doctoral dissertation*, Faculty of Education, Harvard University.

Nelson, D. (2007, October). *A national analysis of minorities in science and engineering faculties at research universities*. Retrieved June 14, 2008, from http://cheminfo.ou.edu/~djn/diversity/Faculty_Tables_FY07

Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, *15(2)*, 4–14.

Sparks, D., (1992). Merging content knowledge and pedagogy: An interview with Lee Shulman. *Journal of Staff Development, 13*(1). Retrieved June 12, 2008, from http://www.nsdc.org/library/publications/jsd/shulman131.cfm

Stanton-Salazar, R. D. (1997). A social capital framework for understanding the socialization of racial minority children and youths. *Harvard Educational Review, 67*, 1–39.

Stetsenko, A., & Arievitch, I. (2004). The self in cultural-historical activity theory: Reclaiming the unity of social and individual dimensions of human development. *Theory & Psychology, 14*, 475–503.

Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap. Best ideas from the world's teachers for improving education in the classroom*. New York: Free Press.

Tharp, R. G. (1989). Psychocultural variables and constants: Effects on teaching and learning in schools. *American Psychologist, 44*, 349–359.

Wellman, D. (1999). Transforming received categories: Discovering cross-border identities and other subversive activities. In C. Clark & J. O'Donnell (Eds.), *Becoming and unbecoming White* (pp. 78–91). Westport: Bergin & Garvey.

Chapter 19
Deconstructing Chinn and Hana'ike: Pedagogy Through an Indigenous Lens

Suzanne L. Stewart

Introduction

Learning in Indigenous communities worldwide has changed drastically since the exploration of Europeans, often seen as heralded by Columbus in 1492. The arrival of shiploads of western Europeans across Indigenous lands from Canada to the South Pacific heralded a change not only in the resident populations' ways of knowing and being but also in an entire way of life for Indigenous groups. Presently, the cultural landscape of Indigenous country is constantly evolving. This evolution is a process in which we interact and change through features of human knowing and their implications for human change. Attaining postsecondary education is one way in which adults of all ages and cultures seek to change their lives through increasing capacity for knowledge, skills, and employment. Through individual, group, and class-size interventions, culturally responsive educators need to be trained and capable of meeting the learning needs of culturally diverse populations in the postsecondary school system; however, there is a realization that current education practices are not meeting the challenges of the broad range of Indigenous cultural identities represented in today's colleges and universities (Malatest and Associates 2002). This is especially true for teacher education within the postsecondary system. Educators are becoming aware that the values in which the current systems of pedagogy are rooted in European-North American (i.e., Eurocentric) culture and that those values and those of culturally different students, such as those with Indigenous ancestry, frequently come into conflict in learning processes (Barnhardt 2002).

My position as author is one of Canadian Indigenous woman, parent, academic, and psychologist. My formal education and vocation as professor in counseling psychology within faculties of educations in Canadian Universities has afforded both a detailed and broad view of some of the issues relevant to Indigenous education in the postsecondary context. In a review of the current literature on Indigenous learning in postsecondary school contexts in Canada, I seek to identify and describe

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_19,

my lens in terms of some of the most important issues in teacher education for Indigenous teachers and for non-Indigenous teachers working with Indigenous students. The goal of this chapter is to describe some of the issues in Indigenous teacher education that epitomize my understandings of the context, and to apply them to Chinn and Hana'ike's chapter. Much of the existing literature presents therapeutic interventions or theoretical frameworks for working with Indigenous populations within the public education system and to a lesser degree, from Canadian and American Indigenous band-operated schools. This chapter is designed to appeal to educators who wish to increase cross-cultural consciousness and practices from an Indigenous paradigm. Through a process of exploration of current intersections between Indigenous epistemologies, Indigenous pedagogies, and Chinn and Hana'ike's work, this discussion seeks to generate more questions about Indigenous learning and the postsecondary institution's role. Thus, there is a focus on both the development of an Indigenous paradigm of education in the academy and future research into teacher education in the context of Indigenous epistemologies in the postsecondary system.

Indigenous education is a broad topic in terms of teacher education. For the purpose of this discussion, three of the issues relevant to Indigenous learning in teacher education in postsecondary contexts are presented in-depth. These issues are (1) historical context of education, (2) educational attainment, and (3) cultural ways of knowing (an Indigenous pedagogy).

Historical Context of Education

In examining how Indigenous peoples of all ages learn and exist in a society dominated by a culture not their own, understanding sociopolitical historical realities are necessary in order to set the context for discussion of the issues. According to oral tradition, prior to first contact with Europeans in the sixteenth century, North America's Indigenous peoples' societies existed with successful methods of dealing with educational and health challenges. In Canada, implementation of federal government policy through the creation and enforcement of the Indian Act in 1876 has also destroyed Indigenous cultures through the creation of land reserves, residential schools, and bureaucratic control. Indigenous settlements were chosen by non-Indigenous governments, who forced Indigenous groups off their traditional lands and onto other territories, often grouping bands together that had previously no history of living together (Dickason 1997). These groupings were forced to make new social structures and sustainable ways of life. Indigenous groups were also relegated to lands with little or no natural resources, that is, lands not deemed habitable or desirable for European settlers (Royal Commission on Aboriginal Peoples 1994).

Through the colonization, bureaucratization, missionization, and education processes of the Canadian colonial governments, the control of education, healing, and other health practices were largely transferred from Indigenous peoples to programs and institutions sponsored by the Canadian government (Malatest and Associates 2002). According to Waldram (2004), while this new system helped to mitigate some of the devastating health problems brought from Europe (such as influenza, tuberculosis, and small pox, which developed through the early contact period) that killed off about 90% of the population, it failed to protect the traditional education, ways of knowing, and health and well-being of Indigenous people in several ways.

Historically, traditional teachers and healers were ridiculed and persecuted by the dominant culture and by governmental legislation (Waldram 2004). Traditional teachers, often Elders or healers in community, were forced to practice their traditions such as Potlatch, Sundance, and shamanic healing in secret. Many Indigenous people no longer availed themselves of the benefits of their skills and knowledge, either because they did not know how to access these services or because they had been taught to mistrust, fear, or condemn their own healing traditions through residential school teachings. Through this process of eliminating the practice of traditional healers and educators, a great deal of very valuable cultural knowledge has been lost. Currently, such persecution takes the form of overt and subtle discrimination, which has been cited by Kirkness and Barnhardt (1991) as the most serious challenge being experienced by Indigenous students in postsecondary institutions.

Secondly, western perspectives that dominate formal education have their roots in modernism, worldviews that value objective truth, rational thinking, and the constancy of measurement (Duran 2006). This focus on a western perspective to education in terms of secondary and postsecondary schooling means that Indigenous communities have had limited access to certain western types of education programs. Such programs focus exclusively on western health care, teaching, and learning styles that are based on competition and individuality rather than on Indigenous ways of healing, learning, and teaching (Mussell et al. 1993). An Indigenous way of knowing learning, for example, is intimately intertwined with community development and interdependence, which are currently needed to restore Indigenous individuals, families, and communities to a level of health and wellness (Smith 1999).

Indigenous peoples and communities lost control over the institutions and processes that were supposed to protect the well-being and health of their people, including education (Battiste 2002). Colonialism ensured that Indigenous people were taught that the dominant society knew best which services and programs they needed. The creation and enforcement of residential schools for Indigenous children, which, as discussed earlier, has been linked in the literature to generations of personal and community trauma, has also fostered mistrust in western education as a whole (Royal Commission on Aboriginal Peoples 1996). Even now, as many Indigenous communities are negotiating with Canadian governments for the transfer of secondary education and programs to their control, they are often being given administrative responsibility for existing programs but very little real power to actually recreate education programming in order to move toward maximum health and well-being (Waldram 2004).

Educational Attainment and Achievement

Indigenous university students represent an elite population within the greater population of Canadian Indigenous peoples because compared to non-Indigenous Canadian populations, very few Indigenous adults enter and complete postsecondary studies. Statistics show that in the case of status Indians, only 20% of those under the age of 24 have pursued some form of postsecondary education, compared with 42% of their non-Indigenous peers (Junor and Usher 2004). However, the gap in university graduates remains wide. In 1996, 6% of Indigenous people aged 25–64 completed university education. This increased to 8% in 2001. For non-Indigenous Canadians, 23% of the population aged 25–64 had a university education in 2001, up from 17% a decade earlier (Statistics Canada 2003). Thus, the actual number of Indigenous graduates remains very small, as Indigenous people currently account for about 3.9% of the overall population of Canada (Statistics Canada 2003).

The assimilative nature of postsecondary education is considered a barrier to educational achievement by Malatest and Associates (2002). These authors conducted a study in which they interviewed Indigenous postsecondary students in British Columbia. Results from the study indicate "strong assimilative forces are still seen as a prominent feature of postsecondary education for many students. These results have led to an over-arching distrust and hostility to education in many parts of the Aboriginal community" (p. 15). Malatest and Associates further suggest that this distrust and hostility have been factors in poor secondary performance, which result in a lack of academic preparedness for Indigenous youth.

Nevertheless, often, Indigenous youth express a desire to achieve secondary and postsecondary education, especially when supportive factors such as family and community sobriety are present (Juntunen et al. 2001). Postsecondary institutions however remain unconcerned with the role of culture when it comes to understanding or accommodating the learning needs of indigenous students. A detriment to Indigenous educational success is the problem of untrained educators who work with Indigenous students (McCormick 1997). Educators are inadequately (or not at all) educated in issues facing Indigenous learning, development, and assessment (Thomason 1999). Hampton (1993) states that "western education is hostile in its structure, curriculum, its context, and its personnel" (p. 262). It is clear that western academic practices often fail to meet the needs and expectations of Indigenous students entering universities in Canada.

Discussion of Chinn and Hana'ike's Work

The issues articulated by Chinn and Hana'ike are important to Indigenous teacher education because the authors carry the cross-cultural discourse one step further past the need to look at alternative ways to service culturally different students. The authors make an urgent call for culturally competent teachers in the context of

Native Hawaiian Children, with some data and literature to back up this claim, but mostly in the context of the case study of David. The authors suggest that one way to further understand the failure of the secondary school system for Native Hawaiian students is to examine standard academic teaching practices and then contrast them with David's cultural and place-based curriculum.

Chinn and Hana'ike are missing the next step in their discussion. What is Indigenous knowledge and learning? There is no one clear answer, as the question is about comparative knowledge, and legitimate pedagogy does not exist to answer it. western epistemologies have posed questions regarding what Indigenous peoples know or how they think and learn (psychologies), but these inquires have been steeped in biases, racism, and arrogance (Kenny et al. 2004). Presently it is challenging for Indigenous peoples to deconstruct Indigenous knowledge and learning because the dominant culture has created mysticism and romance around Indigenous knowledge and learning, a point missing within Chinn and Hana'ike's article.

The fact remains that in the literature, debates concerning competing knowledge claims could continue indefinitely. Examining specific implementations of Indigenous ways of knowing could offer some insight, as attempted by the presentation of David's case study. In Indigenous policy research, for example, the research is holistic and balanced, and the diverse positions on knowledge claims must all be considered in the context of ethical research practice (Erasmus and Ensign 1998). Knowledge claims are scrutinized for how they can best represent an Indigenous worldview, Indigenous systems of knowledge, and balance a holistic perspective on policy research. Thus, it becomes critical to be aware that all sources of data derived from research in Native communities are ethically questionable if their methodology does not include appropriate attention to a Native cultural and social approach to contemporary research (Hudson and Taylor-Henley 2001).

Traditional knowledge has been described as hinging on respect for all life-forms as literally conscious and intrinsically interdependent and valuable (Corsiglia and Snively 1997), and David's case study touches on these ideas, but further elaboration would underscore the importance of this education. Indigenous peoples' lives are characterized by a lengthy history of relations between community members, nonhumans (wild animals, insects, trees, rivers, grass, etc.), and lands (Gadgil et al. 1993). Escobar (1998) writes that "unlike modern constructions, with their strict separation between biophysical, human and supernatural worlds, local models in many non-western contexts [like traditional ways of knowing] are often predicated on links of continuity between the three spheres and embedded in social relations that cannot be reduced to modern, capitalistic terms" (p. 61).

Each culture throughout the world has a set of paradigms, which are a collective set of values and knowledge of the way to live and be in the world (Lee 1995). A distinction that may be made about Indigenous values is that they inform a body of knowledge about specific environments that span several thousands of years, in many cases since time immemorial (Escobar 1998). Chief Wavey (1993) notes that "we spend a great deal of our time, through all seasons of the year, traveling over, drinking, eating, smelling and living with the ecological system, which surrounds us" (p. 11). Indigenous peoples are characterized as having, for example, intimate knowledge of trap lines, waterways, spiritual/traditional lands, as well as knowing their relationship to Earth, which is expressed in cultural values such as sharing and caring (Escobar 1998).

It is vital to remember that colonization has interrupted many traditional ways of living and knowing for Natives throughout the world (Mussell et al. 1993), as discussed earlier in this paper. However, many Natives groups today are presently undergoing a profound spiritual renaissance of traditional ecological value renewal and Indigenous ways of knowing – two concepts which are intimately intertwined (Wenzel 1999). This discussion reflects a return to traditional ways of knowing by its exploration of Indigenous education in the context of an Indigenous paradigm.

Traditional Indigenous learning and teaching can be described as rooted in respect and cooperation, as David suggested in his case study. For example, write that Aboriginal children in traditional cultural settings watch, listen, practice cooperatively, ask for feedback only after they have mastered a task, work in a hands-on manner, and are generally holistic (i.e., mind, body, and spirit) learners. In contrast, children from dominant cultures tend to work and learn through a system that is based on individualism and competitiveness, logical-sequential learning, and linear and analytical thinking (Herring 1997). Battiste and Youngblood Henderson (2000) write that the process of cognitive transmission of Indigenous learning is intimate and oral; it is not distant or literate, and that Native peoples view their languages as forms of spiritual identity; Native language can reflect philosophies of how to live as well as knowledge base and cognitive–spiritual power.

An important aspect to understanding how Native students learn in school is grasping the oral nature of Native cultures, which forms a part of the integrity of relationship as articulated in David's case study. Indigenous peoples come from an oral tradition (McCormick 1997), in which knowledge and learning is passed on through generations by the telling of stories, music, dancing, ceremonies, and rituals. This type of cultural-based learning is integral to Indigenous identities, and cannot be overlooked as a valuable tool and resource for Indigenous learning in working successfully with Native students (McCormick 1997).

Indigenous within-group communication and learning is a more complex process to discuss, particularly in the context of postsecondary education, which occurs mainly in the western world. Indigenous knowledge is not a linear concept that remains stable across all Native peoples; it is a diverse knowledge that comprises many layers (Battiste and Youngblood Henderson 2000). According to some Native Elders, those who are in possession of such knowledge cannot categorize it in Eurocentric thinking, partly due to the fact that the processes of categorizations are not part of Indigenous thinking (Kawagley 1993). Further, Indigenous knowledge is very much a part of a specific community (i.e., language-based), band, or even family, and cannot be separated from the bearer of such knowledge to be codified into a definition (Battiste and Youngblood Henderson 2000). For example, those who possess such knowledge use it in everyday activity and existence and it becomes part of identity within a personal or cultural context. Kawagley (1993) identifies these personal cognitive maps as manifesting in humility, humour, observation, tolerance, experience, listening to natural and spiritual worlds, and social interaction. Therefore, I view this contextual and personal facet of Indigenous knowledge as a sensitive area of inquiry, and caution that discussing it out of context may be intrusive or disrespectful to Indigenous cultures. David's case study echoes this concern when it suggested that utilizing traditional knowledges of Elders may create a venue for cultural appropriation or possibilities for modification.

One way that is a respectful approach to thinking about Indigenous knowledge and ways of being and doing is by removing one's self from a cross-cultural or multicultural lens to a *different* way of thinking. Abandoning Indigenous education from a western paradigm would mean enveloping a worldview that comes from within Indigenous cultures, such as what is termed in anthropology as emic approach. One such worldview is described by contemporary Indigenous researchers as Indigenous standpoint pedagogy.

My approach to teaching teachers in the university is based on an Indigenous pedagogy that places education in the context of culture, values, relationship, and historical realities. It is this understanding of teaching and learning that provides me with the foundation of what Philips, Whatman, Hart, and Winslett (2005) have termed "Indigenous Standpoint Pedagogy" (ISP), which is described as being the "inherently political, reformative, relational, and deeply personal approach that is located in the chaos of colonial and cultural interfaces" (p. 7). ISP fundamentally identifies and embeds Indigenous community participation in the development and teaching of Indigenous perspectives, or standpoints, and is a multifaceted process. It is mainly concerned with Native perspectives in education, not as an alternative to western approaches but as a legitimate form of education in and of itself. For example, I bring this perspective to my work as an academic by virtue of my identity as a Yellowknife Dene woman and my desire to work from an Indigenous perspective in all aspects of my teaching methods and goals. What this means in practice is that I value multiple perspectives on learning and teaching in my interaction with students and coworkers, such as linear and nonlinear thinking, differing time orientation, holistic approaches and dualism, and community-based and individual focused connection. The foundation to this pedagogical approach lies in relationship, as this is the center of success for meaningful communication with students and coworkers. "Yet only through communication can human life hold meaning" (Freire 1970/2003, p. 61).

Indigenous postsecondary research and education are a fact of life in Canada and other traditional Indigenous territories worldwide, such as David's Native Hawaiian community – yet how do we define these from a specific cultural perspective? Likely we would be doing so from a unique perspective that was different across and sometimes within cultures. Chinn and Hana'ike echo this point when they suggest that teachers need more than concrete toolkits; they require exposure to collaborative, culturally responsive, community and place-based learning that permit teachers to address and reconcile the clashes and continuities between western and Native systems of knowledge. The dominant western paradigm of education as practiced in most settings is not one of cooperative knowing and learning, rather it is a model of objectivity and competition. An Indigenous paradigm of education is focused on restoring balance to the self through relationship with others and the environment. This Indigenous conception of education is not new or innovative, it has been in existence and successfully employed by Indigenous people in Canada and other places for thousands of years, as David suggests in his case study when he states that relying on his Grandmother's wisdom and knowledges for structuring classroom activity and curriculum were integral to the success of his approach. What is new is the articulation and validation of this definition as legitimate in the context of university research and teaching within an overarching history of oppression. Since colonization, western paradigms have been forced on Indigenous peoples in ways that invalidated and disregarded successful epistemological and healing methods that had previously been available to Indigenous people. As a result, many Indigenous communities today flounder in attempts to deal with their education problems by utilizing the only resource currently available to them through the public education system, which is dominated by western models of education and psychology. Yet at the same time, we must acknowledge the reality that Indigenous people today exist in both Indigenous and western worlds where a pedagogical approach that reflects this reality and serves to offer up both paradigms in a complementary way, rather than in a dominating or subordinating manner, may be appropriate.

Western-thinking educators and researchers must make significant changes in order to address needs that are not currently being well met. I propose that university academics could receive education about Indigenous peoples' educational needs, including information about the historical experiences of Indigenous peoples, the Indigenous paradigm, and form a comprehensive understanding of their own cultural sensitivities in the educational relationship with students and communities. Learning from case studies such as David's could be an invaluable resource for students studying to become teachers, and for teachers already working with Indigenous students. Further, postsecondary institutions could build capacity for research in Indigenous communities by revising ethical protocols to incorporate Indigenous methodologies, especially Indigenous knowledges, into research with Indigenous groups, and by recruiting Indigenous scholars through the acceptance of Indigenous paradigms within the academy.

Conclusion

Current literature on Indigenous learning in postsecondary schools in Canada identifies and describes some of the most important issues in working with Indigenous students in terms of theoretical learning themes and constraints that hinder academic success. What is missing is empirical data concerning the needs and goals of Indigenous students from a strength or wellness-based model that is grounded in an Indigenous paradigm, and how this might look in practice: Chinn and Hana'ike's case study begins to fill this gap by articulating and defining the development of culturally relevant and place-based education from a Native Hawaiian perspective in ways that have implications for both curriculum and professional development in teacher education. This chapter and Chinn and Hana'ike's work make it clear that there is an urgent need for more research from within Indigenous communities on how to successfully create and deliver both secondary and postsecondary education. If non-Indigenous institutions such as universities and settler governments are to support Indigenous peoples in recovering from colonization, reexamining and modifying the paradigm of education at all levels to include an Indigenous pedagogy is one place to enact meaningful change for students of all cultures.

References

Barnhardt, R. (2002). Domestication of the Ivory Tower: Institutional adaptation to cultural distance. *Anthropology and Education Quarterly, 33*, 238–249.

Battiste, M. (2002). *Indigenous knowledge and pedagogy in first nations education: A literature review with recommendations*. Prepared for the National Working Group on Education and the Minister of Indian Affairs Indian and Northern Affairs Canada, Ottawa, ON.

Battiste, M., & Youngblood Henderson, J. (2000). *Protecting Indigenous knowledge and heritage: A global challenge*. Saskatoon: Purich Publishing.

Corsiglia, J., & Snively, G. (1997). Knowing home: NisGa'a traditional knowledge and wisdom improve environmental decision making. *Alternative Journal, 23*, 22–27.

Dickason, O. P. (1997). *Canada's first nations: a history of founding peoples from earliest times*. Toronto: Oxford University Press.

Duran, E. (2006). *Healing the soul wound*. New York: Teachers College Press.

Erasmus, P., & Ensign, G. (1998). *A practical framework for liaison work in Native communities*. Wetaskiwin: Taylor Printing.

Escobar, A. (1998). Whose knowledge, whose nature? Biodiversity, conservation, and the political ecology of social movements. *Journal of Political Ecology, 5*, 54–82.

Freire, P. (1970/2003). *Pedagogy of the oppressed*. New York: Continuum International.

Gadgil, M., Berkes, F., & Folke, C. (1993). Indigenous knowledge for biodiversity conservation. *Ambio, 22*(2/3), 75–91.

Hampton, E. (1993). Toward a redefinition of American Indian/Alaskan native education. *Canadian Journal of Native Education, 20*, 137–145.

Herring, R. D. (1997). *Multicultural counseling in schools: A synergetic approach*. Alexandria: American Counseling Association.

Hudson, P., & Taylor-Henley, S. (2001). Beyond the rhetoric: Implementing culturally appropriate research projects in First Nations communities. *American Indian Culture and Research Journal, 25*, 93–105.

Junor, S., & Usher, A. (2004). *The price of knowledge 2004: Access and student finance in Canada*. Montreal: Canada Millennium Scholarship Foundation.

Juntunen, C. J., Barraclough, D. J., Broneck, C. L., Seibel, G. A., Winrow, S. A., & Morin, P. M. (2001). American Indian perspective on the career journey. *Journal of Counseling Psychology, 48*, 274–285.

Kawagley, A. O. (1993). *A Yupiaq worldview. A pathway to ecology and spirit*. Prospect Heights: Waveland Press.

Kenny, C., Faries, E., Fiske, J., & Voyageur, C. (2004). *A holistic framework for Aboriginal policy research*. Ottawa: Status of Women Canada.

Kirkness, V. J., & Barnhardt, R. (1991). First Nations and higher education: the four Rs – respect, relevance, reciprocity, responsibility. *Journal of American Indian Education, 30*(3), 1–15.

Lee, C. C. (Ed.). (1995). *Counseling for diversity*. Needham Heights: Allyn & Bacon.

Malatest & Associates. (2002). *Best practices in increasing Aboriginal postsecondary enrolment rates*. Canada: Prepared for the Council of Ministers of Education.
McCormick, R. (1997). Healing through interdependence: The role of connecting in First Nations healing practices. *Canadian Journal of Counselling, 31*, 172–184.
Mussell, W. J., Nichols, W. M., & Adler, M. T. (1993). *Meaning making of mental health challenges in First Nations: A Freirean perspective* (2nd ed.). Chilliwack: Sal'i'shan Institute Society.
Philips, J., Whatman, S., Hart, V., & Winslett, G. (2005, June). *Decolonising university curricula – reforming the colonized spaced in which we operate*. Paper presented at the Indigenous Knowledge Conference, Reconciling academic priorities with Indigenous realities, University of Wellington, New Zealand.
Royal Commission on Aboriginal Peoples. (1994). *The high arctic relocation: A report on the 1953-55 relocation*. Ottawa: Minister of Supply and Services.
Royal Commission on Aboriginal Peoples. (1996). *Highlights from the Report of the Royal Commission on Aboriginal Peoples*. Ottawa: Ministry of Supply and Service.
Smith, L. T. (1999). *Decolonizing methodologies: research and indigenous peoples*. London: Zed.
Statistics Canada (2003). *2001* Census: analysis series. Education in Canada: Raising the standard. Retrieved March 12, 2008, from http://www12.statcan.ca/english/census01/Products/Analytic/companion/educ/pdf/96F0030XIE2001012.pdf.
Thomason, T. C. (1999). *Psychological and vocational assessment of Native Americans*. ERIC Document ED432428. Greensboro, NC: ERIC Clearinghouse on Counseling and Student Services.
Waldram, J. B. (2004). *Revenge of the Windigo: The construction of the mind and mental health of North American Aboriginal peoples*. Toronto: University of Toronto Press.
Wavey, R. (1993) International workshop on indigenous knowledge and community based resource management: Keynote address. In J. Inglis (Ed.), *Traditional ecological knowledge: concept and cases* (pp. 11–16). Ottawa: International Development Research council and Canadian Museum of Nature, International Program on TEK.
Wenzel, G. W. (1999). Traditional ecological knowledge and Inuit reflections on TEK research and ethics. *Arctic, 42*, 113–124.

Chapter 20
Critical Pedagogy of Place: A Framework for Understanding Relationships Between People in (Contested) Shared Places

Sonya N. Martin

In Pauline Chinn and David Hana'ike's chapter exploring the role of place, culture, and situated learning on teacher agency in science, Pauline and David employ Cultural Historical Activity Theory (CHAT) and Actor Network Theories to examine David's lived experiences as a middle-school science teacher in Hawaii. Through ethno- and biographic narratives, Pauline and David offer a "genealogical" examination of David's early experiences as a learner, focusing on the ways in which his identity as a Hawaiian native has shaped his growth and development as a science teacher. Specifically, Pauline and David emphasize the intentionality of David's establishment of activity networks with individuals within schools and the local community as being connected to his identity. They provide examples of how these activity/social networks have supported his development of a teaching practice that has enabled him to successfully connect school learning to place, culture, and science for students who, like David, identify as Hawaiian natives.

Presenting the auto/ethnographic descriptions of their histories *as* and *with* individuals in this community, Pauline and David offer the reader not only names of people, but also trace their connections with others in the context of specific places on the islands. This reminded me of David Gruenewald's (2003a) paper, "The Best of Both Worlds: A Critical Pedagogy of Place," in which Gruenewald explored the connection between lived experience and place by quoting Paulo Freire:

> People as beings "in a situation," find themselves in temporal-spatial conditions which mark them and which they also mark. They will tend to reflect on their own "situationality" to the extent that they are challenged by it to act upon it. (Freire 1970/1995, p. 90, as quoted in Gruenewald 2003a p. 4)

In this quote, Gruenewald explores the significance of people reflecting on their "situationality," including recognizing that "being in a situation has spatial, geographical, contextual dimensions" (2003a, p. 4). This concept was especially interesting to me as I considered Pauline and David's use of genealogy as a lens for examining the socio/cultural/historical context of lived experience within a given

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_20,

space/place over time. This genealogical approach for thinking and writing about the history of individuals in communities underscores Gruenewald's theorization of a critical pedagogy of place. Angela Calabrese Barton (Aikenhead et al. 2006) elaborates and calls attention to the importance of place in "how we understand ourselves and each other as members of a larger community, and how we situate our practice of science and science teaching" (p. 403). Employing parts of Gruenewald's framework and Barton's critique of critical pedagogy of place in my analysis of Pauline and David's research, I maintain there is not only a need for individuals, such as David, to be able to recognize and evaluate their own situations within communities, but to also expand the scope of their analyses to include an examination of the greater connection between different people and the ecological contexts in which all communities are rooted.

To better understand Hawaiian peoples' relationships with place, we must consider both the genealogical connections people have to places that are ancestral (such as native Hawaiians) and generational (such as the settlers to the islands). To do so from a critical place-based education perspective, we must focus on the historical record of the land and its peoples. In upcoming sections, I expand on Pauline and David's research using Gruenewald's (2003a, b) articulation of a critical pedagogy of place as an analytic framework for considering the spatial–temporal–socio–historical–cultural contexts of place, especially contested spaces, like Hawaii which are shared by indigenous people and newcomer settlers. Specifically, I seek to extend the analysis begun by Pauline and David and move away from the singular perspective of one person in this place to consider the situationality of larger groups of people who share the land and resources (and educational system) by offering the reader additional context about the peoples of Hawaii.

The Colonization of Hawaii

Hawaii has often been cited as a proud American example of a harmonious societal blending of peoples and cultures. However, in the last two decades more researchers, including Pauline and David, have begun to explore the negative effects colonization has had on both the indigenous Hawaiian population, as well as the ecological health of the islands. In his book, *Race and Ethnicity in Hawai'i*, Jonathan Okamura (2008) contends that ethnicity is the dominant organizing principle of social relations in present-day Hawaiian society, and he argues that the educational system provides a means for subordinating some ethnic groups in relation to others. Drawing from state and US Census statistics (American Community Survey 2008), the following represent the current demographics of Hawaiians by ethnicity: White (27%) Japanese/Okinawan (25%), Filipinos (23%), Native Hawaiian (20%) Chinese (15%), and Korean (5%).[1] These numbers demonstrate that Asian "settlers" make up

[1]Note data reflects Census data identifying people as multiracial/multiethnic, so the sum totals to more than 100%.

more than half of the population of Hawaii. For this reason, I focus on the events that have made large-scale Asian settlement possible in Hawaii by briefly outlining the history of colonization of Hawaii within the last 150 years.

Using excerpts from *Strangers from a different shore* by Ronald Takaki (1989), as well as Candace Fujikane's (2008) essay, *Asian settler colonialism in the US colony of Hawai'i,* I present in this section Asian settlement in Hawaii as being inextricably linked to American colonial efforts to secure a cheap, expendable labor base for the growing Hawaiian sugarcane plantation economy of the 1850s. Both Takaki and Fujikane describe this period as a time when the indigenous Hawaiian population began to decline due to disease brought by White settlers, with 1852 marking the arrival of the first major group of male Chinese contract laborers. By 1882, Chinese plantation laborers constituted nearly a quarter of the total population in Hawaii. Anti-Chinese sentiment grew across the USA at this time, eventually resulting in the 1882 legislation of the Chinese Exclusion Act, forcing plantation owners to seek cheap labor from new sources when the 1898 annexation of Hawaii by the USA barred further immigration.

Takaki (1989) and Fujikane (2008) note that the first Japanese government-sponsored laborers arrived in Hawaii in 1885 as part of Japan's "peaceful expansion policy" which supported emigration of citizens to other countries. By 1900, the Japanese settler population was second only to the Chinese. On the verge of bankruptcy and reeling from a nationwide famine, the Korean government briefly supported labor emigration to Hawaii and Mexico in 1903, but by 1905, the Korean government halted the policy due to reports of worker mistreatment (Ch'oe 2006). After winning the Russo-Japanese and Sino-Japanese wars of 1904–1905, Korea became a forced protectorate of Japan, halting any further emigration and beginning 40 years of Japanese occupation of Korea (Takaki 1989). Responding to protests by Japanese laborers who sought to improve working conditions, plantation owners sought new, cheap labor from the Philippines in 1906. The Philippines was acquired from Spain after the Spanish-American war of 1898 (along with Guam and Puerto Rico) and, subsequently, large numbers of Filipino laborers began being shipped from one American colony to another to work the expanding sugar plantations. By the 1930s, Filipinos had replaced the Japanese as the largest ethnic labor group on the plantations (Saranillio 2006).

Following the US termination of the contract-labor system in 1900, whereby it became illegal to require the completion of 3–5 years of labor before workers could return to their home country or take employment elsewhere, many plantation laborers found they had no power to fight unfair employment practices other than going on strike. Takaki (1989) reports plantation owners purposefully developed an ethnically diverse workforce to repress unions and break ethnic labor strikes. For example, owners capitalized on the animosity of the Japanese by Koreans (whose homeland was forcibly occupied) by mobilizing Koreans to different plantations to work as strikebreakers when Japanese laborers organized to strike. Described as a significant precursor to the large-scale organization of pan-Asians that emerged in the late 1960s, the unification of interethnic labor groups in the 1920s continued throughout the 1940s. Laborers began to leverage greater power with the plantation owners, with some Asian groups eventually emerging as economic and political powers in present-day Hawaii (Espiritu 1992).

This historical narrative of the US-settler colonialism of Hawaii provides a global context for understanding the early exodus of Asian laborers from their ancestral homelands, making it clear that Asian settlers have a long and rich history in Hawaii. It is also clear that the experiences of these settlers are not only different from those of the indigenous peoples whose land their labor has helped to colonize, but also that their experiences differ significantly from one ethnic group to the next. Drawing from Freire's earlier quote, "being in this situation" has marked these settlers in many ways, for example, by altering their languages, sociocultural practices, and even their diet/health. In addition, the racial/ethnic makeup of early Asian settlers has been marked by change over time as many of the early male laborers married native Hawaiian women, as well as women laborers of other races/ethnicities who have since given birth to three, four, and five generations of Hawaiians over the last 150 years. That about 21% of Hawaii's population identified themselves as multiracial on the 2000 Census, a figure nearly nine times greater than reported in the rest of the USA (Okamura 2008), is indicative of the complex, social and cultural diversity that exists in Hawaii today, much of it a result of Asian settlers.

In addition to being marked by the situation of emigrating to this land, these settlers also "marked the land" on which they toiled, first by clearing forests to grow sugarcane, and later by building roads, airports, and hotels that have marked the islands of Hawaii as a popular vacation place. Seen as "progress" from a colonial lens, for the indigenous people of Hawaii, these developments have not only resulted in a degradation of their homeland but also contributed to a physical/legal loss of access to ancestral sites of great spiritual significance. In addition, they too have suffered a loss of language, cultural practices, and sense of continuity of a way of life as a result of the annexation of their lands and the colonization and destruction of the social fabric of their society. In the upcoming sections, I provide a wider context for examining the current-day occupation of Hawaii by both the descendents of the plantation owners and laborers, and the native peoples who are indigenous to the islands.

Asian Settlers and Hawaii as a Shared (Contested) Place

Traditionally, settler historiography has tended to conceal the roles different people have played (and continue to play) in the oppression of the colonized inhabitants of a land, such as Native Americans on the US continental mainland, Aborigines of Australia, and the indigenous peoples of Hawaii. Writing from the context of Hawaiian scholarship on US colonialism, Fujikane (2008) asserts that settlers to Hawaii cannot "insert themselves into a genealogy of the land," no matter how long the history of their oppression in Hawaii. Acknowledging that Native Hawaiians are genealogically connected to the land, with the islands serving as a literal ancestor to their peoples, Fujikane (2008) says of Asians in Hawaii that they

> may not be able to identify with the Asian homelands many of them have never seen, but it does not change their condition in Hawai'i: in this colonized location, they are settlers in another's homeland. (p. 21)

Fujikane contends that by celebrating and claiming their role in the "building" of the settler colony of Hawaii as laborers on the plantations, industries, road systems, and shopping centers, Asian settlers seek to legitimate their claim to Hawaii as *their* place and, in doing so, become complicit in erasing the history of Native Hawaiians and their claim to the same lands (2008, p. 4). This argument suggests a need for educators to recognize that social spaces and places are products of culture, meaning that the geographical relationship between people and place must become a focus of critical social analysis. Gruenewald suggests that the pedagogical potential of place-based education becomes apparent for participants only when they become conscious of their role in the "sociopolitical process of place making" (2003b, p. 627). This is especially critical in educational systems where power and resources are not shared equally.

In her analysis of data collected in 2005 by the Hawaii Department of Education, Fujikane noted that 13,207 public school teachers characterized themselves as Japanese (34%), White (27%), Hawaiian (10%), Filipino (6%), Chinese (5%), Korean (1%), and Mixed/Other (17%). Citing an inequitable representation of Asian and White settlers in positions of power as legislators and administrators, Fujikane (2008) and Okamura (2008) raise questions about the role of political leaders and teachers collectively shaping the ways in which the histories and contributions of different ethnic groups are presented and interpreted in Hawaiian public schools where 87% of all native Hawaiian children are educated (Kekahio 2007). The majority of native Hawaiian children attend schools that are "failing" to educate them as measured on federally mandated math and English assessments. Currently, 16.6% of public schools in Hawaii serve predominantly native Hawaiian populations, and yet only 23.4% made adequate yearly progress (AYP) as determined by the No Child Left Behind regulations. Additionally, more than half of these schools have not met AYP for 5 consecutive years and risk being restructured through state takeovers. These statistics do raise some questions about the state of education for native Hawaiian children who, unlike the children in David's school, are unlikely to be taught by Native Hawaiian teachers.

By employing native Hawaiian language, cultural practices, such as the hula halau, and drawing on the natural history of the islands in his science teaching, David offers a truly transformative learning environment for the native Hawaiian students that he teaches. This commitment to engage students in culturally relevant curricula experiences set David and the private Kamehameha School system[2] in

[2]The Kamehameha School is a private school with three campuses that have a special preference admission policy to admit only students who can prove Hawaiian ancestry.

which he teaches apart from the mainstream public schools. However, since the majority of native Hawaiian students are taught by non-Hawaiian teachers in mainstream schools (Chinn 2006), it is critical that teachers who do not share the same genealogical connections to the land and community as David be educated to reflect on their situationality and, as Freire suggested, be "challenged to act upon it" (as quoted in Gruenewald 2003a, p. 4). Thus, the implications of Pauline and David's research suggests a critical need for more teachers like David, who attempt to counter the marginalization and devaluation of indigenous knowledge by the mainstream educational system, especially in the public school system.

The history of the colonization and subjugation of Hawaii's indigenous population in relation to the current position of power that settlers hold in the educational institutions in the state of Hawaii raises some questions about the role of education in the production of social space and the reproduction of power relationships in this setting. Gruenewald (2003a) asserts that a critical pedagogy perspective of place demands that the history of the peoples within a shared space be fully explored, as "diverse social experiences produce diverse and sometimes divergent perspectives toward cultural and ecological politics" and that for these reasons, "social and ecological problems are often perceived and prioritized differently by different groups" (p. 6). Differences in priorities and perspectives are reflected in public policy, curricula choices, funding for schools, and even teacher education initiatives.

By highlighting the positive influence David's teaching practice had on his Native students' learning, Pauline and David make clear the challenges faced by the majority of Hawaiian native students who are educated as "other peoples' children." Clearly, their research underscores the need to expand representation of native Hawaiians in the education system in Hawaii. However, the absence of any discussion of the greater historical/cultural/social context or situationality of "people as beings in this place" limits the potential of Pauline and David's work to be transformative for not only those students and teachers who are not native Hawaiians, but also those who are. By engaging communities in place-conscious education, where teachers and students study the relationship between people and place over time, Greenwood[3] believes educators can "challenge learners to consider where they are, how they got there, and to examine the tensions between different cultural groups' inhabitation [of a shared place] over time" (p. 2009, p. 4). By choosing to focus on the history of one individual person's relationship to a place and community, Pauline and David neglect to discuss David's relationship with the diverse groups of people who (unequally) share the same lands and communities in which he and his students live and attend school. Without an examination of the events that have brought non-indigenous peoples to the islands, resulting in not only the destruction of the land, but also the devaluation of cultural practices of the native Hawaiians, it is difficult to understand the significance of Pauline and David's work.

[3]Please note this author has changed his name from Gruenewald to Greenwood. When citing his work in this chapter, I will reference the name that is consistent with the publication.

Thus, I argue the need for teacher education programs to actively prepare teachers to critically consider their own situationality within the context of school and schooling, especially in shared/contested places, like Hawaii. In doing so, educators gain the opportunity and tools with which to question the ideologies and politics that work to produce and reproduce power relationships within spaces/places that benefit some individuals and groups of people over others.

In the next section, I extend this argument from the context of the diverse educational system of Hawaii to the changing landscapes of American schools where new waves of immigration make necessary the need for educators, especially in urban and rural settings, to consider science curricula that promote an understanding of the socio-ecological relationships between people and place in contested places. Specifically, I conclude this chapter with a discussion of Greenwood's belief that critical place-based (science) education can and should empower individuals in communities to engage in explicit decolonization and shared reinhabitation of places and spaces by attending to the spatial–temporal–socio–historical–cultural contexts of people *being in places* together.

The Role of (Science) Education in the *Decolonization and Reinhabitation* of Shared Places

In the context of my research as an urban science educator, I see some parallels in the challenges the different communities of Hawaii face as they seek to come to terms with the ways in which the identity of individuals and groups within this shared space have been impacted by the history of Hawaii's colonization. Through my work in urban schools, I encounter individuals like David and his students who are struggling to come to terms with the changes that are taking place in our community. Like many large urban centers, Philadelphia has a fast growing immigrant population, many of whom are emigrating from countries with long histories of imperial colonization by other, more powerful nation-states. Many of these newcomers are English language learners whose children represent the fastest growing segment of students in US public schools in rural and urban communities. The majority (83%) of the teachers in US public schools are White and middle class (NCES 2007), suggesting they are unlikely to share the same race, language, socioeconomic status, culture, or even religion with their students. These families are settling into neighborhoods, just as Asians have settled on the islands of Hawaii. These neighborhoods consist of both physical places and social spaces, which have been constructed over time by those who have inhabited the land for generations. In doing so, people have filled these places with ideologies which give shape to the cultural identities of the inhabitants of the neighborhoods, as well as the land on which they built their homes and communities. As a result, the original inhabitants of these neighborhoods and the newcomers who are settling among them are challenged by the need to share the same physical place and the social space.

The conflict around human migration resides not in the movement itself, but in the tendency, as Gruenewald (2003b) suggests, for people to fail "to consider places as products of human decisions" and in doing so, begin to "accept their existence as non-controversial and inevitable" (p. 627). He argues that "by not challenging unconscious assumptions about the cultural formations of places," we "obscure the connections between education, culture and place," and in doing so, we "release people from their responsibility as place makers" (Greenwood 2009, p.11). As in the Hawaiian public schools, teachers in Philadelphia urban schools are responsible for educating "other people's children" and they are being asked to do so without themselves having been educated about the history of the place (the land around them) or the people, including the original settlers or the newcomers. This is true because current curricula trends in US schools, and indeed, around the world, ignore the significance of place in education. Students everywhere are learning the same information regardless of the different places they inhabit, including generations of current and future K-12 educators.

By failing to educate our students/citizens about their relationship to place, we forfeit any power we have as science teachers, and as community members and leaders, to acknowledge and validate the knowledge our students bring with them from their lived experiences. In doing so, Joe Kincheloe (2006) argues, science educators implicitly deny the "notion that any science is socially constructed" (p. 155). As well, these practices negate any opportunities for teachers and students to engage in critical dialogue about the nature of science knowledge or even the purpose of science education.

In this chapter, I have advocated the need for paying attention to the personal narratives of the individual students and teachers in a classroom, a school, and community. Learning about and sharing the histories of groups of peoples who inhabit physical places and social spaces enables educators and students to challenge assumptions of cultural colonization. Such a perspective seeks not to minimize the struggles and conflicts associated with the history of human migration, but to help individuals understand their experiences within the historical context of ever-changing people and places. From this perspective, it becomes important to reconsider the purpose of education in relationship to the places and social spaces we inhabit, both as individuals and collective groups of people in shared communities.

Greenwood asserts that if educators have the goal of having students interrogate place as part of the school curricula, they should be inquiring, "what has happened in this place and what needs to be remembered, restored, or conserved?" (2009, p. 3). While many educators and policy makers insist that current pedagogical practice focusing on standardization of curricula promotes equitable learning opportunities, critical place-based science educators argue these practices limit individuals' not only from asking what has happened, but more importantly, *what could/should happen in this place* and *what role could/should I or my community play in deciding what happens in this place*? A science curriculum that promotes an understanding of the socio-ecological relationships between people and place aims to empower individuals in communities. Critical reflection on each individual's situation within a community can enable teachers and students to engage in the decolonization of school and science, followed by the collective reinhabitation of shared places and spaces.

Transformative Potential of Recognizing Difference as a Resource for Improving Teaching and Learning of Science

Pauline and David's research readily demonstrates the power of employing autoethnography and autobiography in education research. Findings from their study support this methodology as being transformative for David's science teaching practices. His critical examination of his coming to be a teacher enabled him to identify and confront the ways in which places and social spaces, shaped by socio/historical/cultural/economic forces, have informed his educational experiences over time. Presented from the perspective of the researchers, Pauline and David offer a thoughtful critique of their experiences as teachers and learners in a dynamic, complicated education system in Hawaii. However, missing from their analyses of David's classroom teaching practices and his interactions with members in the larger community are the perceptions of these same events by the students, teachers, and families who their research reportedly benefitted. There is no doubt that the work David and Pauline have done in these schools is supporting students to be successful. What is unclear is *how* and *why* these practices have been beneficial. Without providing an avenue for accessing the perspectives of all the actors in an activity system, researchers limit the potential for learning how different individuals within a community make sense of the same experiences.

A growing group of urban science educators are introducing cogenerative dialogue as a means for engaging students in conversations about sense of place and identity as related to science teaching and learning (e.g, see Martin 2009). Cogenerative dialogues are discussions involving students and teachers that become a site to foreground problems occurring in classrooms and schools, and more importantly, to collectively generate solutions (Roth and Tobin 2001). This method has been used to generate dialogue among people who differ with regard to age, gender, race, ethnicity, social class, religious beliefs, and native language (Tobin 2006). Research involving cogenerative dialogues in urban science classrooms has demonstrated that by engaging different stakeholder groups (including students, parents, other teachers, and administrators) in conversations around curriculum choices, pedagogical choices, and classroom/school policies, participants are able to create solidarity across differences associated with ethnicity, native language, social class, age, and gender. As a result, teachers and students have been supported to cogenerate a shared understanding of individual goals for learning and teaching science, enabling them to collectively transform the way school science is experienced by individuals (Martin 2006).

By employing cogenerative dialogues as a pedagogical tool, teachers, like David, could empower their students, teaching peers, and community members to challenge the colonizing power of school curricula. By engaging in a critical, collaborative discussion about what is currently being taught and learned in school science, individuals could also identify new roles for all participants that could expand opportunities for incorporating indigenous knowledge in the science classroom. Used as a methodological tool, researchers, like Pauline, can engage a wider audience of stakeholders in collective discourse around issues of difference and provide polysemic perspectives on how place-based science education can promote the reinhabitation of shared places. From a critical place-based education perspective, cogenerative dialogue offers educators a means to engage participants in dialogue and consider their situationality in an effort to transform it by asking, both as individuals and as a collective, *what should happen in this place?,* and *what role should I play in constructing this place?* When teachers and students gain critical awareness of self, in relation to both people and the environment, they can begin to “reinhabit their places, that is, pursue the kind of social action that improves the social and ecological life of the places, near and far, now and in the future” (Gruenewald 2003a, p.7). This seems a truly noble goal for science education in any place.

References

Aikenhead, G., Barton, A. C., & Chinn, P. (2006). Towards a politics of place-based science education. *Cultural Studies of Science Education, 1*, 403–416.

American Community Survey. (2008). *Selected population profiles: Race alone or in one or more combinations*. Hawai’i Department of Business, Economic Development and Tourism. Retrieved November 15, 2009, from http://hawaii.gov/dbedt/info/census/ACS2008/acs_hi_2008_pop_profiles/

Chinn, P. (2006). Preparing science teachers for culturally diverse students: Developing cultural literacy through cultural immersion, cultural translators, and communities of practice. *Cultural Studies of Science Education, 2*, 367–402.

Ch’oe, Y. (2006). *From the land of Hibiscus: Koreans in Hawai’i, 1903–1950.* Hawai’i: University of Hawai’i Press.

Espiritu, Y. L. (1992). *Asian American panethnicity: Bridging institutions and identities*. Philadelphia: Temple University Press.

Fujikane, C. (2008). Asian Settler Colonialism in the US Colony of Hawai’i. In C. Fujikane & J. Okamura (Eds.), *Asian settler colonialism: from local governance to the habits of everyday* (pp. 1–42). Hawai’i: University of Hawai’i Press.

Greenwood, D. A. (2009). Place, survivance, and White remembrance: A decolonizing challenge to rural education in mobile modernity. *Journal of Research in Rural Education, 24*(10), 1–6. Retrieved December 3, 2009, from http://jrre.psu.edu/articles/24-10.pdf

Gruenewald, D. (2003a). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*, 3–12.

Gruenewald, D. (2003b). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal, 40*, 619–654.

Kekahio, W. (2007). *Native Hawaiians in public schools: Implications of AYP status in predominantly Native Hawaiian schools*. Kamehameha Schools Research & Evaluation Division. Retrieved December 3, 2009, from http://www.ksbe.edu/spi/PDFS/Reports/K-12/ayp_200705.pdf

Kincheloe, J. L., McKinley, E., Lim, M., & Calabrese Barton, A. (2006). Forum: A conversation on “sense of place” in science learning. *Cultural Studies of Science Education, 1*, 143–160.

Martin, S. (2006). Where practice and theory intersect in the chemistry classroom: Using cogenerative dialogue to identify the critical point in science education. *Cultural Studies of Science Education, 1*, 693–720.

Martin, S. (2009). Learning to teach science. In K. Tobin & W.-M. Roth (Eds.), *World of science education: Handbook of research in North America* (pp. 567–586). Rotterdam: Sense Publishers.

National Center for Education Statistics. (2007). *The condition of education 2007* (NCES 2007-064). Washington, DC: US Government Printing Office.

Okamura, J. (2008). *Ethnicity and inequality in Hawai'i*. Philadelphia: Temple University Press.

Roth, W.-M., & Tobin, K. (2001). The implications of coteaching/cogenerative dialogue for teacher evaluation: Learning from multiple perspectives of everyday practice. *Journal of Personnel Evaluation in Education, 15*, 7–29.

Saranillio, D. I. (2006). Colonial amnesia: Rethinking Filipino "American" settler empowerment in the US colony of Hawai'i. In A. T. Tiongson Jr., E. V. Gutierrez, & R. V. Gutierrez (Eds.), *Positively no Filipinos allowed: Building communities and discourse* (pp. 124–145). Philadelphia: Temple University Press.

Takaki, R. (1989). *Strangers from a different shore: A history of Asian Americans*. Boston: Little, Brown.

Tobin, K. (2006). Aligning the cultures of teaching and learning science in urban high schools. *Cultural Studies in Science Education, 1*, 219–252.

Chapter 21
River Advocacy: Valuing Complex Systems as the Groundwork for River Relationships

Tina Williams Pagan

> The students reach a small, flowing stream that dissects a forest trail behind the school; this day is like many others as Ms. Douglas' high-school environmental science students collect water-quality data as part of a long-term, student-led stream monitoring project.
>
> Upon arriving at the stream, Steve immediately catches sight of a large crawfish moving near a rock in the streambed and shouts, "Look, can I catch it and have it for dinner?" The class laughs as each group opens their water-quality test kits. The initial excitement for collecting monthly water-quality data has subsided, and the private group conversations that once revolved around the stream morph into basketball and dating talk. When asked who wants to put on waders and collect aquatic invertebrates using nets, the group goes silent. Ms. Douglas calls on a student. Susan puts on the waders in a less-than eager fashion and does as she is told. After returning to the bank with stream leaf packs, a few students bend down and begin to sort through the debris for the presence of macroinvertebrates. After an hour, with biological and chemical data jotted on their papers, the students leave the forest and return to their classroom.

Environmental educators commonly make use of stream studies to develop their students' understanding of the interrelationships of the natural world and provide them with an authentic context for investigating problems associated with our resources. By engaging in local stream monitoring, students become familiar with riparian systems and water-quality standards that scientists and regulators use to assess the health of a water body. Although water-quality standards provide the legal backing to address impairments, *an educator's aim of collecting and analyzing numerical water-quality data reduces the complexity of a river to the degree that it limits how students relate to and understand biological systems.* If educators desire to guide students to share in responsibility for what occurs in our society, teachers should reconsider how to effectively foster a conscientiousness of nature and build connections with biological systems as part of their instruction. In this chapter, I suggest educators ought to move toward curricula reforms that delve into the complexity of living systems and focus on the underpinning question of a river's rights to accomplish their environmental education goals.

Part of the difficulty in developing students' conscientiousness of nature is trying to understand how they may possibly connect with a river. To examine the

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_21,

relationship people have with rivers, I initiated a qualitative study looking at how Georgia river advocates make meaning of their feelings and articulate their understanding of and connection with a particular river. Findings from the study provide valuable insight into the process in which advocates attain a connection with rivers and consider what it is to have regard for both self and the river. The term “river advocate” is used to describe the meaningful, transactional thought-and-action relation of an individual who, through ongoing personal and collective experiences with watersheds, develops a heightened awareness of particular rivers and views them as complex living, biological communities. Consequently, these advocates demonstrate caring thoughts and emotions originating from their relationships and appear to reflect on a realization of their own actions, that is, how they contribute or disrupt rivers, which motivate them to take further actions. I will expound on river advocates’ dialogue with a river throughout this chapter. Fittingly, environmental educators gain to benefit from an understanding of river advocacy – it informs teachers of the ongoing dialogue an advocate shares with a river, transformative effects of a human–river relationship, and the potential for shared responsibility in what occurs within society.

Taking a closer look at the growing interest in the water quality of local rivers, I will briefly explore the appeal of longer-term stream studies for school teachers and students. Often educators seek school-led water-quality studies to address curriculum standards and provide a means to teach “students the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world and identify and analyze environmental problems both natural and human-made” (College Board AP 2009, p. 4). Studies evaluating stream monitoring programs suggest they combine hands-on, inquiry-oriented activities (Krapfel 1999) with the opportunity to experience key concepts in science (Overholt and MacKenzie 2005). In some cases, the programs motivate students to examine alternative solutions for resolving water-quality impairments at a study site.

But I want to consider the implications of situating water-quality data as a fundamental objective in our school-based stream studies. Water-quality parameters provide a reasonable estimate of a water body’s condition; however, citizen monitoring regiments commonly used by educators are unable to fully capture the hydrological features, functions, and constant fluctuations making each stream unique. Asking students to define a river as numerical data and subsequently, by placing an emphasis on collecting water-quality data, educators convey to their students that legitimate river knowledge is relegated to a test, not what students come to experience. Compounded by the need for credible data, some states like Georgia do not corroborate citizen water-quality data and refuse to authorize it as accepted data unless the water samples are tested by a certified laboratory (University of Tennessee 2004). This is significant because these underlying assumptions suggest students that the value of a river lies in how it ranks within the US Environmental Protection Agency’s water-quality standards and how ultimately protecting our rivers is the responsibility of professional scientists. Prioritizing water-quality testing in schools is likely to hinder some students from developing a lasting human–river relationship and concern for a river’s rights. While it could be argued that student water-quality data that identify pollution might trouble some students and lead them to take action, educators ought to seek reform that persuades every student to take responsibility for what occurs in our society and nature.

> Seeing the mine site and then reading subsequently about the fact that it was the way the mine was operated … what I read about was there was a lot of cyanide discharge they used to extract gold out of the mine waste, and that leaked out into the river so it got contaminated for miles and miles downstream. I remember a sign saying, "Do not drink this water it is contaminated with heavy metals." That's something I remember pretty vividly. I guess that's what got me interested in pursuing the things I do." (Butch, Fig. 1)

Let me explain. As suggested by Thayer-Bacon's (2003) notions of "caring reasoning," Georgia river advocates develop a heightened awareness by paying attention to particular rivers. Consequently, these advocates demonstrate caring thoughts and emotions originating from their relationships and they appear to reflect on a realization of their own actions, that is, how they influence rivers, which motivate them to take further actions. Their different views regarding their personal and collective relationships with a river involve transactional exchanges, or pluralistic ways of engaging with a river. Although Georgia river advocates individually connect with rivers in unique and diverse ways, their commitment embodies the dualism between nature and self. They lack a clear and constant position on what their "place" in nature is – a term that characterizes the ongoing dialogue between a river advocate and a river. By achieving dialogue, a process through which advocates achieve a connection with rivers, advocates consider what it is to have regards for both self and the river. Though advocates appreciate rivers, they oscillate between whether to grant a river its "own rights" or to treat it as an object. Despite that, this oscillation dispels notions of

Fig. 1 A Georgia river advocate's relationship with a polluted river (Butch). Visual data collected as part of a *River Advocacy study*

romantic relationships with rivers which could so easily be scrutinized (Fig. 1). Struggling with how to decenter themselves, I nonetheless argue that advocates are closer to an Earth-centered view emerging out of a similar belief that rivers are living, connected, biological communities that sustain everything.

> [The river] sustains everything. It sustains the fish, the birds, the alligators, the grasses, the trees. You gotta have it, I mean you gotta have oxygen, too, but we can't see oxygen. We can see the water. (Scarlett, Fig. 2)

In the spirit of ecojustice, children should engage in society and the environment (Mueller 2009). This includes growing in their ability to reduce their impact on the environment so that "others" (people, animals, and plants) can prosper – requiring members in biological communities not to infringe on the interests and ability of even rivers to function (Shiva 2005). Taking into account how river advocates conceptualize a moral tenet of granting rights to nature (Cullinan 2008) entails the view that a river has its innate value and right to support life – a fundamental legal right which hinges on acknowledging a river is more than an owned object. This idea opposes current property rights and entitlements allowing property owners to sell, alter, or threaten the integrity of rivers as they deem desirable. Students ought to recognize rivers as a "subject" asserting that rivers are living, complex systems and deserving of rights. A moral principle can be taught, in part, by expanding how students come to learn about nature, specifically our rivers. Consequently, school science ought to position students to share some responsibility for what occurs in our society. How can we teach conscientiousness of nature? For some river advocates, it requires eliminating ideals that truncate a person's experiential knowledge of a nonhuman entity in support of exclusive token science; it allows for multiple forms of knowing and engaging with rivers. By extending their heightened awareness of

Fig. 2 A Georgia river advocate's attentiveness to the flowing water and ever-changing dynamic of a nearby estuary (Scarlett). Visual data collected as part of a *River Advocacy study*

a river and understanding of a river's complexity, advocates recognize their own actions. They realize how they contribute or disrupt rivers. For a river advocate, these thoughts that emerge from dialogue with the river commonly evoke action and, in turn, generate further emotions and desire to learn more about that river. The dialectic process between emotions and action builds and, over time, matures accountability to nature.

With the average lifespan of Alabama Water Watch school-led stream monitoring groups teetering around 2.2 years (Robinson and Deutsch 2007), it is imperative that environmental science educators seek ways to investigate problems with our natural resources and instill in youth a responsibility for what occurs in our society. As educators, can we advance a moral precept that views rivers as "others" deserving of rights? Is it possible that current school-based stream studies might bring about human–river relationships? I argue it is too simple a way to delve into the intricacy of a living system and encourage students to attend to a river's disparity. Current school policy suggests water-quality education ought to align with token science knowledge. Instead, I suggest school reform ought to foster student–river relationships and allow students to discover that rivers are complex biological systems. In this sense, reform initiatives should be designed in ways which enable students to identify and associate with attributes of the river that speak to them – acquired through recreation and relaxation, identification of contamination and immediacy, empowerment and sense of pride, and/or involvement in and actions to stop river abuses. And, in turn, educators can help students connect with rivers to identify injustices and analyze their underlying assumptions regarding river rights.

Acknowledgments Funding for this project was provided by a USDA-CSREES 406 grant cooperating with the University of Georgia. Findings will be used to inform state and regional Extension water-quality programs as well as science educators.

References

College Board AP. (2009). *Environmental science course description.* Retrieved October 20, 2009, from http://apcentral.collegeboard.com/apc/public/repository/ap-environmental-science-course-description.pdf.

Cullinan, C. (2008). If nature had rights: What would people need to give up? *Orion, 27*, 26–31.

Krapfel, P. (1999). Deepening children's participation through local ecological investigations. In G. A. Smith & D. R. Williams (Eds.), *Ecological education in action* (pp. 47–78). New York: Suny Press.

Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.

Overholt, E., & MacKenzie, A. H. (2005). Long-term stream monitoring programs in US secondary schools. *The Journal of Environmental Education, 36*, 51–56.

Robinson, L., & Deutsch, B. (2007). *Life cycle of a volunteer water monitoring program and implication for credibility.* Paper presented at the USDA-CSREES National Water Conference. Retrieved September 5, 2009, from http://www.usawaterquality.org/conferences/2007/PPTs&Posters/Meetings/Vol_mon/Robinson&Deutsch.pdf.

Shiva, V. (2005). *Earth democracy: Justice, sustainability, and peace*. Cambridge: South End Press.

Thayer-Bacon, B. (2003). *Relational (e)pistemologies*. New York: Peter Lang.

University of Tennessee. (2004). *A comparative analysis of water quality monitoring programs in the southeast: Lessons for Tennessee.* Retrieved October 20, 2009, from http://eerc.ra.utk.edu/what-new/mainbook.pdf.

Chapter 22
Bringing the Invisible to Light: Art as Places for Advocacy

Jamie Calkin

The river scene above is close to my heart. Not just because I painted it, but because it represents one of my favorite childhood memories. The first thing my dad, brother, and I would do when we got to our favorite river was to kicknet for crayfish, especially hellgrammites (larval dobsonflies) to fish with. Those positive experiences helped me to pursue river advocacy in my high-school science classroom, specifically stream testing. Later, I was able to take several graduate level courses in stream ecology. I did a lot of kicknetting in them too. So I have a lot of responses to many of the ideas discussed in Tina Pagan's chapter. In this response, however, the following ideas will be discussed: (1) my ambivalence in terms of the calls for educational reform, (2) the value of stream testing/river advocacy in public school classrooms, and (3) river advocacy, specifically in terms of the visual arts as a way of knowing.

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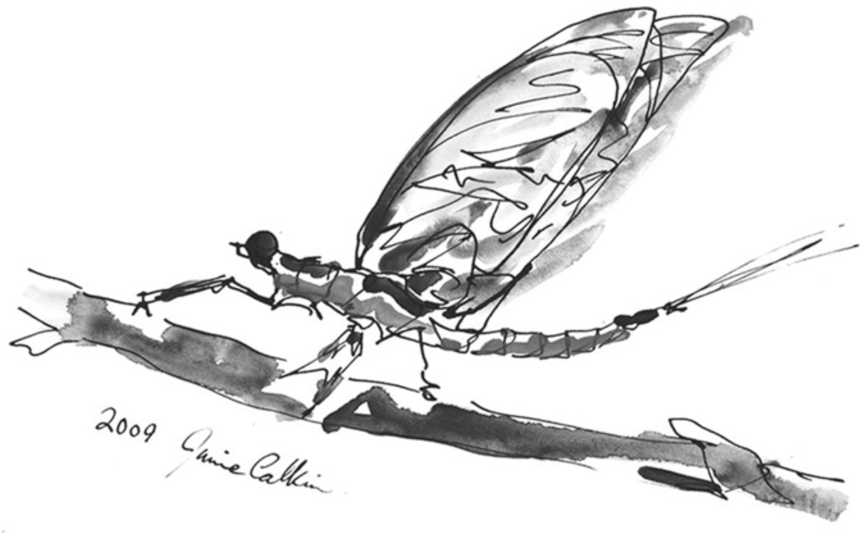
D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_22,

On the one hand, I am quite cynical and skeptical about calls for school reform centered on “knowing” rivers (nature) in more authentic ways. I just do not feel it is possible in current public school classrooms, especially when the rationale stems solely from the theory of journals (i.e., the ivory tower). Systemic change in public schools is incredibly difficult. Public schools are becoming narrower in their focus while “knowing” a river requires the opposite. Teachers do not have time to either read educational literature or apply the novel approaches such as those called for in Pagan’s chapter.

That said, stream investigations do seem like they fit many of the requirements for an environmental science or biology classroom activity – they are hands-on, local, and possible to study in K-12 contexts … and I think within this climate of testing, accountability, and so forth, the science concepts taught using stream studies make them still arguably worthwhile. However, I think it can be incredibly difficult to establish and maintain a program of river advocacy, especially if the river or stream is not on the school campus.

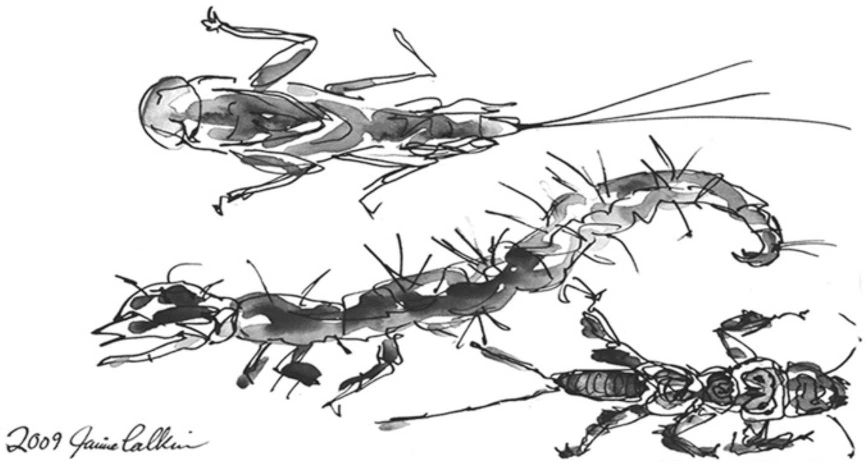
I think Tina’s notions of “knowing” rivers and streams in more ways than through narrow science content and processes is a good point for all science teachers to consider. For the most part, science concepts, especially the way in which they are taught, do not contribute to a deep understanding or appreciation of nature. That was the frustration I had as a middle-school environmental science teacher.

A more holistic approach to learning about a river ecosystem might be possible in elementary or middle schools, where the classroom teacher can have a much easier job of integrating many different subjects and collaborating with colleagues to teach in multidisciplinary ways. Still, the requirements of accountability and standardized testing make this kind of thinking only a dream for most teachers in the present school culture.



Can art offer a way to "know" a river? I think it can to some extent … especially in the lower and middle grades and with those comfortable with drawing and painting – field sketching and painting is what I think of when "studying" a stream using art. I think especially in terms of affective learning where art has the potential to "bring to light" the often ignored emotional aspects of science. I remember the places I have painted on site – and those memories tend to be very positive and often still very vivid. The following picture brings back memories of cold gusty air and loud traffic from the nearby street. I also remember how much this picture meant to the owner of that business, a local bakery. She hung it proudly and used the image on it to display her daily menus. For both of us, this sketch was more than a representation of a geographical space or means of livelihood. This drawing was a symbol of the kind of relationships we valued and had formed over time. I had an intuitive sense of how to capture the spirit of the bakery and essence of its Being, beyond the logic of language. This was enhanced by early morning conversations with the owner, and the smell of coffee brewing and fresh pastries.

Can art save the planet? I agree with Jerry Saltz (2006) "art cannot 'help protect the environment' or turn back global warming; it cannot change the world except incrementally and by osmosis. I suspect that the only disciplines that will have any chance of 'protecting the environment' will be the same ones that created the conditions in the first place: Science, politics, and philosophy" (p. 47).



Most educational literature is not easily accessible and rarely makes a real difference. However, drawings and other forms of art can go a long way to change that, providing students and community members with dynamic ways to advocate not only for rivers, but for others. The art used in this response may not change the world or protect river ecosystems. But what these sketches can do is make the text more understandable and inviting. In this sense, art becomes a site for advocacy, engaging people in thinking about their own experiences and relationships with rivers or any other aspect of the world in which they live.

Reference

Saltz, J. (2006). The political landscape. *Art Review, 2*, 47.

Chapter 23
River Advocacy as a Case of/for Novelizing Discourse in Science Education

Michiel van Eijck

Introduction

Tina Williams Pagan addresses stream studies that environmental educators commonly use to develop their students' and river advocates' understanding of the interrelationships of the natural world. She provides these individuals with an authentic context for investigating problems associated with resources. Her critique focuses on educators' aim of collecting and analyzing numerical water-quality data, which reduces the complexity of a river to the degree that it limits how students relate to and understand biological systems. She suggests that we shift toward river advocacy as an overarching aim of reform involving stream-based activities. Accordingly, curricula should be designed in ways which enable students to identify and associate with attributes of the river that speak to them and educators should help students connect with rivers to identify injustices and analyze their underlying assumptions regarding river rights.

My understanding of place-based approaches in education such as river advocacy results from research on similar topics – namely, stream and marine stewardship and conservation studies in the context of education – informed by cultural-historical perspectives (e.g., van Eijck and Roth 2007a). From this standpoint, I agree with Pagan's suggestions of curricular reform. As a form of place-based education, I think that river advocacy has the potential to link students, their life worlds, and their experiences in particular settings to formal science education. Ultimately, harvesting this potential may help students to reach an understanding of how crude scientific tools dealing with water-quality standards provide the legal backing to address impairments relevant to their own life and that of others in their community.

However, curricular reform toward river advocacy is not an easy task. Because the discourse of the natural sciences is established deeply in current science education, harvesting the potential of place-based education also weighs difficult for river advocacy. This is exemplified by Pagan, once she points out how the complexity of

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
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a river is reduced to the degree that it limits how students relate to and understand biological systems. She shows how natural scientific perspectives dominate in the discourse of place-based activities at the cost of students' engagement. Accordingly, her work follows up with recent studies in science education questioning precisely this "monologic" dominancy of the language of science (e.g., van Eijck and Roth 2009). The problem addressed in such studies is a discourse monopolized by the natural sciences, resulting in a monologue (of scientific ideas) inherent to science education with which students are not able to identify and that does not help them significantly to learn to use the tools of science for their own well-being and that of others in their local community. Indeed, there is a deep cognitive connection between language and tool use. Accordingly, learning to use the tools of science requires also the learning of language related to that tool use (Vygotsky 1986). This, in turn, requires a dialogue rather than monologue. Following this line of thought, the task is thus to bring dialogue into the discourse of science education. With this task in mind, I embrace a perspective rooted in the dialogic literary philosophy of Bakhtin. My aim is to show how Pagan's case of river advocacy calls for and provides an outlook internalizing dialogue in the discourse of science education.

In what follows, I argue that Pagan's ideas can be taken as a case of/for *novelizing* science education. This refers to a Bakhtinian struggle of *linguistic stratification* by which "folk" language becomes part of established discourses and, as a result, renews these discourses. Accordingly, I show how Pagan's work lays bare inherent instances of satire and parody required for this process. Such instances provide guidance toward a science education in which dialogue is internalized and that opens up opportunities for harvesting the potential of place-based education. Regarding the scope of this book, I conclude by showing how novelizing the discourse of science education also pertains to ecojustice and indigenous knowledge.

Novelizing

When reading Pagan's study, I was struck by the data by which she illustrates how individuals may engage in canonic place-based education centered on water-quality testing of a local river. In the vignettes, several discursive layers are present upon which activities like these unfold, each with their own specific linguistic characteristics. Particularly striking is how Pagan describes the interaction between these discursive layers since it goes straight to the heart of the dialogic perspective of Bakhtin.

Together with his colleagues Pavel N. Medvedev (Bakhtin and Medvedev 1978) and Valentin N. Vološinov (Bakhtin and Vološinov 1973), collectively known as "the Bakhtin circle," Bakhtin theorized the relationship between the everyday material and social world that we inhabit and how it comes to be reflected and refracted in literary texts. The resulting literary theory appeared to be reflective in the sense that Bakhtin's later studies on the development of new literary genres in the novel since ancient times pertain to the cultural-historical development of human languages more generally (i.e., Bakhtin 1981). Particularly useful for this response is that development can be taken as a dialogue internalized in the novel's discourse between more or less established literary genres, such as those of the natural sciences, and everyday "folk" languages, such as those of river advocates – a process Bakhtin calls *novelization*. To me, Pagan's study clearly exemplifies this process of novelization in the discourse of science education.

One prominent discursive layer observable in the vignettes is the discourse of natural sciences such as environmental science and biology. From a curricular perspective, it is the unifying discourse that ought to provide purpose and meaning to the educational activities and the scientific terms to be "used" by the advocates (although the advocates may not experience it as such). After all, *science* is significant. Without a generally accepted scientific discourse, terms such as "aquatic invertebrates" and "macroinvertebrates" would not have their common *scientific* meaning. Accordingly, pertaining to the linguistic characteristics of science education, the discourse of science brings about what Bakhtin (1981) calls a "centralizing tendency" (p. 67) from which scientific words obtain their very particular meanings.

However, creeping out of the cracks of what is linguistically kept together by the dominant literary genre of the natural sciences is another discursive layer – the one on which the language of science education unfolds in its own typical way. Characteristic of this discourse is the use of intermediary languages by which concepts share meanings from both the scientific discourse and "folk" discourse. From a scientific perspective, the use of these intermediary languages may lead to the use of words and meanings that do not exist in the discourse of science (e.g., "forms of energy," Kaper and Goedhart 2002a, b). Indeed, as every science teacher will admit, using the language of the natural sciences *as is* will not help engage students in its discourse. Thus, in the typical discourse of science education there is a *decentralizing* tendency as well – one that disrupts the dominancy of linguistic characteristics from the natural sciences.

The struggle between these two tendencies, one centralizing and another decentralizing, results in what Bakhtin (1981) calls "linguistic stratification" (p. 67). Once dominant literary genres and "folk" languages are woven together in novelized discourses, new literary genres with their own specific linguistic characteristics may emerge. Thus, internalized in the discourse of science education, there is already some kind of a dialogue between the language of the natural sciences and students' "folk" language as a result of which the language of science education develops as another discursive layer with its own literary genre. However, as Pagan's study shows, this dialogue is not yet complete and finished. Rather, there is another discursive process going on, reflecting how "folk" language struggles to become part of the established discourse of the natural sciences.

A Case of/for Novelizing the Discourse of Science Education

In the vignettes presented by Pagan, one can observe another discursive layer (deceptively) standing apart from the discourse of the natural sciences: the typical "students' basketball and dating talk." On first sight, this typical "student talk" has little to do with the kind of discourses commonly desired in science education.

Rather, it is often considered "annoying" by teachers during classroom activities. The literary genres employed in this discourse are of a completely different order than the one in the natural sciences. They express to the highest extent, students' idiosyncratic "folk" language. As a Dutchman, I experienced the idiosyncrasy of the literary genres employed in this language when I worked in an educational project in Canada. While doing an educational ethnography, I followed students in comparable place-based projects and once they engaged in this kind of talk. Whereas I had hardly any problem with understanding my colleagues at the university, I could hardly understand students' "basketball and dating talk."

Pagan highlights the emergence of typical "basketball and dating talk" to address students' decreased engagement in the stream-based activities. Once disengaged, they no longer employ literary genres of the natural sciences in their language use. Accordingly, in the stream-based activities criticized by Pagan, the literary genres of the natural sciences dominate students' "folk" language at the cost of their interest. Thus, to me, with her study, Pagan calls *for* the novelization of science education by means of river advocacy. Ultimately, in this kind of education, the established literary genres of the natural sciences employed in stream-based activities ought not to dominate students' "folk" language at the cost of their engagement.

Interestingly, Pagan's study can also be read as a case *of* the novelization of science education. However, in this case, the process is taking a completely different direction than the process of curricular reform proposed by Pagan. The opening vignette, for instance, features a student, Steve, who engages in the stream-based activities in his own typical way: "Upon arriving at the stream, Steve immediately catches sight of a large crawfish moving near a rock in the streambed and shouts, 'Look, can I catch it and have it for dinner?'" Here, Steve *satirically* engages in the stream-based activities. Catching a crawfish is certainly not the purpose of the stream-based activities. Rather, it is the opposite of those aspects of the discourse of the natural sciences that provide meaning and purpose to the water-quality measurements. Scientists have their ethic codes too, and the water-quality activities are rather related to a kind of responsibility for the river rather than harvesting its resources for dinner. Hence Steve's performance is even *ironic*.

To Bakhtin (1981), ridiculizing literary forms such as satire, travesty, irony, and parody have always been the prime literary forms along which "folk" languages struggle to get themselves heard in dominant, established literary genres: "especially among the folk, there flourished parodic and travestying forms that kept alive the memory of the ancient linguistic struggle and that were continually nourished by the ongoing process of linguistic stratification and differentiation" (p. 67).

Thus, perhaps unwittingly, the study of Pagan goes another step further in showing that river advocacy actually works in novelizing the discourse of science education. This is observable once a river advocate, Scarlett, is featured: "[The river] sustains everything. It sustains the fish, the birds, the alligators, the grasses, the trees. You gotta have it, I mean you gotta have oxygen, too, but we can't see oxygen. We can see the water." Here, an originally scientific word, "oxygen," that has a precise and particular meaning in the discourse of science, is ridiculized by the advocate.

Taken literally, Scarlett uses the word "oxygen" without violating its natural scientific meaning. But of course oxygen is invisible! We all know this since our first steps in science education. Thus, her use of the word "oxygen" is completely different from what is considered appropriate in the discourse of science. By positioning it in the way she does, "it is permeated with the parodic and ironic accents of the author" (Bakhtin 1981, p. 46). As a result, the entire expression obtains a completely new meaning – one used to question the very discourse of science education. To me, then, this vignette is particularly salient since it provides evidence that river advocacy provides an opening for the advocate to question the dominant established literary genre of the natural sciences and to internalize dialogue in this discourse. By allowing students and river advocates to contribute to novelizing the discourse of science education, river advocacy has the potential to internalize a dialogue between the natural sciences and "folk" language in place-based activities.

Towards an Internalized Dialogue in Place-Based Activities

I think Pagan's study can be read as an outstanding example of river advocacy since it lays bare the openings for science educators toward place-based activities in which dialogue is internalized in the discourse at hand. In such place-based activities, "folk" language becomes part of the discourse. This is not only a matter of teachers who invent intermediary languages to bridge the gap to "folk" language or scientific literary genres that become part of students "folk" language. Rather, such activities provide space for ridiculizing the established literary genres of the natural sciences and therewith, along a process of linguistic stratification, to invent new languages on the plane between the language of the natural sciences and individuals' "folk" language. Particularly, given the cognitive connection between language and tool use, the emergence of such new languages is required for a process of learning to use the tools of science for individuals' own well-being and that of others in the local community. Hence, I read in Pagan's study how river advocacy is harvesting the potential to open spaces for such a language-tool development and therewith to link humans, their life worlds, and their experiences in particular settings to formal science education.

To conclude, I think the message from the work of Pagan pertains to more than place-based activities only. Given the scope of this book, I think novelizing the discourse of science education is also important in regard to both ecojustice and indigenous knowledge. This relation lies in the requirement of providing space for speaking through places such as rivers by means of "folk" language. As stated in the introduction to this section of the book, place refers to the word *plateia*, a central place for feasts, celebrations, events, and meetings in ancient Greece (πλατεία, street). Hence the significance of places is in people's events and meetings that "take place" in the place. Providing space for speaking through places calls for a process in which all relevant voices to which the place matters can be heard irrespective of their language. This requirement extends place-based activities to ecojustice philosophy and education for ecojustice since this requires a fair process of speaking through places. Novelizing the discourse of science education opens up opportunities for further shaping ecojustice theory and education in place-based activities.

What is more, the notion of "folk" language refers to the language of daily, public life taking place in places. It is the daily language of the local voice – the one indigenous and deeply connected to the place that cannot be covered by the natural scientific voice of universality and eternity (van Eijck and Roth 2007b). Thus, the novelization of the discourse of science education in place-based activities opens up a space to bring in indigenous knowledge in place-based activities. According to what I have read in the work of Pagan, river advocacy has the potential to harvest this resource for learning as well.

References

Bakhtin, M. M. (1981). *The dialogic imagination*. Austin: University of Texas Press.

Bakhtin, M. M., & Medvedev, P. N. (1978). *The formal method in literary scholarship: A critical introduction to sociological poetics*. Baltimore: Johns Hopkins University Press.

Bakhtin, M. M., & Vološinov, V. N. (1973). *Marxism and the philosophy of language*. Cambridge: Harvard University Press.

Kaper, W., & Goedhart, M. (2002a). "Forms of energy," an intermediary language on the road to thermodynamics? Part I. *International Journal of Science Education, 24*, 81–96.

Kaper, W., & Goedhart, M. (2002b). "Forms of energy," an intermediary language on the road to thermodynamics? Part II. *International Journal of Science Education, 24*, 119–138.

van Eijck, M., & Roth, W.-M. (2007a). Improving science education for sustainable development. *PLoS Biology, 5*, 2763–2769.

van Eijck, M. W., & Roth, W.-M. (2007b). Keeping the local local: recalibrating the status of science and traditional ecological knowledge (TEK) in education. *Science Education, 91*, 926–947.

van Eijck, M., & Roth, W.-M. (2009). Authentic science experiences as a vehicle to change students' orientation towards science and scientific career choices: Learning from the path followed by Brad. *Cultural Studies of Science Education, 4*, 611–638.

Vygotsky, L. S. (1986). *Thought and language*. Cambridge: MIT Press.

Chapter 24
Implications of Sense of Place and Place-Based Education for Ecological Integrity and Cultural Sustainability in Diverse Places

Steven Semken and Elizabeth Brandt

Introduction

Emotional and intellectual estrangement – or even the outright eviction – of people from places personally and culturally important to them is rampant in this time of anthropic sprawl, economic globalization, and cultural homogenization. Placelessness (Relph 1976) unmoors individuals, often with detrimental effects to self-identity and well-being. Mass displacement, typically to suit the economic or political purposes of others, removes aboriginal or historically resident populations, each of which possesses a diachronic collective memory of local environmental processes and cycles, hard-won expertise in how to dwell sustainably in a place, and usually the most vested interest in preserving that place. Contested places are the loci of past, ongoing, and potential future conflicts and displacements, which threaten ecological integrity (Nabhan 1997) and cultural sustainability (Cernea 2000) around the globe.

Place-based education, explicitly situated in the learner's physical and cultural surroundings, has been invigorated as a means of "reclaiming the significance of the local in the global age" (Gruenewald and Smith 2008, p. xiii). This approach is now most often practiced by educators in stable and secure places within the mainstream of the developed world. However, place-based education whether offered formally in schools or informally through public outreach offers unique benefits for troubled communities in contested places, where ideas and opinions on the value and use of local spaces and resources diverge, conflict, and defy reconciliation. Such conflict may be catalyzed or compounded by people's misconceptions or lack of functional knowledge of the contested place, and these are exactly what place-based teaching and learning are intended to address. Refugees who have been resettled in a stable but foreign place can also be helped to bond with and live well in their temporary or permanent new home.

In the following, we begin with a summary of the nature of place and its relationship to place-based education, mediated by sense of place: a construct that synthesizes the human connections to place. We then review the evolution of place-based educational

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_24,

philosophy to show a progressively greater emphasis on how to dwell sustainably in places and thereby preserve their environmental and cultural viability. To illustrate potential applications of this philosophy to contested places, we offer examples of the human damage done by forced displacement of two indigenous groups in the southwest USA and in Malaysia, and then present the complex of issues surrounding an ongoing place-related dispute in a naturally and culturally diverse southwest US community. We conclude with a discussion of reasons why and ways that place-based education can be brought to bear on these and other disputes over richly meaningful places, in order to safeguard their ecological and cultural attributes.

Place, Sense of Place, and Place-Based Education

We live in physical landscapes comprising landforms, water, air, and ecosystems. On this substrate, we have created cultural landscapes populated by *places:* spatial localities imbued with meaning by human experience (Tuan 1977), whether in situ or vicariously. Places are social constructions. Their meanings originate from the interplay of the natural attributes of the place, and all of the humanistic and scientific ways that people can sense and understand it (Casey 1996). For example, a place may be meaningful as a ceremonial site for an indigenous people or a home to an endangered species, or for its portrayal in a famous artwork, or for a deposit of an economically valuable resource. Simply naming a place gives it meaning. Place meanings become as diverse as all those who inhabit, visit, use, learn, value, preserve, or otherwise experience the place. In many places, different meanings coincide, sometimes come into conflict as local demographics change, and are renegotiated through discourse, scholarship, media, economics, and law. Anthropologist Keith Basso (1996) wrote that

> places are as much a part of us as we are of them–yours, mine, and everyone else's–and senses of place partake complexly of both. And so, unavoidably, senses of places also partake of cultures, of shared bodies of "local knowledge" (the phrase is Clifford Geertz's) with which persons and whole communities render their places meaningful and endow them with social importance. (Basso 1996, p. xvi)

While making meaning in places, people frequently form emotional attachments to them. Such place attachments can vary in intensity from simple acknowledgment that a place exists to a willingness to make meaningful personal sacrifices in order to preserve or enhance the place (Relph 1976). The *sense of place,* as commonly characterized in the place-focused disciplines of geography, environmental psychology, and rural sociology (e.g., Brandenburg and Carroll 1995) is the combination of all meanings and attachments that an individual or community affixes to a place. Sense of place encapsulates the relationship of humans to places.

Places are dynamic; just as geologic and climatic processes modify the physical landscape, population and cultural changes alter the meanings and dimensions of a place, albeit at very different rates. Cultures and worldviews are often distinguished in part by their relationships to place: how geographically rooted they are (Orr 1992);

what roles the attributes of a place play in their lifeways, teachings, and history (Cajete 2000); how important place is to individual or group identity (Proshansky et al. 1983), and so on. Places may abide for centuries, like the pueblos of the southwest USA; metamorphose, as in the growth of the city of Phoenix, Arizona, atop Hohokam ruins; or weather away, like abandoned mining camps. Old place names may be forgotten and new ones bestowed. Place-making itself is the only constant in the cultural landscape.

But places are also part of the biological world, and humans are also attached to the living entities and lifelike processes in particular places. Biologist Edward O. Wilson argues in his *biophilia hypothesis* that humans are genetically predisposed to focus attention and bond to the other forms of life in their environments (Wilson 1984). While mainstream biology has a specific and limiting definition of what is living, some cultures view meteorological, hydrological, and geological phenomena as animate beings, life processes, persons, or consciousness; though possibly occurring at rates different from what humans can resolve. In such cultures, relationships among humans, fauna, flora, weather, and landforms may be described in kinship terms (McNeley 1987). These overlap with what may be termed a "geophilic" connection: influence of physiography on sense of place (Silko 1986).

Place-based (Elder 1998) or *place-conscious* education (Gruenewald 2003) situates teaching and learning in place by design. Ault (2008) describes it as the coherent integration of place and discipline, ranging from the use of place only as context, for example, in teaching disciplinary concepts, to wholesale reworking and melding of disciplinary cognitive agendas so that "place itself becomes the principal object of inquiry … leading to the enhancement of self and connection to community" (Ault 2008, p. 631). Place-based education, while still far from a mainstream approach, is today practiced in a considerable variety of formal and informal settings. A number of these have been richly catalogued by Sobel (2004) and Gruenewald and Smith (2008), and on the websites PromiseOfPlace.org and PEECworks.org. Further, Orr (1992) and Gruenewald (2003) have identified a number of more traditional academic subjects and curricula appropriate for place-based synthesis.

Recently, stronger connections have been made between sense of place – previously of interest mostly to geographers, environmental psychologists, architects, and planners – and theory and practice of place-based education. Working in two geographically and socioculturally distinct settings, Semken (2005) and Lim and Calabrese Barton (2006) noted that students bring their own senses of place into any learning environment or activity, and recommended that these senses of place should be acknowledged and constructively leveraged by teacher and curriculum. Semken and Butler Freeman (2008) argued that enrichment of sense of place in the course of learning is a valid and assessable learning outcome of place-based education.

In summary, places are where we sense and connect to our natural and cultural surroundings, and sense of place is a construct that usefully describes this connection. Place-based education is situated in pedagogically fruitful places and leverages the senses of place of students and teachers. It is highly relevant to environmental ethics, conservation, ecological integrity, and cultural sustainability, because all of these are also situated in places.

Evolution of Place-Based Educational Philosophy Toward Sustainability

Although the term "place-based education" was not used and may not have existed before the late 1990s (Elder 1998), the prosocial value of contextualizing learning in local physical and cultural environments has long been understood. Indigenous knowledge systems and philosophies of education have always been place-based: invested with culturally defined biophilic and geophilic place attachment, and informed by long-term observation of and reflection on natural processes and systems, phenology, animal behavior, and human history. Place-based Indigenous teachings serve to empower successive generations to thrive communally and self-sufficiently amid the climatic, hydrologic, and ecological patterns and cycles specific to their homelands (Kawagley and Barnhardt 1999).

In contrast, this philosophy appeared only sporadically, and each time briefly, throughout the early history of EuroAmerican formal education. In the first 2 decades of the nineteenth century, progressive Swiss educator Johann Heinrich Pestalozzi experimented with pedagogy we would today recognize as place-based (Hutchison 1998):

> Through lessons in map and model-making. … Pestalozzi pioneered the study of place in childhood by having his students explore [local] terrain and topography. (Hutchison 1998, p. 84)

In the USA, as compulsory public education for children was widely instituted in the middle-to-late nineteenth century, strongly influenced by a "Prussian model" of uniform, decontextualized curricula and teacher training (Cousin 1834), the educational philosopher John Dewey (1916) advocated instead for active, experiential learning situated in a child's immediate social and physical surroundings. He named history and geography (both cultural and physical), disciplines fundamentally tied to place, as the most important studies in the curriculum (Dewey 1916). Dewey argued that the prevailing curricula and practices were, even then, overspecialized and largely irrelevant to children's home and community life. Yet his perspective was not simply parochial; he viewed learning situated in place as "the natural starting point … for moving out into the unknown, not an end in itself" (Dewey 1916, p. 212). But institutionalized schooling, with its emphasis on efficiency and compliance, functioned synergistically with the political and corporate workings of an increasingly industrial and consumerist society (Callahan 1964), so Dewey's recommendations went mostly unheeded.

During the interval between the two World Wars, the idea of a "regional survey," a grassroots movement to study and teach about nature in local environments, emerged from the earlier writings and subsequent passionate advocacy of Scottish biologist and urban planner Patrick Geddes (1904, 1905). The movement flourished only briefly in the 1920s and only in Great Britain and the new Soviet Union, in part probably because the curriculum was never well-defined and the concept was mostly of interest to academicians (Meller 1994). Two decades later, American historian and critic Lewis Mumford, an adherent of Geddes, revived the concept of the regional survey in *Values for Survival* (Mumford 1946), a collection of essays strongly influenced by wartime events and the ascent of technology. Mumford believed that authentic synthesis of humanities and science was needed to provide a check on what he saw as the disproportionate social and political influence of the latter. He proffered Geddes's regional survey as

> the backbone of a drastically revised method of study, in which every aspect of the sciences and the arts is ecologically related from the bottom up, in which they connect directly and constantly in the student's experience of his region and his community. (Mumford 1946, p. 151–152)

Mumford elaborated on two attributes of the regional survey that today are typically associated with place-based education (e.g., Gruenewald 2003): that its centered but outwardly expanding focus of attention mirrors a child's, and then a student's, developmentally increasing awareness of the surroundings; and that it situates the study of nature in the context of human interactions with nature. Mumford also recognized that the student's subjective relationships with local environments and communities were integral to the regional survey, presaging the role of sense of place in place-based teaching and learning (discussed below), although he probably had no conception of the term.

It is apparent that these proponents of what is now referred to as place-based education were motivated primarily by interests in child development and socialization. This is implicit acknowledgment of the indispensable role of places in forming human perceptive abilities and identity (Casey 1996). But whereas environmental consciousness has always been at the heart of Indigenous place-based teaching and learning (Cajete 2000), it did not likewise imbue mainstream writings on place-based models of education until after the watershed times that saw publication of influential books such as *Silent Spring* (Carson 1962), *The Population Bomb* (Ehrlich 1969), *The Limits to Growth* (Meadows, Meadows, Randers and Behrens Meadows et al. 1972), and *Diet for a Small Planet* (Lappé 1975); as well as the emergence of the philosophy of bioregionalism (Berg and Dasmann 1978).

In environmental education, David Orr's *Ecological Literacy* (Orr 1992) is considered by many to be a comparably seminal work. Synthesizing quantitative data with critical reviews of philosophers and scholars from Bacon to Thoreau to Lovelock, Orr forcefully argued that contemporary models of education, fixated on classical works and afflicted by overspecialization, have abetted anthropogenic damage to environmental systems. To Orr, a universal symptom of mainstream learning, found in teachers and students alike, is "deplacement," manifested not only as ignorance of local natural and cultural history, but also as a diminished capacity to teach or learn through observation and physical interaction with surroundings. Orr described this estrangement of pedagogy from place as both unsustainable and irremediable from within the current system. His alternative is explicitly situated in place, infusing Dewey's experiential curriculum and Geddes's and Mumford's regional survey with environmental inquiry and an ethical commitment to preservation of life and habitat (Leopold 1966). Orr named two important outcomes of this approach as *ecological literacy* – intimate understanding of natural processes and limits comparable to the abilities to read and calculate – and "reeducating people in the art of living well where they are" (Orr 1992, p. 130).

Gruenewald (2003) drew deeply from humanistic and scientific works on place to characterize its pedagogical value in terms of five dimensions: perceptual, sociological, ideological, political, and ecological. Presented as a theoretical framework for place-conscious or place-based education, this analysis also abundantly demonstrates that authentically place-based teaching is as transdisciplinary as the construct of place itself (Gruenewald 2003). Here, Gruenewald also introduces the idea of "accountability to places": using measures of social, cultural, economic, climatic, and ecological health of the places where students live and learn as indicators of instructional success, instead of test scores. Similarly, Ault (2008) recontextualized "competitive equity," application of uniform standards and tests with the intent of eliminating sociocultural disparities in student success, as "reciprocal equity," in which building relationships and meeting responsibilities to place have the same desirable result.

Standardization, Globalization, and Displacement

The current emphasis in US K-12 schools on curriculum standards and program evaluation by standardized testing, while outwardly intended to foster equity and make schools accountable, is nevertheless in keeping with the century-old, decontextualized efficiency paradigm (Gruenewald 2008). This, in turn, has been cited as a contributing factor, along with consumerism (Sack 1992), immersion in entertainment media and virtual reality (Pergams and Zaradic 2006), and economic globalization (Mander and Goldsmith 1996), to placelessness (Relph 1976) and estrangement from nature (Louv 2006) among citizens of developed nations. This syndrome is empirically linked to environmental degradation, or acquiescence thereto (Vorkinn and Riese 2001), and to extinction of languages and cultures around the globe.

Globalization and conflict around the world have displaced millions of people and climate change is predicted to displace hundreds of millions more (Dasgupta et al. 2007). Recent estimates are that about two billion people are currently displaced (Cernea 1997). In 2009 alone, a record 45 million people were displaced, and more are conflict refugees. Over half of these are children. As many as 10% of the population in developed countries are immigrants, and in many places this percentage is much higher.

As people become resettled, often in distant nations and separated from their families and former communities, it is even more critical that they be enabled to build affirmative new senses of place through place-based education. Without a sense of connection to place, they are unmoored and may suffer from disorders of identity and personhood. They are not only homeless, but placeless. Cernea (2000,

p. 3664) notes: "For refugees, homelessness and; 'placelessness' are intrinsic by definition." Involuntary relocation is harmful to the displaced, who are extremely likely to suffer from posttraumatic stress disorder. Cernea (1997) cites other negative consequences of relocation.

An example of the effects that can result from displacement and relocation can be seen in a collectively traumatic event that befell the Navajo Nation late in the previous century. This is the largest indigenous nation living on the most extensive reservation in the USA, extending across the high-desert Colorado Plateau region of northern Arizona, northwestern New Mexico, and southeastern Utah. The Navajo reservation surrounds the smaller reservation of the Hopi Tribe, earlier occupants of the region who are culturally and linguistically distinct from the Navajo, but who have coexisted with them for centuries. The Navajo were also displaced in the nineteenth century and interned for some years before returning to their homes in this area. This episode is today known as "The Long Walk." In 1974, the Navajo–Hopi Land Settlement Act was established to partition jointly used lands in a buffer zone between the two reservations (Schwartz 1997). Few Hopis were displaced, but hundreds of Navajos were subjected to what has been referred to as the largest forced relocation in American history since the internment of Japanese-Americans during World War II (Schwartz 1997). "New Lands" were established for relocatees in an area with similar physiography, climate, and ecology adjacent to the existing reservation, but most Navajos did not readily acquiesce, because their culture attaches them to very specific places by burial of the umbilical cord near the homestead soon after birth.

> This attachment to place is first established during the prenatal stage of life and reaffirmed at every step on the path to full Navajo personhood is solidified shortly after birth through burial of the umbilical cord. This act anchors an individual to a particular place. This sense of anchoring, and the spiritual and historic nature of the connection to one's home, is implicitly understood in the Navajo world. (Schwartz 1997, p. 43)

Schwartz (1997) quotes Katherine Smith, a Navajo from Big Mountain, a place of particularly strong resistance to relocation:

> We are not like that [referring to the Euro-American propensity to move]. We just live on this, in these six sacred mountains all the time, all of our life. When you are in the pregnant, you are inside of your mother. You got your mother's breath, and it's the same with the Big Mountain, that way. It is my breath. See, I was born around the Big Mountain, and so that is my mother too. So all of my life, I just will always be thinking of this place. My spirit is going to be here forever. (Smith, quoted in Schwartz 1997, p. 47)

The threat of removal was traumatic to the majority of relocatees, who were concerned about loss of grazing lands for the livestock that form the basis of their livelihood, and loss of the ability to pass these lands and herds to their children (Scudder 1982). Observers noted effects such as impoverishment, depression, increased alcohol abuse, and higher rates of illness and mortality.

Swainson and McGregor (2008), in their discussion of Malaysia's removal of two indigenous Orang Asli communities for dam construction, point out that although the government provided a compensation package that was designed to improve their post-relocation living conditions, the people themselves felt that monetary compensation could not replace their loss of place, their spiritual connection of a river now inundated, their role as guardians for this river, and their identity. Differences were found between the two villages related to their place-based values, attachments, and spirituality; and the success of their relocation. The authors conclude that compensation and socioeconomic assessment of consequences may often miss the mark. Ethnographic techniques such as participant observation, in-depth unstructured and structured interviewing, and use of cognitive techniques such as free listing, can tease out information on place meanings and place attachment prior to relocation, and inform predictive assessments of adjustment after relocation. Ideally, such data should be used proactively before final decisions are made, to avert the many negative consequences of relocation. With what was learned from this study and earlier work by Scudder (1982, 2009) and others, governmental and private organizations can go beyond current policy such as that of the World Bank for relocations and resettlements.

Contested Places

Place is fundamental to both individual and sociocultural identity. It is also a set of persistent emotional ties that form part of the basis of identity; that is, place attachment, one component of the sense of place. For the most part, place attachment is molded through the oral tradition, both in literate and nonliterate traditions. However, it can also be created through social and historical memories; and explicit teaching in schools, cultural institutions such as museums, and visits to cultural and historical sites. These processes create place meanings, which also contribute to sense of place.

When different groups have different senses of place attached to the same places or areas, conflict may occur. In many cases, these concerns are relatively local, and are often ignored by development planners, whether large or small. Projects can and do displace and often impoverish millions of people throughout the world; dam-building is one of the most prevalent causes. Many of the people affected most strongly by such displacement are indigenous people. Although there is a robust literature on this problem (e.g., Scudder 1982, 2009), and in spite of scholarly consensus on causes and effects, devastating impacts continue worldwide. Places may be contested by competing rhetorics, public campaigns, advertising, political power, legal action or threat of this where appropriate laws exist, but can also escalate to sabotage, direct conflict, and even wars.

As globalization and development spread, contestation over places important to different groups for different reasons can be expected to occur. This will be an evermore important effect as the world population grows, and as different ideologies and religions expand their spheres of influence.

Contemporary Example of a Contested Place: Superior, Arizona

The physical and cultural landscapes of the region around Superior, Arizona, 80 km east of Phoenix, epitomize a diversely meaningful place: a passage between low deserts and rugged mountains used for millennia, an area occupied by indigenous peoples both prehistorically and historically, a mining district that yielded millions of dollars in silver and copper while attracting an ethnically diverse population to work the mines, and a struggling rural community whose cultural identity is challenged by the encroachment of the nation's fifth-largest metropolitan area.

At Superior, the physical landscape directly influenced and continues to influence the evolution of the cultural landscape. The town is situated at the dramatic boundary between two major physiographic provinces of the southwestern USA. The Basin and Range province is characterized by parallel serrated mountain ranges and alternating broad, flat, arid basins extending far to the west and southwest. This is Sonoran Desert country typified by saguaros, legume trees, creosote bush, and venomous reptiles. In the other direction, the land rises abruptly to Apache Leap, a precipitous cliff of volcanic rock, through the ruggedly mountainous Transition Zone, then higher still to the Mogollon Rim and its ponderosa forests, which mark the edge of the high-desert steppes of the Colorado Plateau. Such variation along a relatively narrow belt reflects a complex geological evolution over 1.8 billion years (Jenney and Reynolds 1989), including episodes that veined and infused the subsurface with deposits of silver and copper, among the deepest and richest in the western USA (Hammer and Peterson 1968). Mining was the driver for land seizures by EuroAmericans from native peoples, and stimulated the American settlement of what became the Territory, and later State, of Arizona.

After the US war with Mexico, the 1848 Treaty of Guadalupe Hidalgo, and the 1864 Gadsden Purchase, all of the region around Superior, homeland to the Yavapai and Apache people, had become part of the USA. Military actions to seize land for mining and settlement ensued. Those indigenous people who survived were placed on reservations, but even these were further reduced by federal action whenever a new mineral deposit was discovered within their boundaries. Thus, the Yavapai and Apache soon came to retain very little of their original homeland. Dispossession of indigenous peoples from their aboriginal natural and cultural environments limits or eliminates their capacity to follow traditional lifeways, in turn causing losses to food security, well-being, and the deeply place-based sense of cultural identity. Nevertheless, many native people retain ties to places no longer readily accessible to them, particularly in the southwestern USA. Even when such lands have come under government control, visits to pray, collect resources, and maintain a sense of cultural affiliation still take place.

The US military was drawn to the Superior area for its geographic advantages, and a soldier stationed here in 1870 discovered a silver lode that triggered the establishment of a permanent mining community within a decade. The silver boom did not last, but great copper deposits were also at hand, and copper was suddenly in demand for electrification projects across the nation. Smaller local operations consolidated into the Magma Mine, an important underground copper mine that operated profitably most years through booms and busts. The Magma Mine was the economic mainstay of Superior until it closed in the early 1990s, causing major economic losses and the departure of about half of the town's population.

However, an even richer copper deposit was discovered about 2,135 m (7,000 ft) beneath the surface east of Superior, a depth inaccessible to mining technologies until only recently. The global mining firms Rio Tinto and BHP Billiton formed a new company, Resolution Copper Mining (RCM), to explore the feasibility of extracting this deposit, which appears to be the richest undeveloped copper resource in North America. The proposed mine would have a life span of about 66 years, and its total economic impact on the state has been estimated to exceed US$46 billion (Pollack and Company 2008). RCM reports that since 2001, it has invested about US$290 million in exploration, feasibility studies, remediation of the former Magma Mine site, construction, and community education and outreach projects (Matthews 2009). Another US$4 billion may be needed to complete the mine (Sullivan 2009).

For many Superior residents, the proposed Resolution mine is the best hope of saving the town, but Apache and Yavapai people, still strongly attached to places throughout the area, have contested the proposal. Each tribe has former lands in the area, sacred sites, sites for resource collection, and environmental concerns. One of the significant places potentially impacted by the proposed new mine is a popular campground in Oak Flat, the headwaters basin of Queen Creek east of Superior. This place, currently under jurisdiction of the US Forest Service, would almost certainly be physically impacted by mining, and is part of a Federal-owned parcel RCM seeks to obtain by exchange for other environmentally sensitive lands that the firm has purchased. Such an exchange must be approved by the US Congress. Land exchange bills have been introduced several times without passage, and at the time of this writing, a new one (Senate Bill 409 or S. 409) is in committee.

Oak Flat has been an important camping and gathering area for Apache people for centuries, and has some significance for the origins of certain Apache clans. The area is rich with Emory's oak trees, a source of acorns that constituted an important food source for the Apache and Yavapai, and remain important for cultural purposes today. Acorn stew, always served at ceremonies, is emblematic of Apache identity. Basso (1996) has noted that Apaches use place names as icons of human events that happened in these places. They use the stories of these localized events to teach moral lessons, thus anchoring their moral system in the landscape. For these reasons, Apache people view Oak Flat as sacred and as critical for the maintenance of their traditions and culture. Apache spiritual and political leaders oppose the proposed mining project:

> Apache spiritual beings, our Gaan, exist within the three sacred sites of Oak Flat, Gaan Canyon and Apache Leap affected by S. 409. These sites become RCM property and subject to its proposed mine. Yet, to Apache, the Gaan live and breathe in those sites.

> The Gaan are the very foundation of our religion; they are our creators, our saints, our saviors, our holy spirits. (Nosie 2009, p. 6)

The leaders have also expressed concern over possible environmental damage and have questioned how many mining jobs would actually be made available to tribal members. The Oak Flat area also includes cliffs and boulders long favored by climbers and other recreationists, who have expressed opposition to the land exchange and the mine. Local chapters of national environmental organizations and local grassroots environmental groups have expressed a range of positions regarding S. 409, from strong opposition (Bahr 2009), to support with certain qualifications (Campana 2009), to approval (Shearer 2009). This is a reflection of differing views on potential damage to the Oak Flat area, and the ecological and environmental value of the parcels that RCM has offered in exchange.

The Apache Leap escarpment, located between Oak Flat and the town of Superior at its base, is not within the footprint of the mine but is also a place of dispute, because of its spectacular beauty and its many archaeological sites, which are presumed to be Apache but might also be Yavapai. Both the Apache and the Yavapai were mobile hunter-gatherers or foragers and part-time horticulturists, who established camps and moved through a seasonal round collecting wild foods, hunting, and planting limited crops. They also had centuries of peaceful trade, intermarriage, and adjacent band territories; and both were interned together on the San Carlos Apache Reservation (about 60 km east of Superior) for a generation, until the Yavapai were allowed to leave after 1905. There is a wealth of historic material on the Apache, but much less on the Yavapai. Archaeologists and anthropologists have expressed opposition to the land exchange absent additional research and mitigation efforts at Apache Leap (Society for American Archaeology 2009).

Today, the population of the town of Superior is 69% Hispanic. Many of the residents' ancestors came here in the nineteenth century, from older mining communities in Mexico, to work the Magma Mine. Their descendents are now raising the fourth generation of Superior residents and for many the self-identity as *mineros* remains as strong as ever. The Magma Mine also employed eastern Europeans, whose descendants have married into the town. There are also two large Chinese extended families, whose grocery and supply businesses have long served the community. The population of Superior was long considered particularly well educated for that of a small, rural town, and many of its citizens have served the state of Arizona in public office.

Residents of Superior are strongly attached to the town and its desert and mountain surroundings. Our ongoing ethnographic, ethnogeological, and pedagogical studies in the area have revealed that residents score very highly on quantitative measures (Semken and Butler Freeman 2008) of place attachment to and place meanings of the town and its adjoining landscapes. Even those forced by economic necessity to move to larger towns in the Phoenix metropolitan area to the west continue to express strong ties to Superior. Many who live elsewhere but claim Superior as their home make frequent visits.

Yet since the closure of the Magma Mine in the 1990s, residents are experiencing some of the consequences commonly reported in displaced people:

> land-lessness … joblessness … homelessness … marginalisation … food insecurity … increased morbidity … loss of access to common property resources; and … community disarticulation. (Cernea 2000, p. 3662)

We were repeatedly told of marriage breakups, unemployment, lack of food security, depression, hopelessness, increased rates of substance abuse, increased crime, loss of land and homes, and impoverishment after the final closure of the Magma Mine. Superior not only lost most of its population and economic base with the loss of the mine; it also lost most of its cultural resources: shops, community organizations, and events. Older residents still mourn the loss of this multicultural vibrancy, but remain fiercely loyal to the town and hopeful for its future. Some community organizations, such as a chamber of commerce, art league, museum, and Ballet Folklorico, still remain; and Superior still celebrates many traditional events with parades, dinners, and dances. In the last 2 years, several new businesses have opened in its downtown, signifying optimism for the survival of the town.

The leaders of Superior have decided that they never again want to be dependent upon a single economic engine, and have begun to explore the possibilities of an artist community and ecotourism, both of which have taken root in and helped to sustain former mining towns in other parts of Arizona and the southwest USA. RCM has expressed its support for a more diverse and sustainable economy and has funded some educational and community-development initiatives, including a planned historic trail that would link Superior to a nearby state park and a well-used cross-state hiking trail. Still, a recent poll (Merrill 2007) indicated that most residents of Superior and neighboring towns strongly endorse development of the Resolution mine as the surest route to renewed prosperity.

Many Superior residents have expressed opinions that Apache and Yavapai opposition to the mine project is illegitimate, because the land in question is not part of their federally designated reservation. Forcibly removed to more distant parts of Arizona in the nineteenth century, the original inhabitants of the Superior area are now viewed as outsiders by many residents whose own families arrived much later, but who have resided here continuously ever since: "We don't tell them [the Apache] what to do. Why do they come here and try to tell us what to do?".

It is interesting to note that a majority of the local participants in this dispute come from underrepresented minority groups that have experienced displacement and relocation at some point in their histories. Nevertheless, a common misconception of many non-Natives is that because the Yavapai and Apache no longer occupy Oak Flat, and because their continued visits for ceremonial or family purposes are not readily apparent to townspeople, that the Native Americans had no concern for the place until RCM showed interest in it; whereupon they saw an economic or political advantage in opposing the mine project.

Misconceptions also exist on the other side of the dispute; for example, reasonable questions about the impact that an underground block-caving copper mine would have on the present land surface become amplified into geologically unsupported assertions that all of Apache Leap could tumble into a yawning pit.

Discussion: Implications of Sense of Place and Place-Based Education for Superior and Other Contested Places

The area encompassing Superior, Apache Leap, Oak Flat, and the surrounding high country and low desert has been a richly endowed, naturally and culturally meaningful place through several millennia of human habitation. It is presently a center of conflict over deeply held place-based values and beliefs, variously held by people who perceive themselves as having equally strong attachments to the place. Hence, the dispute over this and similarly contested places can be seen as a conflict among different and seemingly irreconcilable senses of place. In a time when such contests are increasingly likely to be settled by legal decisions rather than by superior force, place-based education can help each of the different and opposing groups to understand the stakes that each has in the dispute. Few non-Natives understand the bonds to ancestral homelands that traditional Apaches and Yavapais maintain, and few can comprehend why they may hold its spiritual value above its economic value. Few visiting naturalists and rock climbers may accept that a fourth-generation miner in Superior could love the local environment just as much, if not more, than they do. Someone with no geologic or economic background might wonder why RCM would want to mine copper beneath Oak Flat, rather than some other place out in the open desert. Young Superiorites or San Carlos Apaches might wonder what will happen to their families and communities when the mine ceases operations 6 or 7 decades hence.

These kinds of meanings and attachments, if preserved and passed on in their entirety, will help all of the stakeholders in the Superior area, present and future, to politically and legally advocate for its continued ecological integrity and cultural sustainability. This could mean action pivotal to a Congressional decision on the land exchange, but it could also mean long-term, objective, community-based monitoring of the environmental and social impacts of the mine, if it is built on schedule, or an alternative economic development plan, if it is not.

What is most critical is that these dynamically changing places are always cared for in a sustainable way; that schoolchildren who may someday work in such a mine receive an authentically place-based education that enables them to explore the local biosphere, reveals the geological processes that created the copper deposits, portrays the full human history and lifeways of the area, and imparts a balanced understanding of all stances on the issue. Such things are not typically taught in local schools or regional colleges, nor explained in depth by local museums and media outlets, nor distributed on flyers or through digital social networks … but they could be. Place-based teaching and learning can endow succeeding generations not only with the knowledge needed to look after local places, but with love and attachment that will motivate them to do so.

At the same time, locally situated studies and action research needed to inform and periodically refresh an authentically place-based curriculum may reveal constraints on sustainability known only to populations with long histories of residence. Place-based education is a mutually beneficial transaction among people and place if it enhances the senses of place and local knowledge of students and teachers, while also fostering care for places that promotes their ecological integrity and cultural sustainability.

Acknowledgments Ethnographic research conducted by the authors in the Superior area and described in this chapter was part of a project (Sense of Place and Sustainability in Cultural Landscapes) supported by a grant from the Institute for Humanities Research at Arizona State University. The authors also gratefully acknowledge the work of Deborah Williams and Christopher Boone of SHESC and the cooperation of the many Superior-area residents, expatriates, and visitors who have participated in the study.

References

Ault, C. R. (2008). Achieving *querencia*: Integrating a sense of place with disciplined thinking. *Curriculum Inquiry, 38*, 605–637.

Bahr. S. (2009). *Written statement of Sandy Bahr, Sierra Club, Grand Canyon (Arizona) Chapter, before the U.S. Senate Energy and Natural Resources Committee, Subcommittee on Public Lands and Forests, regarding S. 409.* Retrieved July 1, 2009, from http://www.azminingreform.org/Testimony_on_S_409_Final1June09.pdf.

Basso, K. H. (1996). *Wisdom sits in places: Landscape and language among the western Apache*. Albuquerque: University of New Mexico Press.

Berg, P., & Dasmann, R. (1978). Reinhabiting California. In P. Berg (Ed.), *Reinhabiting a separate country: A bioregional anthology of northern California* (pp. 217–220). San Francisco: Planet Drum.

Brandenburg, A. M., & Carroll, M. S. (1995). Your place or mine?: The effect of place creation on environmental values and landscape meanings. *Society and Natural Resources, 8*, 381–398.

Cajete, G. (2000). *Native science: Natural laws of independence*. Santa Fé: Clear Light Publishers.

Callahan, R. E. (1964). *Education and the cult of efficiency: A study of the social forces that have shaped the administration of the public schools*. Chicago: University of Chicago Press.

Campana, S. K. (2009). *Letter from S. K. Campana, Executive Director, Audubon Arizona, to Senator Jeff Bingaman, U.S. Senate Energy and Natural Resources Committee, regarding S. 409.* Retrieved July 1, 2009, from http://www.azminingreform.org/Audubon%20AZ%20Southeast%20Land%20Exchange%20061709.pdf.

Carson, R. (1962). *Silent spring*. Greenwich: Fawcett.

Casey, E. S. (1996). How to get from space to place in a fairly short stretch of time: Phenomenological prolegomena. In S. Feld & K. H. Basso (Eds.), *Senses of place* (pp. 13–52). Santa Fé: School of American Research Press.

Cernea, M. (1997). The risks and reconstruction model for resettling displaced populations. *World Development, 25*, 1569–1587.

Cernea, M. (2000). Risks, safeguards and reconstruction: A model for population displacement and resettlement. *Economic and Political Weekly, 35*, 3659–3678.

Cousin, V. (1834). *Report on the state of public instruction in Prussia*. London: Richard Taylor.

Dasgupta, S., Laplante, B., Meisner, C., & Yan, J. (2007). *The impact of sea level rise on developing countries: A comparative analysis: World Bank Policy Research Working Paper WPS4136.* Retrieved August 1, 2009, from the World Bank website, http://econ.worldbank.org.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: Macmillan.

Ehrlich, P. R. (1969). *The population bomb*. San Francisco: Sierra Club.

Elder, J. (1998). *Stories in the land: A place-based environmental education anthology*. Great Barrington: The Orion Society.

Geddes, P. (1904). Civics: As applied sociology. *Sociological Papers, 1*, 101–118.

Geddes, P. (1905). Civics: As concrete and applied sociology (Part 2). *Sociological Papers, 2*, 57–111.

Gruenewald, D. A. (2003). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal, 40*, 619–654.

Gruenewald, D. A. (2008). Place-based education: Grounding culturally responsive teaching in geographical diversity. In D. Gruenewald & G. Smith (Eds.), *Place-based education in the global age: Local diversity* (pp. 137–153). New York: Lawrence Erlbaum.

Gruenewald, D. A., & Smith, G. A. (Eds.). (2008). *Place-based education in the global age: Local diversity*. New York: Lawrence Erlbaum.

Hammer, D. F., & Peterson, D. W. (1968). Geology of the Magma Mine area, Arizona. In J. Ridge (Ed.), *Ore deposits of the United States* ((pp, Vol. 2, pp. 1282–1310). New York: American Institute of Mining, Metallurgical and Petroleum Engineers, Inc.

Hutchison, D. (1998). *Growing up green: Education for ecological renewal*. New York: Teachers College Press.

Jenney, J. P., & Reynolds, S. J. (Eds.). (1989). *Geological evolution of Arizona*. Tucson: Arizona Geological Society.

Kawagley, A. O., & Barnhardt, R. (1999). Education indigenous to place: western science meets Native reality. In G. Smith & D. Williams (Eds.), *Ecological education in action: On weaving education, culture, and the environment* (pp. 117–140). Albany: State University of New York Press.

Lappé, F. M. (1975). *Diet for a small planet*. New York: Ballantine Books.

Leopold, A. (1966). *A Sand County almanac*. New York: Ballantine Books.

Lim, M., & Calabrese Barton, A. (2006). Science learning and a sense of place in a urban middle school. *Cultural Studies of Science Education, 1*, 107–142.

Louv, R. (2006). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill: Algonquin Books.

Mander, J., & Goldsmith, E. (Eds.). (1996). *The case against the global economy: And for a turn toward the local*. San Francisco: Sierra Club Books.

Matthews, R. G. (2009, April 13). Recession erodes resistance to copper mine. *The Wall Street Journal,* 1–2.

McNeley, G. (1987). Home: A family of land and people. *Diné Be'iina: A Journal of Navajo Life, 1*, 161–164.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). *The limits to growth: A report for the Club of Rome's project on the predicament for mankind*. New York: Universe Books.

Meller, H. (1994). *Patrick Geddes, social evolutionist and city planner*. London: Routledge.

Merrill, B. (2007). *2007 Community attitude survey: Arizona Copper Triangle.* Retrieved June 15, 2008, from http://www.resolutioncopper.com/res/ourcommunities/07-RCC-551_exec_summary_HR.pdf.

Mumford, L. (1946). *Values for survival: Essays, addresses, and letters on politics and education*. New York: Harcourt, Brace.

Nabhan, G. P. (1997). *Cultures of habitat. On nature, culture, and story*. Washington, DC: Counterpoint.

Nosie, W. (2009). *Testimony of Wendsler Nosie Sr., Chairman of the San Carlos Apache Tribe, before the U.S. Senate Energy and Natural Resources Committee, Subcommittee on Public Lands and Forests, regarding S. 409.* Retrieved July 1, 2009, from http://www.azminingreform.org/Wendsler%20Nosie%20Testimony%20S%20409%20final%20061509.pdf.

Orr, D. W. (1992). *Ecological literacy: Education and the transition to a postmodern world*. Albany: State University of New York Press.
Pergams, O. R. W., & Zaradic, P. A. (2006). Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, internet use, and oil prices. *Journal of Environmental Management, 80*, 387–393.
Pollack, E. D., & Company. (2008). *Economic and physical impact report, Superior, Arizona, prepared for Resolution Copper Company.* Scottsdale: Elliott D. Pollack & Company.
Proshansky, H. M., Fabian, A. K., & Kaminoff, R. (1983). Place-identity: Physical world socialization of the self. *Journal of Environmental Psychology, 3*, 57–83.
Relph, E. (1976). *Place and placelessness*. London: Pion Limited.
Sack, R. D. (1992). *Place, modernity, and the consumer's world: A relational framework for geographical analysis*. Baltimore: Johns Hopkins University Press.
Schwartz, M. (1997). Unraveling the anchor cord: Navajo relocation, 1974 to 1996. *American Anthropologist, New Series, 99*, 43–55.
Scudder, T. (1982). *No place to go: Effects of compulsory relocation on Navajos*. Philadelphia: Institute for the Study of Human Issues.
Scudder, T. (2009). Resettlement theory and the Kariba Case: An anthropology of resettlement. In A. Oliver-Smith (Ed.), *Development and dispossession: The crisis of forced displacement and resettlement* (pp. 25–47). Santa Fé: School of American Research Press.
Semken, S. (2005). Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates. *Journal of Geoscience Education, 53*, 149–157.
Semken, S., & Butler Freeman, C. (2008). Sense of place in the practice and assessment of place-based science teaching. *Science Education, 92*, 1042–1057.
Shearer, R. (2009). *Testimony of Rosemary Shearer, Executive Director, Superstition Area Land Trust, before the Senate Energy and Natural Resources Committee, Subcommittee on Public Lands and Forests, concerning S. 409.* Retrieved July 1, 2009, from http://www.resolutioncopper.com/res/mediacenter/SALT-Testimony-Senate-FPL-4.pdf.
Silko, L. M. (1986). Landscape, history, and the Pueblo imagination. *Antaeus, 57*, 82–94.
Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Great Barrington: The Orion Society.
Society for American Archaeology. (2009). *Testimony of the Society for American Archaeology before the Senate Energy and Natural Resources Committee, Subcommittee on Public Lands and Forests, regarding S. 409.* Retrieved July 1, 2009, from http://www.saa.org/Portals/0/SAA/GovernmentAffairs/SAA.TESTIMONY.pdf.
Sullivan, D. (2009, April 25). Resolution Copper may spend billions on mine. *The Arizona Daily Star.* Retrieved April 25, 2009, from http://www.azstarnet.com/sn/printDS/290241
Swainson, L., & McGregor, A. (2008). Compensating for development: Orang Asli experiences of Malaysia's Sungai Selongor dam. *Asia Pacific Viewpoint, 49*, 155–167.
Tuan, Y. F. (1977). *Space and place: The perspective of experience*. Minneapolis, MN: University of Minnesota Press.
Vorkinn, M., & Riese, H. (2001). Environmental concern in a local context: The significance of place attachment. *Environment and Behavior, 33*, 249–263.
Wilson, E. (1984). *Biophilia: The human bond with other species*. Cambridge: Harvard University Press.

Chapter 25
Responding to Place

David B. Zandvliet

Introduction

Why do we learn about environmental issues? It is in part because of a growing concern about the state of the environment, yet we are often confused by the complexities of the economic, ethical, political, and social issues related to it. Daily, references are made in the popular media to issues, such as climate change, loss of biodiversity, pollution, and continued job losses in our communities.

Still, the issues we face, as individuals and within our broader society, are so pervasive and so ingrained within our cultural ways of being that we can no longer look to science and technology alone to solve these problems. As a consequence, I believe that environmental learning should include a sustained critique on the dominant societal and industrial practices that contribute to both widespread and localized environmental problems as experienced by communities worldwide.

My reading of Semken and Brandt's work suggests to me that they share this view of environmental learning. In response to a critical view of curriculum – they assert that place-based education may be a more beneficial form of science education – particularly in contested areas/places, where they describe the many disputes over land and resource use, access, or ownership as essentially conflicts among different "senses of place." They illustrate this idea by describing two case studies of recently displaced indigenous groups, and an analysis of an ethnographic study of contested places. They assert through this work that place-based education can be a beneficial transaction among people and place – if it enhances the senses of place and local knowledge of students and teachers, and fosters a care for places that promotes their ecological integrity and cultural sustainability.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_25,

"Valuing" Place-Based Education

The notion of a place-based education has been well-described by Sobel (1993, 1996), and related ideas have been expanded on by others including critical pedagogy and rural education (Gruenewald 2003), community contexts (Hutchinson 2004), eco-literacy (Orr 1992, 1994), ecological identity (Thomashow 1996), and experiential learning (Woodhouse and Knapp 2000). The idea of place-based learning connects theories of experiential learning, contextual learning, problem-based learning, constructivism, outdoor education, indigenous education, and environmental education. In defense of what he describes as a *critical pedagogy of place*, Gruenewald (2003) writes that our educational concern for local space (or community) is overshadowed by both the discourse of accountability and by the discourse of economic competitiveness to which it is linked.

In my opinion, place becomes a critical construct to its opponents, not because it is in opposition to economic well-being but because it challenges assumptions about the dominant "progress" metaphor and its embedded neoconservative values. Past efforts at science education reform (though well-intentioned) have only served to replicate hegemonic values and norms in the curriculum while failing to correct the real problems facing society and local communities by remaining "placeless" in their approach or by developing a technocentric form of curriculum that advocates instead for a mobility-oriented and technologically skilled workforce – often at the expense of locally held community values and needs.

Semken and Brand state that *emotional and intellectual estrangement* or the outright eviction of people from places personally and culturally important to them is rampant in an era of anthropic sprawl, economic globalization, and cultural homogenization. They assert that *placelessness* can have detrimental effects to self-identity and well-being and that place-based education (explicitly situated in the learner's physical and cultural surroundings), might offer unique benefits for troubled communities. In their consideration of the educational issues, they begin with a summary of the nature of place and its relationship to place-based education, and then review the evolution of place-based educational philosophy to show a progressively greater philosophical emphasis on how to dwell sustainably.

While the philosophical issues they describe around place are important, Semken and Brandt do not situate these ideas in the context of the science education curriculum as it has been influenced by reform movements over the past decades. Valuing "place" within the context of broader curricular reforms is an important part of the story in that it describes more fully what deficiencies a place-based education is responding *to* (i.e., shortcomings of the dominant discourse in science education reform). The next section provides an overview of historical reform efforts and their importance for the "valuing" of place-based education.

"Place" in the Context of Technocentric Curriculum Reform

In my work, I adapt a framework for thinking about pressures, which often drive change in an increasingly technological world and I use this to situate my arguments for what place-based education is responding *to*. The model consists of three spheres of influence: described as the ecosphere, sociosphere, and technosphere (Gardiner 1989). The *ecosphere* relates to a person's (or group's) physical environment/surroundings, whereas *sociosphere* relates to an individual's interactions with other people within that environment. Lastly, *technosphere* is described as the total of all person-made things (present and future) in the world.

Realistic interpretations of change incorporate a balance between the contributions from each of the spheres of influence. However, for many organizations, the influence of the *technosphere* often drives dominant changes in a system. In relating curriculum reform to this model, I assert that the *technosphere* relates effectively to "teaching about the tools." A central assertion I make here is that this influence manifests itself in formal school curricula through the adoption of *technocentric* curricula. This often occurs at the expense of other mediating influences, which include the effects from local geographies (ecosphere) as well as those from local cultural and social norms (sociosphere). The next section argues that the implementations of science–technology–society (STS) curricula are salient examples of an increasingly *technocentric* view of curriculum.

Science–Technology–Society (STS) Frameworks

Worldwide calls for scientific/technological literacy are historically based on the premise that technological societies need sufficient numbers of qualified professionals who can participate fully in the modern scientific-technological endeavor and who can propagate or maintain economies. Therefore, scientific literacy became a technological goal for a "science education for all citizens" (American Association for the Advancement of Science [AAAS] 1989, 1993). Evolutions in science and technology, coupled with community-based environmental concerns and reforms in science education during the last three decades contributed to the creation of the science–technology–society (STS) perspective within science education in the USA (Bybee 1993). Such shifts were also seen in the development of distinct technology curriculum in Australia, Canada, the UK, and in many developing countries (National Research Council [NRC] 1996; Council of Ministers of Education 1997). In response to this pressure, many nations began including technical education components across the curriculum in keeping with this general trend to make education more vocationally relevant.

In consideration of the historical development of STS frameworks, there were several arguments for incorporating technology into the curriculum of a general education by combining it with science (Layton 1993). In reviewing the variety of science–technology–society (STS) courses, Layton distinguished between the following: (1) science-determined courses in which the sequence of knowledge is identical to that of traditional disciplinary science education, with the STS material added on; (2) technology-determined courses in which the science content is determined by its relation to the technology or the socio-technological issue being studied; and (3) society-determined courses in which the science and technology to be studied are determined by their relevance to the societal problem under consideration. Unfortunately, none of these options truly recognized the value of localizing these curriculum efforts in the context of place-bound communities.

Solomon (1993) summarized that the STS movement should not only aim at providing future citizens with authentic real-world issues, but intend to challenge students' engagement in science and technology by learning socioscientific issues and by participating in making informed, responsible decisions, based on scientific knowledge. For more than two decades, proponents of the STS movement advocated for the integration of science, technology, environment, and social issues in science curricula claiming that there is no such thing as "pure science" and that science education should consider the way scientific investigation is subject to social, environmental, and political considerations and contexts.

Though well-intentioned, I assert that STS problem-based approaches became overstructured in their implementation and often communicated (implicitly) that science and technology are seen as potential solutions to social or environmental problems. As a result of this inherently *technocentric* focus, STS curricula were seldom critically examined for their own underlying values and dominant (hegemonic) practices. While this outcome is not what the proponents of STS frameworks had envisioned – it is often what has translated into practice within the educational policy realm and in the viewpoints of practicing teachers who work on a daily basis with these curricula.

A more humanistic or *socially* influenced vision for science curriculum calls on students to instead communicate effectively with others in the process of decision-making *within* the context of complex social and scientific issues. Aikenhead (2005) suggests that students need to ask questions, obtain evidence, understand characteristics and limitations of science processes, identify value positions or ideologies of both sides, and have access to appropriate social criteria for judging credibility of scientists. Since values are a constant feature of decision-making, Aikenhead relates that there is much evidence that students often give higher priority to values, common sense, and personal experience than to knowledge. This is also a strong argument for the inclusion of "place" and "community" as the repository for this experience in our mainstream curriculum reform efforts.

Science, Technology, Society, Environment – STS(E) Frameworks

As discussed in the previous section, the development of science curricula that attempt to address the characteristics of more humanistic forms of science education while also addressing social interactions *within* and *among* scientific and local communities are historically based on STS ideas. However, these considerations have also been critically examined within the domain of environmental education. Environmental education in most countries is a grassroots endeavor and not mandatory or part of the core curriculum for schools. So, in response to these criticisms, a humanistic vision for an STS framework (in the USA, Canada, and elsewhere) was extended to include a variety of environmental issues. The resulting curriculum domain has been described as a science–technology–society–environment (STSE) framework.

Scientific literacy within the context of STSE, according to Hodson (1998), is not merely about knowing scientific ideas and facts or being able to participate in any form of inquiry. It is more about wanting to and being able to make decisions and perform actions in routine life by every community member. According to this perception, science education should be accessible to all, interesting, relevant and useful, nonsexist, multicultural, humanized, and value-laden.

As such, the STSE focus was an attempt at developing a more humanistic form of issues-based science education at its very inception. However, despite the intended humanistic focus of this perspective, a cursory analysis of curriculum content in one Canadian jurisdiction (Sammel and Zandvliet 2003) revealed that the implementation of STSE offered only a socio-historical perspective and that the dominant focus remained on understandings of only *positive* scientific connections rather than exploring how science has been socially constructed or how it could potentially silence a variety of voices.

By extension, the view of environment in the implementation of the STSE domain in Canada (and elsewhere) appears to be informed by the same epistemological (technological) focus as the previous STS frameworks. This is seen as conceptually different from other types of environmental learning that instead seek to embed learning in the context of community-based problem-solving or interdisciplinary learning. The next section seeks to further problematize the inclusion of environmental education within such technocentric visions of science education.

Problems with a "Scientific" Environmental Education

Problems with a purely scientific view of environmental education such as that related by the STS or STSE frameworks described in the previous section have been related by Bowers (1999), who remarked that the terms "environmental education" and "science education" were increasingly seen as interchangeable. He then problematizes this emerging relationship:

> The effect of this categorization is that the other areas of teacher education and graduate education continue to ignore the connections between the values and ideas they promote and the cultural behaviours now overwhelming the viability of natural systems. (p. 161)

While the inclusion of more technological and environmental concepts in science classes is seen by many as advancing the current reform efforts, I assert that students exposed to this model of education are asked to understand environmental and technological issues only within prescribed or predetermined limits (Sammel and Zandvliet 2003). Environmental learning of this kind is viewed as a modified "science education." Without the inclusion of an important sociocultural component, environmental learning of this kind maintains and promotes only hegemonic beliefs and values while not addressing collateral problems relating to scientific developments. Environmental learning (broadly defined) can seek to promote an understanding of scientific and environmental issues in the wider interdisciplinary context and in particular provide a model for the interpretation of curriculum in local communities. To make this happen educators must look outside the traditions of classic curriculum reform and insist on the adoption of place-based and socially relevant strategies that make scientific (and environmental) issues readily accessible to communities. McBean and Hengeveld (2000) state:

> Society in general, accumulates and processes knowledge through experience, perception and intuition. Thus new information and facts are best understood and assimilated if these are placed within the context of the existing knowledge and past experience of the individual or community. (p. 5)

To summarize, a "scientific" environmental education can be seen as another case of reactive change dominated by technical influences. To counter this influence a consideration of science and environment should begin on a personal level, assisting students in learning about their own community while aiding in their understandings of scientific ideas relevant to their own personal context. Essentially, content learning would focus on defining a notion of community and with sense-making activities within more personally defined (or value-laden) contexts. Environmental learning of this nature has been described as an interdisciplinary endeavor addressing multiple themes including complexity as well as themes such as aesthetics, social responsibility, and ethics (Ministry of Education 2007).

Socioscientific Issues-Based (SSI) Approaches

In recent years, the discourse within science education has broadened from earlier STS/STSE views of scientific and technological issues to include a discussion of how science and societies share a more complex interdependence. This academic dialogue at once acknowledges that scientific research agendas are frequently based on the perceived needs of society. However, it also acknowledges that in other instances, the pursuit and development of science helps shape and influence the development of social norms. For example, perceived social needs such as the desire to eliminate disease and improve agricultural productivity have also led scientists to develop techniques for harvesting stem cells and genetically modifying organisms. As a result, these technologies have given rise to a host of ethical quandaries as well as having presented new norms that society must now struggle with and for which there may be no solutions (Sadler and Zeidler 2005).

The inclusion of socioscientific issues in curriculum is distinguishable from earlier STS/STSE approaches as it considers the ethical and moral implications that underly scientific or environmental issues. To sum up, a socioscientific-issues (SSI) approach arises from an alternative framework that unifies the development of moral and epistemological orientations of students while also considering the role of emotions and character as key components of science education (Sadler and Zeidler 2005). Still while the weighing and debating of community held values can and should occur in science classrooms, many teachers still believe that dealing with values or moral issues should occur in social studies or in extracurricular activities, and not in science classrooms (Tal and Kedmi 2006). For example Hughes (2000), asserted that:

> Teachers fear that extensive coverage of socio-science devalues the (science) curriculum, alienates traditional science students and jeopardizes their own status as gatekeepers of scientific knowledge. (p. 426).

Despite this limitation, I believe that this developing discourse around SSI is very promising for science educators as it may leave behind the hegemonic conditions embedded within the earlier STS and STSE perspectives and provide more room for marginalized voices (such as indigenous communities) in the dialogue of how to deal with the troubling environmental issues faced by the broader society. Further, the open-ended nature of SSI problems also allows room for a broad range of interpretations: offering opportunities for localizing and interpreting curriculum related to scientific, technological, and environmental developments. In short, the SSI approach may allow for a more ecological and inclusive framework for many place-based forms of science education: one that acknowledges the importance of context and community in its consideration of real-world problems. In short, it may allow for an emerging *ecological* framework for science education.

Ecological Frameworks

As noted at the beginning of this chapter, our educational concern for local space (community in the broad sense) is sometimes overshadowed by both the discourse of accountability and by the discourse of economic competitiveness to which it is linked (Gruenewald 2003), and it is this discourse that Semken and Brandt are responding to. In short, place has become a critical construct, not because it is in opposition to economic well-being but because it challenges assumptions about the dominant "progress" metaphor and its embedded neoconservative values, which I have argued are so dominant in systemic curriculum reform efforts. An ecological framework breaks from this mold by taking as its first assumption that education is both "*about*" and "*for*" local communities.

Ecological frameworks attempt to apply the principles of Ecology-derived from the Greek *oikos* (or household) to an examination of the relationship of all living things with their environments and with one another as living and interdependent systems. In a philosophical sense, ecological notions such as community or complexity also apply to our conception of the human–world relationship and to the theory and practices of education. Ecological frameworks aim to build on a specific understanding; that humankind is an interconnected part of both the human and natural worlds. Further, to understand ecologically is to make sense of the human world as *part of*, not *apart from*, nature; it is to understand humankind's "implicatedness in life" (Orr 1994, p. 105). Understanding ecologically also has an emotional core: one's knowledge about ecological processes and principles is made meaningful due to a personal and emotional attachment to the world and its living communities.

As noted, ecological conceptions of education place an emphasis on the inescapable "embeddedness" of humans and their technologies in natural systems. Rather than seeing nature as "other," ecological education involves the practice of viewing humans as one part of the natural world, where human societies and cultures are a product of the interactions between our species and the places in which we find ourselves (Smith and Williams 1999). Such an approach also negates issues of "right" or "wrong" and allows individuals or groups to consider multiple perspectives (including diverse moral and ethical stances) on an issue or problem, thereby allowing the relevant sociocultural critiques to be placed alongside scientific considerations. Such frameworks are also congruent with the socioscientific, issues-based (SSI) approach described in the previous section.

The concept of an ecological model for science education lies also at the nexus of a science education, which emphasizes particular forms of knowledge construction conceived of and implemented outside of "authentic" communities, and grassroots "environmental learning" which instead juxtaposes this knowledge with other "place-bound" sociocultural, values-based constructs, which have been described as an environmental ethic. It is my assertion that these ecological principles can be mapped onto a more holistic model, which might allow science education to flourish in a more inclusive framework – one that allows standardized curriculum to be "interpreted" for local sociopolitical conditions. The model would also assert the notion of "place" having primacy in the interpretation of formal curriculum.

Connections to Place-Based Education

Semken and Brandt note in their work that stronger connections have recently been made between sense of place and the practice of place-based education (e.g., Semken 2005). They note that students bring their own senses of place into any learning environment or activity, and argue that these should be acknowledged and constructively leveraged by both the teacher and curriculum. The enrichment of sense of place in the course of learning science is seen as a valid and assessable learning outcome for place-based education – particularly in contested places (such as Superior – the context for one of their reported case studies). These ideas are enriched by the inclusion of ethical and moral reasoning that is beginning to emerge as espoused in the socioscientific issues-based approaches.

Semken and Brandt further relate that "place" is fundamental to both our individual and collective sociocultural identities and that it is also a set of persistent emotional ties that form part of the basis of identity; that is, *place attachment* as one component of the *sense of place*. They assert that place attachment can be molded through oral traditions; however, they also describe and analyze how it can also be created through social and historical memories; explicit teaching in schools, cultural institutions such as museums; and through purposeful visits to cultural and historical sites. They argue that these processes create place meanings, which also contribute to sense of place. I assert that these ideas relate to one's sense of belonging in a community – a key aspect of an ecological framework.

Finally, I agree with Semken and Brandt's notion that places are where we sense and connect to our natural and cultural surroundings, and that sense of place is a construct that usefully describes this connection. Place-based content and pedagogy are highly relevant to the development of environmental ethics, conservation, ecological integrity, and cultural sustainability. As such, the methods and perspectives in place-based forms of education form a necessary part of a science education that is rooted in ecological notions of science, community, and self.

Conclusion

Placing the theory and practice of place-based education within a critique of historical science education curriculum reform reveals that the inclusion of environmental topics often only considers scientific and technical information, and that teaching within a "values free" context can be problematic for science education. The alternative concept of an *ecological* framework for science education lies at the nexus between a science education emphasizing particular forms of knowledge construction conceived of and implemented outside of "authentic" communities, and grassroots "environmental learning" that juxtaposes this knowledge with other sociocultural and values-based constructs – including ethical and moral reasoning. I assert that students need to consider multiple values-based views about environmental in their science classrooms and that this should occur within the context of a localized and ecological view of communities. Such a framework would also allow students to develop valuable sociocultural skills and cognitive attributes through exposure to real-world problems. Further, these would be grounded in personal experience and in their sense of place as it relates to their localized, social and ecological environments.

The consideration of an inclusive, *ecological* framework for science education responds to the critique of mainstream curriculum by providing for issues-based and place-based pedagogies, while allowing teachers to interpret curriculum in ways that refocus learning "on" and "in" communities. Teaching within an ecological framework focuses energies on the importance of quality of *life within communities* while assisting students in the development of a *sense of place* within them. While Semken and Brandt (and others) have made arguments for place-based learning, I have attempted to take this view further by describing the need for critical and embodied approaches in their implementation. Central to this is the idea that our assumptions about teaching are best enacted when these actions are embedded deeply within the complexity and authenticity of real communities.

References

Aikenhead, G. (2005). *Science education for everyday life: Evidence based practice*. New York: Teachers College Press.

American Association for the Advancement of Science. (1989). *Science for all Americans*. Washington, DC: American Association for the Advancement of Science.

American Association for the Advancement of Science (AAAS). (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

Bowers, C. (1999). Changing the dominant cultural perspective in education. In G. Smith & D. Williams (Eds.), *Ecological education in action: On weaving education, culture and the environment*. Albany: State University of New York Press.

British Columbia Ministry of Education. (2007). *Environmental learning and experience*. Retrieved September 6, 2009, from: http://www.bced.gov.bc.ca/environment_ed/.

Bybee, R. W. (1993). *Reforming science education: Social perspectives and personal reflections*. New York: Teachers College Press.

Council of Ministers of Education, Canada. (1997). *Pan-Canadian protocol for collaboration on school curriculum*. Retrieved November 1, 2009, from http://www.cmec.ca/science/framework/

Gardiner, W. L. (1989). Forecasting, planning, and the future of the information society. In P. Goumain (Ed.), *High technology workplaces: Integrating technology, management, and design for productive work environments* (pp. 27–39). New York: Van Nostrand Reinhold.

Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher, 32*, 3–12.

Hodson, D. (1998). *Teaching and learning science: Towards a personalized approach*. Buckingham: Open University Press.

Hughes, G. (2000). Marginalization of socio-scientific material in science-technology-society science curricula: Some implication for gender inclusivity and curriculum reform. *Journal of Research in Science Teaching, 37*, 426–440.

Hutchinson, D. (2004). *A natural history of place in education*. New York: Teachers College Press.

Layton, D. (1993). *Technology's challenge to science education: Cathedral, quarry or company store*. Buckingham: Open University Press.

McBean, G. A., & Hengeveld, H. G. (2000). Communicating the science of climate change. *Canadian Journal of Environmental Education, 5*, 9–23.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Orr, D. (1992). *Ecological literacy*. Albany: State University of New York Press.

Orr, D. (1994). *Earth in mind*. Washington, DC: Island Press.

Sadler, T., & Zeidler, D. (2005). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching, 42*, 112–148.

Sammel, A., & Zandvliet, D.B. (2003). Science reform or science conform: Problematic epistemological assumptions with/in Canadian science reform efforts. Science, Mathematics and Technology Education, 3(4), 513–520.

Semken, S. (2005). Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates. *Journal of Geoscience Education, 53*, 149–157.

Smith, G. A., & Williams, D. R. (1999). *Ecological education in action: On weaving education, culture and the environment*. Albany: State University of New York Press.

Sobel, D. (1993). *Children's special places*. Tucson: Zephyr Press.

Sobel, D. (1996). *Beyond ecophobia: Reclaiming the heart in nature education*. Barrington: Orion Society.

Solomon, J. (1993). *Teaching science technology and society*. Philadelphia: Open University Press.

Tal, T., & Kedmi, Y. (2006). Teaching socioscientific issues: Classroom culture and students' performances. *Cultural Studies in Science Education*, 1, 615–644.

Thomashow, M. (1996). *Ecological identity*. Cambridge: MIT Press.

Woodhouse, J., & Knapp, C. (2000). *Place-based curriculum and instruction* (ERIC Document Reproduction Service No. EDO-RC-00-6)

Chapter 26
Envisioning Polysemicity: Generating Insights into the Complexity of Place-Based Research Within Contested Spaces

Christina A. Siry

In *Implications of Sense of Place and Place-Based Education for Ecological Integrity and Cultural Sustainability in Contested Places*, Steven Semken and Elizabeth Brandt explore the construct of place and suggest that place-based education can serve as a mutually advantageous transaction between people and place in contested areas. In this chapter, I extend the implications they have introduced and contend that a critical theoretical perspective is required in work with contested places and displaced people in order to recognize the multitude of complexities involved. Building from their work, I suggest using polyvocal and polysemic research in and around contested places as a means to acknowledge multidimensional intersubjective perspectives while also emphasizing connections to place.

Introduction

Steven Semken and Elizabeth Brandt discuss foundations of place-based education and posit that such an approach can be advantageous in contested places for supporting ecological integrity and cultural sustainability. Their review of the literature on place-based education and sense of place is thorough and clearly represents the myriad possibilities for exploring the ways in which people make meaning and form attachments to particular places. I bring my perspectives grounded in sociocultural theory to further these ideas as I explore their discussion of the contested area of Superior, Arizona, and I elaborate on the implications that they introduce, with the aim of exploring the complexity and tensions inherent in endeavors toward education in contested spaces.

I conduct science education research framed through critical perspectives, and as such I consider issues of power and seek to recognize and encourage multiple

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ways of knowing. My research is focused on dialogic encounters as ways to build solidarity within a group, and I am concerned with the role of self and other, and the ways in which we research *about*, and *with,* others. Central to my teaching and research is a commitment to embracing polysemicity through cowriting and coresearching, as I seek to support exploration of diverse lived experiences and work toward multilogicality. It is through a multiperspectival logic that incorporates pluralistic approaches to research that I envision recognition of the complexity of issues in contested places and with displaced peoples in particular.

Framing Context with Critical Complex Lenses

Semken and Brandt provide a comprehensive overview of the evolution of place-based philosophies and offer perspectives on the construct of sense of place. Through a discussion of a proposed large-scale mining project in Superior, Arizona, a "center of conflict over deeply held place-based values and beliefs," they mention that various forces in contested places can threaten both the ecological integrity and the cultural sustainability of an area. They suggest place-based education to reconcile such conflicts, and attempt to connect the literature on sense of place with work concerning displaced people. As their chapter comes to a close, they suggest "place-based education can help each of the different opposing groups to understand the stakes that each has in the dispute." It is with this closing suggestion that I begin, as I elaborate on the ideas introduced in their concluding paragraphs and suggest a deeper recognition of the complexity of considering place-based research in contested places.

Positioning the contextualized nature of research can emphasize the intricacies of contested places and situate research within the broader sociocultural, political, historical, and economic forces. This can serve to highlight the intensely personal, temporal and subjective nature of sense of place. In the example of Superior, such a contextualized emphasis can reveal the multifaceted issues and a wide variety of perspectives surrounding the mine. The unequal power relations between a multinational company, displaced indigenous peoples, and a community struggling to survive, have created a complicated situation with diverse stakeholders involved in this dispute over the development of a new large-scale copper mining project. This conflict includes a tribal coalition who have opposed the mine and proposed land exchange as it involves sacred land that is spiritually integral. Further perspectives come from the town's residents, some of whom support the mine, and others who do not. In addition, there are others who have a stake in this conflict, including rock climbers, as well as environmentalists, who claim that the new mining will threaten the ecology of the area (Access Fund 2008). Adding to the complexity of this issue are recent budget cuts of the mining company, as well as a political corruption scandal over the acquisition of land by the mining corporation (Jarman 2008). Further complicating this disputed place is the history of the forced removal of the indigenous peoples, which, as Semken and Brandt indicate, was grounded in

Arizona's long history of land seizing (often for mining purposes). My point in mentioning these stakeholders is that each brings his or her own cultural identity and individual narratives that comprise peoples' histories, and clearly this situation is fraught with economic, spiritual, political, cultural, and historical complexities.

Given that the situation is quite more complicated than a simple "for" or "against" binary relating to the mine (Thompson 2008), a different way of framing this conflict moves beyond the dichotomies presented by positioning the argument around the interests of the Apache versus the group of townspeople that are pro-mine. Rather, it is more fruitful to consider the complexities of place and contested areas by incorporating what Joe Kincheloe and Kenneth Tobin have referred to as "the power of contextualization" (2006, p. 9), to highlight the personal and contextualized nature of a given situation. A critical epistemology of complexity (Kincheloe 2001) can serve to situate the unfolding struggles in Superior within the broader sociocultural, political, and historical context and provide a lens with which to connect back to the possibilities in place-based education. Such a critical complex lens on this work can illuminate the oppressions in the communities so that they can be addressed and confronted, without necessarily pitting the indigenous peoples as existing in de facto opposition to the more recent residents. As the focus is shifted we are able to look at both the details of positions of these populations as well as the broader practices that reproduce inequities.

Ironically a multinational corporation and the US Congress have the potential to dictate the fate of this land, which has huge implications of both cultural sustainability and ecological integrity of the area. The globalization of industry, labor, and capital is evident in transnational corporations like Resolution Copper Mining, a division of Rio Tinto, which is a British/Australian mining company based in London. In the context of a geo-global economy, there is little expectation of a vested sense of commitment toward environmental justice and to a community.

Working Toward Sustainability and Community Survival

The complexity of this particular contested space is highlighted for me in reading the points that the authors have made about the possibilities for cultural sustainability and ecological integrity presented by the rejecting of the mine and the resulting land swap. This contrasts starkly with the support of the mine by community residents. Cultural sustainability and ecological integrity are intertwined and cannot be easily separated. In this particular situation in Superior, there is a dispute over a deeply meaningful place, which emphasizes the importance in contested areas to try to find a way to work with the other toward socially and environmentally just outcomes. In discussing the environmental justice movement, Robert Bullard explained:

> The environment is everything: where we live, work, play, go to school, as well as the physical and natural world. And so we can't separate the physical environment from the cultural environment. We have to talk about making sure that justice is integrated throughout all the stuff that we do. (Schweizer 1999)

To that end, there is a need for a research paradigm to try to come together across difference. In the area of education for sustainability particularly, George Glasson (2010) suggests that researchers will need to examine ecojustice issues embedded in distinct historical, cultural, and political connections. Such connections to the land and resources can be emphasized through coming together across different positions. Joe Kincheloe (2008) advocated the importance of radical listening; that is, listening to the other with the explicit purpose of trying to understand their viewpoints and their standpoints. In this focus on learning from the other, he emphasized critical listening and consideration of diverse perspectives as a central piece of decolonizing knowledge, and this is a valuable lens for research in disputed areas.

Facilitating place-based education in a contested space requires a different set of expectations and processes than in a noncontested space. Approaches for considering research with people *in* and *around* contested places need to acknowledge the multidimensional intersubjective perspectives while recognizing the connections to place, and emphasizing the possibility to effect change in circumstances. Paulo Freire (2006) focused on problem-posing education for people to see the realities of their world not as static, but as a process, and this can be a useful approach for people who have been displaced or are living in a contested place. In these situations, people have an acute, personal, understanding of the broader political context that has mediated their experiences, and as such, perhaps this is where place-based education can embrace a critical pluralistic focus. The idea that you "start small and then become political" is a luxury of those for whom the political has not intruded upon and disrupted their lives/livelihoods. However, this can be turned on its head, so to speak, so that rather than place-based education that begins with the immediate surroundings and works out, research can begin with participants' political, economic, and social understandings of living in contested places, and work its way inward to place-based constructs, ecological explorations, and toward environmental justice.

There is a need to find a way to conduct collaborative place-based research that begins with the broader context and moves into critically considering possible actions for the communities that are affected by the contestations, in order to recognize the conflict and histories with a critical, complex lens on context and action. Places are dynamic social constructions, and conversations of how communities in conflict can try to work together to address the underlying issues that are at play can create possibilities for pushing back on the powerful economic and political forces, through a hybrid of place-based education and collaborative research for working with the other. While in place-based education, place is the main object of inquiry, in this melded approach, the main object of inquiry could be on finding ways to come together across difference with the purpose of turning to issues of place. The big question that needs to be asked is how can these communities work together to achieve cultural sustainability for the indigenous people, community survival for the residents of the town and ecological integrity of the natural settings? Issues of time and power are critical to working with people in contested places, and conducting locally situated participatory research connected with place-based approaches can possibly lead to cultural sustainability and ecological integrity. A role of education and educational research within a contested place can be to bring people together with disparate histories, with an emphasis on how to value and learn from the others' perspectives and support place-based education to promote change in environmental contexts and in socio-historical contexts as well.

Seeking Polysemic and Collaborative Research Approaches

Research is not neutral. It is informed by what people bring to the process, including their theories, perspectives, and intentions (Martin et al. 2006, p. 170). In a context that is fraught with contested perspectives, research that is polyvocal and polysemic can serve to provide an opportunity for people to provide their perspectives and as such, it is research that not only documents, but that seeks to politicize, and problematize. One of the questions that is raised for me in reading this work is, where are the voices of the participants? Basu (2008) has suggested that including participant voices into educational research can give power to communities of practice as well as adding to theory, and it is toward this end that I imagine adding the voices of those involved in the research would strengthen the points made in the chapter. Semken and Brandt conclude with mentioning action research, and building on this point, I am suggesting an approach blending a focus on place-based education with collaborative research approaches, in order to work toward shared decision-making and problem-solving coupled with local activism.

A polysemic approach to collaborative research provides recognition and affirmation, as it encourages a variety of stakeholders (teachers, students, local residents, indigenous peoples) to recognize the differences in their place/history/community and emphasizes the need for working together from the inside, rather than have decisions solely decided in courts and boardrooms. Incorporating a dialogic focus (Bakhtin 1981) can support such polysemicity. Mikhail Bakhtin's dialogue is much more than the words that are used in a conversation. It is a way of life that replaces a monologic approach with an understanding and acceptance of difference and multiple perspectives. Through fluid approaches that are negotiated by stakeholders to be responsive to difference (Tobin 2008), participants identify what is salient and together attempt to come to issues and concerns for focus, and a sense of place can support them as they discover their individual and collective connections. Positioning research in this manner motivates collective action and politicizes place-based education to become situated within the broader socio–political–historical context.

Polyvocal, polysemic research is a theoretical and political tool that embodies praxis, in that the action that is undertaken is informed by the theories that emerge and evolve from collaborative relationships. As power shifts, there are opportunities for taking increased agency as participatory, polysemic research breaks down the traditional boundaries between "researcher" and "researched." In addition to the possibilities of place-based education within the communities broadly, teachers in the local schools could contribute to the process of seeking solutions by considering the historical contexts that have led to the point the communities are at.

Barbara Thayer-Bacon and Diana Moyer (2006) have written about the ways in which history can be used as lens through which to guide future action. Historical analyses can reveal the ways in which current situations are interrelated with broader economic and social interests, and considering histories can illuminate the ways in which the community has arrived at its current situation.

Carolyne Ali-Khan (2010) suggests that we conceive of contested places "in relation to the particulars of time" (n.p.), and in the case of Superior, situating the different communities and individual histories and perspectives "on parallel timelines" as Ali-Khan suggests can provide a useful approach to working toward developing understandings around differences. Positioning multiple timelines and complex contexts highlights the similarities and the differences between communities and perspectives, and research then can engage with questions that emerge from the lived experiences of the individuals, and the experiences of the collectives.

Polysemic approaches position research in a way that supports coming together across difference. Further, such work acknowledges the histories and experiences of the different individuals and groups. Creating dialogue (in a Bakhtinian sense) can support the synthesis of place-based education with polysemic research approaches. To embrace a dialogic stance requires recognizing the plurality of experiences as well as the value of communicating across differences, and responds to this recognition by collectively exploring and expanding encounters with the other. This creates an emphasis on the importance of recognizing the incompleteness that is inherent in all of us, and points to the need to keep growing and learning as a member of a collective. A dialogic process is always changing, and it is this understanding and recognition of the importance of being open to others that is central. Research has the potential (and I would argue, the charge) to be transformative for participants and it is in expanding research and place-based education to include differing standpoints and perspectives of participants that the interrelationship between cultural sustainability, ecological integrity, and community survival can be emphasized.

References

Access Fund. (2008). Whatever happened to Arizona's Oak Flat? *Vertical Times, 81*, 10–11.

Ali-Khan, C. (2010). Sharing a disparate landscape. *Cultural Studies of Science Education, 5*, 361–371.

Bakhtin, M. (1981). *The dialogic imagination*. (C. Emerson & M. Holquist, Trans.) Austin: University of Texas Press.

Basu, S. J. (2008). Empowering communities of research and practice by conducting research for change and including participant voice in reflection on research. *Cultural Studies of Science Education, 3*, 859–965.

Freire, P. (2006). *Pedagogy of the oppressed*. New York: Continuum.

Glasson, G. (2010). Revitalization of the shared commons: Education for sustainability and marginalized cultures. *Cultural Studies of Science Education*, *5*, 373–381.

Jarman, M. (2008, November 26). Economy slowing Superior mine plan. *The Arizona Republic*. Retrieved November 26, 2009, from http://www.azcentral.com/arizonarepublic/news/articles/2008/11/26/20081126biz-resolution1126.html.

Kincheloe, J. (2001). *Getting beyond the facts: Teaching social studies/social science in the twenty-first century* (2nd ed.). New York: Peter Lang.
Kincheloe, J. L. (2008). *Knowledge and critical pedagogy: An introduction*. Dordrecht: Springer.
Kincheloe, J., & Tobin, K. (2006). Doing educational research in a complex world: Preface. In K. Tobin & J. Kincheloe (Eds.), *Doing educational research: A handbook* (pp. 3–14). Rotterdam: Sense.
Martin, G., Hunter, L., & McLaren, P. (2006). Participatory activist research (teams)/action research. In K. Tobin & J. Kincheloe (Eds.), *Doing educational research: A handbook* (pp. 157–190). Rotterdam: Sense.
Schweizer, E. (1999). Environmental justice: An interview with Robert Bullard. [Electronic version]. *Earth First Journal*. Retrieved November 20, 2009, from http://www.ejrc.cau.edu/earthfirstinterviewrb.htm.
Thayer-Bacon, B., & Moyer, D. (2006). Philosophical and historical research. In K. Tobin & J. Kincheloe (Eds.), *Doing educational research: A handbook* (pp. 139–156). Rotterdam: Sense.
Thompson, J. (2008, February 18). Reluctant Boomtown. *High Country News*. Retrieved November 23, 2009, from http://www.hcn.org/issues/364/17513
Tobin, K. (2008). Collaborating during turbulent times. *Cultural Studies of Science Education, 3*, 793–798.

Chapter 27
Place-Based Education as a Call from/for Action

Michiel van Eijck

This section features four accounts of the kind of struggles educators encounter once they engage in place-based activities. These struggles are characterized by overcoming dualisms such as global/local and subject/object. From the four chapters, simultaneously, one can learn how "place" guides educators to ways along which they can overcome such dualisms. The four studies presented in this section share a notion of place inextricably bound with human action. As highlighted repeatedly in this section, the word "place" refers to the ancient Greek word *plateia* (πλατεία, street), a central place in town where people came to both talk to and listen to others and where human action is "taking place." Human action, in turn, can be taken as a dialectic unit, which is realized both on the ideal and material plane, thereby uniting global/local and object/subject dualisms (Leont'ev 1978).

Departing from human action, place can be considered the channel through which students act globally from their locality, that is, from their "own" world to the world "out there," and make "their world" relevant to others as something that is "taking place." The other way around, a sense of place is required for students to take action locally on global issues "taking place" in the world "out there." More or less, the same counts for the subject/object dualism. On the one hand, place-based education objectifies what the students-in-action (subject) are doing once taking action locally on issues that matter to "their" place. Simultaneously, on the other hand, place connects the subject to the object-of-action by allowing students (subjects) to take action on local issues that matter to them.

In summarizing this section, I highlight the notion of place as related to the dialectics of human action. Thus, each of the chapters can be read as a call *from* action to the readers of this book, that is, as a message from subjects' real human action "taking place" locally. As well, simultaneously, each of the chapters can be read as a call *for* action – a global message with the object to allow others to take action based on what is "taking place" locally. In so doing, I provide an outlook in regard to this book's aim

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Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_27,

to stress the confluence of place-based education with both indigenous knowledge and ecojustice.

A call from local action of individual subjects is given in high detail once Chinn and (David) Hana'ike present an auto-ethnographic case study. They apply cultural-historical activity theory as a lens to understand a genealogy of personal learning leading to professional action as a Native Hawaiian science teacher. The genealogy reveals a unique set of life experiences that support an agentic self affecting change within and across activity systems. David engages in middle school reform involving curricular restructuring and teacher collaboration focused on student learning. Two cross-school studies find his program supports higher student satisfaction and higher science grades of students with below average test scores. David's ongoing development of a strong Hawaiian identity and sense of place supported the integration of cultural activities into school programs. From these accounts of local action through place, Chinn and Hana'ike call more globally for action for culturally responsive science teacher education and professional development once they suggest that David's experiences fit within a range of activity systems which support establishment of transdisciplinary networks oriented to teacher and student learning.

Stewart, in her response, deconstructs the pedagogy put forward by Chinn and Hana'ike through an Indigenous lens. She emphasizes how western academic practices often fail to meet the needs and expectations of Indigenous students at all levels of education. One way to understand this failure is to examine both standard western academic knowledge systems and Indigenous teaching and learning styles. Her position as a Canadian Indigenous academic offers a perspective on these issues by articulating current concerns in the context of existing literature and the case study of Chinn and Hana'ike. She identifies current issues relevant to Indigenous teacher education and explores an Indigenous pedagogy as a decolonizing and valuable way to engage secondary and post secondary students from diverse international Indigenous perspectives. Hence, she further delves into the complexity of contested places such as can be found in Hawai'i and Canada, expanding the local message from action to an even wider, global audience.

The complexity of contested places is also the focus in Martin's response, who positions a critical pedagogy of place as an analytic framework for considering the spatial-temporal-socio-historical-cultural contexts of place. Unpacking the cultural–historical complexity of Hawai'i, she extends this analysis to a discussion about the need for teacher education programs that actively prepare teachers to reflect on the interrelationships between cultural and ecological environments, specifically in the context of science education. For science curricula, this implies the promotion of an understanding of the socio-ecological relationships between people and place that aims to empower individuals in communities to engage in decolonization and reinhabitation of shared places and spaces. Although place appears as a complex matter throughout the first chapter and the two responses, the global call for action emerges as less complex. This is so because these chapters reveal a confluence by dissolving some of the tensions surrounding ideas pertaining to place-based education and indigenous knowledge. That is, in this globalizing world, education focused on contested places inherently deals with similar theoretical issues pertaining to indigenous knowledge and vice versa.

A different turn is taken by Karrow and Fazio as they explore the concept *educating-within-place* as enactments of care within citizen science for ecojustice. They examine the degree to which citizen science programs (e.g., *NatureWatch*) are founded upon various conceptions of place as they inform place-based education theory by considering natural, cultural, and ontological realms of experience. Whereas natural and cultural realms of experience are theorized within place-based education, they maintain, the ontological realm is formatively developed. Drawing on hermeneutic phenomenological perspectives, they unpack this ontological realm, revealing the primacy of the existential of care. They conclude that a program like *NatureWatch* has the capacity to invoke the ontological realm through care and place-based education theory and hence could attain greater coherence through the ontological realm. In other words, educating-within-place could provide a useful conceptual structure to unify place, with being, and educating.

Contradictions inherent to place are taken up in the dialogic response of Adams, Ibrahim, and Miyoun Lim. Recognizing the relevance of the ontological realm, they engage in a fundamental discussion on the concept of "place" and the localization of learning pertaining to education-within-place. They further explore the notion of invoking the ontological in place-based education and derive a number of general principles for place-based education. From this discussion, one can learn that place-based education is not merely a pedagogy that brings science education to specific loci. Rather, it can be considered a broader methodology for understanding issues of "placelessness" currently at stake in education. Hence, a focus on place can be considered a dialectic unit mediating both methodology and pedagogy. Interestingly, they also recognize the primacy of the existential of care for place-based education unpacked by Karrow and Fazio. This idea matters to the aims of this book, since these authors argue that the confluence of both place-based education and ecojustice is necessarily founded upon care, thereby once again dissolving tensions surrounding ideas pertaining to place-based education and ecojustice.

Issues of care and placelessness are addressed as well by Pagan who features *river advocacy* as a means for valuing complex systems as the groundwork for river relationships. The concept of river advocates refers to the meaningful, transactional thought, and action relation of an individual who, through ongoing personal and collective experiences with watersheds, develops a heightened awareness of particular rivers and views them as complex living, biological communities. Consequently, these advocates demonstrate caring thoughts and emotions originating from their relationships and appear to reflect on a realization of their own actions, that is, how they contribute or disrupt rivers, which motivate them to take further actions. In contrast, she addresses stream studies, which environmental educators commonly use to develop their students' understanding of the interrelationships of the natural world and provide them with an authentic context for investigating problems associated with our resources. Her critique focuses on educators' aim of collecting and analyzing numerical water quality data, which reduces the complexity of a river to the degree that it limits how students relate to and understand biological systems. In this context, she suggests a move toward river advocacy as an overarching aim of reform grounded by stream-based activities. Accordingly, curricula should be designed in ways that enable students to identify and associate with attributes of the river that speak to them and educators should help students connect with rivers to identify injustices and analyze their underlying assumptions regarding river rights.

Calkin responds to these accounts of river advocates by providing an essay illustrated by drawings of his own. Often we forget that words and other symbols emphasized in schools seriously limit our ways to experience places in authentic ways. In contrast, Calkin presents drawings to express some of his place experiences that are literally beyond words. He is cynical and skeptical about calls for school reform centered on “knowing” rivers (nature) in more authentic ways. In being so, he reminds us of the inherent but not so surprising limitations of science education as a means of experiencing place. Art, he argues in response, may help to harvest the potential of place-based education toward experiencing places in more authentic ways.

In my response to the chapter of Pagan, I address the monologic nature of the natural sciences in science education, which often dominates over students’ “folk” language at the cost of their interest in place-based activities. Drawing on dialogic perspectives, then, I read Pagan’s study as a case of/for novelizing science education. This refers to a Bakhtinian process of linguistic stratification by which “folk” languages struggle to become part of established discourses. Accordingly, Pagan’s work on river advocacy lays bare inherent instances of satire and irony required for this process. Such instances provide guidance toward a science education in which dialogue is internalized in the discourse of place-based activities.

Collectively, Pagan’s chapter and its responses once again (literally) draw on vignettes from local action to show how place-based activities call for action more globally and vice versa. In this case, the focus is on individuals’ means of expressing experiences of place as related to current science education. Arguably, individuals’ need for a means to establish a dialogue – one of the most basic human needs – reflects another dialectic inherent to place-based education which is relevant in regard to the topic of this book. This dialectic is underpinned by the fact that a listener and a speaker presuppose each other in dialogue (irrespective of speaking through either speech, writing, or drawing). Like I argue in my response, internalizing dialogue in place-based activities, then, further shapes ecojustice theory and education for ecojustice and opens up a space to bring in indigenous knowledge in place-based activities, which further confluences the triad.

In the final chapter and its responses, the confluence of the entire triad of place-based education, ecojustice, and indigenous knowledge is clearly featured as well. Semken and Brandt open with a sketch of the implications of sense of place and place-based education for ecological integrity and cultural sustainability in contested places. Purposefully, they address the central issue of contested places put forward by the responses of Martin and Stewart as well. They argue that place-based education may be particularly beneficial in contested places, where many disputes over land and resource use, access, or ownership are essentially conflicts among different senses of place. They illustrate inherent dynamics with two case studies of recently displaced indigenous groups and an analysis of an ongoing ethnographic study of contested places in a naturally and culturally diverse part of the Southwest U.S. state of Arizona. They claim that place-based education is a mutually beneficial transaction among people and place if it enhances the senses of place and local knowledge of students and teachers, while also fostering care for places that promotes their ecological integrity and cultural sustainability. Once again, the confluence of place-based education, ecojustice, and indigenous knowledge comes to the fore as a call from collective human action.

The notion of ecological integrity is taken up by Zandvliet once he expands it by situating place-based education as a grassroots response to what is viewed by many educators as a potential deficiency in systemic curriculum reform efforts. Here, place-based education as a call for action is most notable. But its global message becomes even more imminent by contextualizing place-based education within the historical backdrop of earlier curriculum reforms worldwide. Zandvliet characterizes aspects of Semken and Brandt's implementations as a form of technocentric curriculum reform. In response, he provides a description of an alternative ecological framework for science education, which references the emerging discourse around place-based education and sense of place that Semken and Brandt refer to – but also includes socioscientific issues-based (SSI) education, grounded in an ecological conception of education that emphasizes the "embeddedness" of human societies and cultures (and their technologies) within place-bound communities. His model describes a range of ecological, sociocultural, and technical influences that provide a framework for educators' diverse interpretations of curriculum. Siry extends the implications Semken and Brandt have introduced by focusing on the issue of cultural sustainability. She contends that a critical theoretical perspective is required in projects with contested places and displaced peoples in order to recognize the multitude of complexities involved. Here again, the dialectics of place as an ongoing dialogue is highlighted as she lays bare the complexity of place-based education as a call from human action. Specifically, she suggests using polyvocal and polysemic research in and around contested places as a means to acknowledge multidimensional intersubjective perspectives while also emphasizing connections to place.

Collectively, the four chapters and their responses featured in this section make clear that place-based education should be at the heart of vibrant schools and communities. Given the dialectics of place, place-based education implies much more than what is suggested by the phrase *Think global, act local*, which is attributed to the father of place-based activity, Patrick Geddes (1915). Rather, "place" pertains as well to reading this phrase the other way round – it is the unit that mediates thinking *and* acting *both* globally and locally. As such, place is the prime dialectic unit by which educators can overcome dualisms they encounter in place-based education and to establish a call from/to action, therewith uniting the object with the subject, the local with the global, and the speaker with the listener. As a result, in this chapter, the contours of the confluence of the ideas behind issues pertaining to the triad of place-based education, ecojustice, and indigenous knowledge become less opaque. However, thinking of speakers and listeners in dialogue opens up a new line of thought that has to do with voices and discourse. Discussing place-based education particularly in contested places, requires one to address the questions of whose voice is speaking through which place, based on which authority, in order to realize its place-based knowledge of the place. This brings us to the next section on indigenous knowledge systems.

References

Geddes, P. (1915). *Cities in evolution: An introduction to the town planning movement and to the study of civics*. London: Williams.

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs: Prentice-Hall.

Part III
Indigenous Knowledge Systems

Chapter 28
One Hundred Ways to Use a Coconut

Jennifer D. Adams

A seed floats for hundreds of miles and finally germinates and grows when it reaches dry land, often in nutrient-poor sands and soils. The coconut has been a source of sustenance and raw materials for many cultures around the globe. It is a plant that I connect with on many levels. Not only was I called a "coconut" in school, because of my Caribbean heritage, but the coconut is also a staple ingredient for several dishes that are commonly consumed in my home today. I remember my instructions on picking out a good coconut from my mother: "To pick out a good coconut, look at the eyes, make sure they are dry. Shake the coconut; it should sound hollow yet juicy." Whenever I travel and have to pick out a good coconut, I recall these instructions and I seem to always manage to get the perfect nut.

I bring up this resilient plant in this section introduction on indigenous knowledge because for me, the coconut represents scientific and technological knowledge developed and used by indigenous and traditional ecological knowledge participants worldwide. I also recall the coconut because a display of this plant helps me to rethink my notions of indigenous knowledge in science teaching and learning, in relation to my experiences as a museum educator some years past.

The natural history museum is a place where there are "people halls," namely, halls that display cultural artifacts from different regions of the world. The museum selectively displays particular aspects of people, but deemphasizes or ignores other important or significant characteristics (Adams 2007). For example, there are notions of primitivism and exoticism culturally reinforced in several of the exhibits. However, thinking deeper, one recognizes that the halls are developed during specific historical periods and reflective of the scientific and anthropological ideals endorsed at that time. As a science educator, I now use these halls and exhibits to demonstrate the ingenuity of indigenous peoples, that is, how they apply complex levels of knowledge to use resources in their environments and to create the tools and other creative elements on display.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_28,

In particular, in one exhibit there is a display case that demonstrates the many uses of the coconut plant within Pacific communities. On display are a wide variety of artifacts derived from coconuts – jewelry, bowls, twine, armor, money, and so forth. In science teacher education workshops, I ask participants to observe this case and ponder the question, "what science do people have to know and understand in order to make and use these objects?" A few moments of observation pass and the teacher participants begin to discuss the complexity of scientific understanding that people of these cultures need in order to survive over the long term. As a group, we converse about the biological, chemical, and physical understandings needed to fashion the resources of coconut plants into the variety of forms on display. Have people lost these unique connections with the natural world? Interestingly, usually some of my teacher participants are originally from tropical environments (e.g., Africa, Caribbean, Latin America). These teachers immediately identify with the coconut plant artifacts and provide the kinds of perspectives that allow us to think about the ways in which the coconut plant is utilized within their own cultural communities. Is this science education? It surely cultivates discussions about other ways that people around the world share knowledge about the environment in clever ways. For workshop attendees, this experience is a first step in recognizing the value of scientific knowledge embedded (even taken for granted) within their own cultural histories and practices. Reflecting back, these activities serve as a form of decolonization, where the goal becomes one of recognizing the ingenuity of how science and technology is indeed inseparable from the creation and use of coconut artifacts uniquely situated in different cultural and ecogeographical contexts.

Heterogeneity in Indigeneity

The coconut plant's origin is disputed. There is a question of whether it originated in South Asia or Latin America. Through a natural history of "accidental" and unnatural historically deliberate migration, the coconut plant ends up around the globe and manages to send out roots and become an integral part of the natural landscape. In the case of volcanic islands, the presence of the coconut plant makes it possible for other plants to emigrate, survive, and be able to mate, adapt, and evolve in a new place, that is, become endemic to a new place. Correspondingly, people maintain their indigenous connections with native lands while others, who were once indigenous to an area, are either forced or voluntary migrate to different locales. These people establish roots in a new place. Maori scholar Elizabeth McKinley (2007) recognizes that indigeneity is not a singular construct, rather it is as complex and heterogeneous as the people the term attempts to define and ranges from people subjugated in their ancestral lands to those who are still removed from their lands today (often only to be subjugated elsewhere). Glenn Aikenhead and Masakata Ogawa (2007) suggest the term "neo-indigenous" to signify a “long-standing, nonEurocentric, mainstream culture” (p. 555) not necessarily related to the first people’s culture who inhabit an area. Concomitantly, there are groups of people who are neither First Nations nor mainstream. For example, the Maroons of Jamaica and Surinam are relatively indigenous in their way of life, indicating that indigenous knowledge is not essential. Therefore, indigeneity connotes ways of knowing that are nonEurocentric, often place-based and often subjugated to Eurocentric cultural and political worldviews, what Sandra Harding (1998) describes as “Europology … metaphors, models, narratives, and discursive resources” that “are those of European history, not of Asian, African, or some other history” (p. 91).

Ladislaus Semali and Joe Kincheloe (1999) further define indigenous knowledge as:

> The dynamic way in which the residents of an area have come to understand themselves in relationship to their natural environment and how they organize that folk knowledge of flora and fauna, cultural beliefs, and history to enhance their lives. (p. 3)

In other words, indigenous knowledge is deeply rooted in place, with “place” being both an external, physical construct as well as internally constituted. “Because Indigenous peoples’ identities are imbued with a sense of place, place becomes a part of their inner space” (Aikenhead and Ogawa 2007, p. 560). This internal constitution of “place” is important for considering the confluence of place-based education, justice, and indigenous knowledge systems in science education. It is this internalization of place that enabled people like African slaves and Indian indentured servants to survive in the Americas, while recreating many aspects of their culture, including language, religion, and food. It is through this lens that people view their connections with the lands they inhabit.

What I understand about the natural world starts with my mother’s Jamaican neo-indigenous worldview. Coming from a rural and agricultural background, my mother’s stories inform my thinking about and being in the natural world. Learning and then eventually teaching science, I found that some of the things that I was taught conflicted with how I understood the world to be. Now I question these things. For example, I learned to appreciate insects when my mother caught them and put them in our hands to observe them. She encouraged us to release them through an open window. She once allowed a treehopper that came in with the cabbage to live in a plastic cup on the dining table until it decided to leave. This way of being conflicted with the ideas learned in my science methods courses where we caught insects, ethered them, pinned, classified, and displayed them for a grade. In contrast, I learned as much about appreciating and identifying insects while keeping them alive as I did when they were pinned and dead in my formal education. Students experience these sorts of tensions when their traditional knowledge is both challenged and examined as suspect in science classrooms.

> “I say it again: Science has not been neutral nor colorblind. hurt could not cure. comrade, Bliss ain’t playing.” Josefina Baez, performance artist

Knowledge Versus Knowing in the Science Classroom

Aikenhead and Ogawa (2007) make a clear distinction between knowing and coming to know. Eurocentric knowledge is something that one acquires; similar to gathering and counting coconuts on a beach. As Paulo Freire (1993) described,

> knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing. Projecting an absolute ignorance onto others, a characteristic of the ideology of oppression, negates education and knowledge as processes of inquiry." (p. 72)

This idea reminds me of the sinking feeling I wrestled with when a well-respected elder science educator announced it was her charge to "bring science to those who have no science." In her Eurocentric worldview, science or scientific knowledge is a product that can be produced, bought, sold, or given away, like alms to the unfortunate. And yet, learning and knowing in indigenous cultures is "a journey that requires experiential processes … it must be experienced in the context of living in a particular place in nature, in the pursuit of wisdom, and in the context of multiple relationships" (Aikenhead and Ogawa 2007, p. 553–554).

Even with pervasive educational discourses about multiculturalism, diversity and equity, and history and literature courses including perspectives and works from different cultures (versus the Eurowestern canon), science remains mostly Eurocentric. Where are the indigenous voices? Scientific colonialism exists in the form of national and "world-class" standards and standards-based curricula and testing mandates. It also exists in the discussions of indigenous knowledge and science education as a topic of increasing interest, with much of the discourse focusing on culturally relevant science education, that is, connecting science to the lives of indigenous/minority/poor/other marginalized students and less on reclaiming what these cultural groups offer to science and science education. Indigenous ways of knowing offer science education a process of learning about the universe – a way of engaging in the natural world – that is holistic, place-based, and is relevant to daily life. What would modern science look like if the kinds of questions asked, and the kinds of data collected, and the ways in which we interpret these data came from a nonexclusive European or North American perspective? What if science were more integrated and welcoming of different worldviews? Let's start a conversation!

The recent fatal sweat lodge incident in Arizona is an example of what happens when indigenous knowledge and skill is appropriated and used without regard to its original cultural significance and purpose. People died and many others fell ill during a "spiritual cleansing ceremony" in a sauna-like sweat lodge. In a statement, Arvol Looking Horse, the 19th generation keeper of the sacred white buffalo calf pipe noted:

> I am concerned for the 2 deaths and illnesses of the many people that participated in a sweat lodge in Sedona, Arizona that brought our sacred rite under fire in the news. I would like to clarify that this lodge and many others, are not our ceremonial way of life, because of the way they are being conducted. My prayers go out for their families and loved ones for their loss. (October 20, 2009)

How can science educators avoid making these mistakes and avoid essentializing indigenous people? In education, we must not repeat the same thing. It is important for educators to include marginalized peoples – indigenous, minority, immigrant, linguistic minorities – in the process of making decisions about teaching and learning. This means not only incorporating indigenous ways of knowing in the science classroom, but also reclaiming lost, deemphasized, or ignored knowledges. By encouraging indigenous knowledge systems inside the classroom, by embracing and valuing them, and blurring the "borders" artificially separating the classroom and community, we create science learning experiences that are relevant to creating an ecologically and culturally sustainable future.

References

Adams, J. (2007). The historical context of science and education at the American Museum of Natural History. *Cultural Studies of Science Education, 2*, 393–440.

Aikenhead, G., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education, 2*, 539–620.

Freire, P. (1993). *Pedagogy of the oppressed*. New York: Continuum Press.

Harding, S. (1998). *Is science multicultural? Postcolonialism, feminism, and epistemologies*. Bloomington: Indiana University Press.

Looking Horse, Arvol (2009, October 20). *Letters to the people: Sedona sweat lodge deaths*. Retrieved October 20, 2009, from www.manataka.org/page108.html#October_20, 2009.

McKinley, E. (2007). Postcolonialism, Indigenous students, and science education. In S. Abell & N. Lederman (Eds.), *Handbook of research on science education* (pp. 199–226). Mahwah: Lawrence Erlbaum.

Semali, L., & Kincheloe, J. (1999). What is indigenous knowledge and why should we study it? In L. Semali & J. Kincheloe (Eds.), *What is indigenous knowledge?: Voices from the academy*. New York: Falmer Press.

Chapter 29
Traditional Ecological Knowledge, Border Theory and Justice

Lyn Carter and Nicolas Walker

> The conquest of the earth, which mostly means taking it away from those who have a different complexion of slightly flatter noses than ourselves, is not a pretty thing when you look at it.
>
> Joseph Conrad Heart of Darkness (1902/1999, p. 7)

Introduction

Recent times have seen a growing preoccupation with diversity as a consequence of the newly intercivilisational encounters of our rapidly globalising world. Globalisation has meant that at the local level, the world's peoples rub more closely together not only ensuring that diversity, plurality and hybridity have become the leitmotifs of the global age, but also raising some deeply vexing questions about their consequences for science education. For example, questions about the ways in which science knowledge should be conceptualised and represented by science education invite debate about the epistemological parity between western science and other non-western sciences or Indigenous Knowledges (IK), as well as our understanding of justice, and our visions for the future. On the one hand, globalisation brings with it an appreciation of Traditional Ecological Knowledge (TEK) as a form of indigenous knowledge while on the other, it sustains rather than challenges existing boundaries and their attendant hegemonic impulses (Li 2003).

Snively and Corsiglia (2001) define TEK as the "timeless traditional knowledge and wisdom of long-resident, oral peoples" (p. 8) acquired over thousands of years of direct human contact with local environments. They emphasise the ecological depth of the knowledges, their persistence, consistency and reliability, their specificity,

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Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_29,

their holistic view of an interconnected world, and their moral and spiritual nature. They also describe its narrative base, where encoded metaphoric stories are often used "to compress and organise important information so that it can be readily stored and accessed" (p. 23), and "solutions to problems can be carefully preserved, refined, and reapplied" (p. 13). Snively and Corsiglia (2001) argue for the broadening of conceptualisations of science to include the significant contributions of indigenous cultures' TEKs in ways that promote epistemological justice and provide ecological knowledge to address the environmental devastation caused by western forms of science and development.

One well-rehearsed and highly influential approach within science education that attempts to grapple with these issues is the ideas of cultural borders and boundaries. Glen Aikenhead (e.g., 2001) and others have developed a number of tenets about borders, their characteristics and functions, and their "crossing" that include:

> (1) western science is a cultural entity itself, one of many subcultures of Euro-American society; (2) people live and coexist within many subcultures identified by, for example, language, ethnicity, gender, social class, occupation, religion and geographic location; (3) people move from one subculture to another, a process called "*cultural border crossing;*" …. (6) most students experience a change in culture when moving from their life-worlds into the world of school science; therefore, (7) learning science is a cross-cultural event for these students; (8) students are more successful if they receive help negotiating their *cultural border crossings;* and (9) this help can come from a teacher (a culture broker) who identifies the *cultural borders* to be crossed, who guides students *back and forth across those borders,* who gets students to make sense out of cultural conflicts that might arise. (Aikenhead 2001 p. 340 my italics)

In Aikenhead's terms, borders can be identified and crossed, and that guides (usually the teacher) can facilitate the passage and help negotiate any cultural conflicts that might arise; in short, clear borders exist between different subcultures like TEK and western science. An effective culture broker would be highly skilled in identifying "the cultures in which students' personal ideas are contextualized" and able to introduce "another cultural point of view, that is, the culture of western science, in the context of Aboriginal knowledge (TEK)" (Aikenhead 2001 p. 340). Aikenhead's (2001) constructs of "cultural border" and "cultural border crossing" have become a type of common sense and taken-for-granted commencement point within multicultural science education scholarship of recent years.

Though Snively and Corsiglia (2001) and Aikenhead (2001) all write from the Canadian context, their views of TEK, borders and border crossing are also relevant to the indigenous peoples of Australia. Aborigines (with a capital "A") as Indigenous Australians are more generally known, were the first human inhabitants of the Australian continent. Their occupancy is believed to be somewhere in the region of 50,000–70,000 years, making them this planet's oldest continual living culture. There exist Aboriginal story and song lines that predate recorded history by tens of thousands of years. Yet, like countless colonised people the world over, the fate of Australia's indigenous people is another retelling of the universal story of colonial oppression familiar to so many. Within the first few years of European settlement in the late eighteenth century, as many as 90% of some indigenous communities died as a result of introduced diseases. Colonial expansion was characterised by sporadic fighting or treaties, and in the worst instances, the systematic genocide or "clearing" of indigenous populations from the most desirable settlement sites around Australia's Southern and eastern seaboards. Protectorates were gradually established to "civilise" and "Christianise," which in truth left most indigenous people officially classified as "native flora and fauna." From 1869 to 1969, Aboriginal children, particularly "half-caste" children, were removed from their mothers and communities and placed in the care of the state with the ultimate hope of "breeding out" black blood lines. The effects for these children, known as the "stolen generations," continue into the present (Read 1981). In 1969, Aborigines finally won the right to be counted in the census of the Australia (human, as opposed to animal and plant!) population, which roughly coincided with their obtention of an unqualified right to vote. And in 1992, the High Court of Australia reversed the doctrine of *terra nullius* (meaning land belonging to no-one) and recognised "native title," giving rights to Aboriginal peoples as the traditional land owners of Australia (Connor 2005).

Despite these recent attempts at recognition, Borrows (2005 p. 2) argues that "(i)ndigenous peoples, by and large, are not sharing the benefits of colonisation." The 2005–2007 Australian Bureau of Statistics figures suggests that while Aborigines constitute only 2.6% of Australia's total population, an indigenous person is 11 times more likely to be in prison, and twice as likely to be a victim of violent crime. Only 39% of Indigenous Australians remain in school until Year 12, compared to 75% of non-indigenous people. A mere 4% of Indigenous Australians hold a bachelor's degree or higher. In response, the Australian government has formulated the National Aboriginal and Torres Strait Islander Education Policy (AEP) to increase educational participation with mixed success. Chronic unemployment, alcoholism and substance abuse are all systemic in some communities, and overall, life expectancy of the average Aboriginal male is around 12 years less than the rest of the community's. A bleak picture indeed! The landmark formal apology made by the Australian Parliament to all Indigenous Peoples on February 13, 2008 saw the Prime Minister Kevin Rudd express the hope of "embrac(ing) the possibility of new solutions to enduring problems where old approaches have failed." In view of previous administrations' refusal to apologise for past wrongs against Aborigines, it signalled for many, the opportunity for a real start towards reconciliation at last.

This chapter draws together the three strands outlined here of borders and boundaries, TEK and story lines from Australian Aborigines. Specifically, it responds to a call to explore new solutions to enduring problems of how to accord epistemological and other forms of justice to indigenous peoples and non-western scientific knowledges. We commence with a discussion of newer and more complex theorisations of borders and border spaces/places drawn largely from the field of cultural studies. More complicated ideas about borders better reflect the intricate interconnections of diversity within contemporaneity, and are hence, necessary to address science education's theoretical shortcomings that have seen borders typically represented until now as unproblematic lines between cultures and knowledge that need to be crossed. Some of this thinking has been commenced elsewhere (see Carter in press) but much remains to be done. We move on to apply these ideas about borders to two examples involving Indigenous Australians. Firstly, we look at the boundary drawing and spatial difficulties in developing appellations for Australian Aborigines. Secondly, we look at layered border zones/spaces within TEK taken from Dennis Foley's 2001 ethnographic text, *Repossession of Our Spirit: The Traditional Owners of Northern Sydney*. Escobar (2007) believes that the development of such ethnographies from the interstitial spaces of modernity/coloniality by those living bordered lives are essential for us to progress justice. We conclude with some comments on the implications for science education.

Borders and Border Spaces

> Space is conceptually nothing and everything until borders are formed, [thereby] creating a bordered space or place. (Rodger 2008 p. 23)

Borders, boundaries and their study have always been of interest to social scholars. Newman (2006) tells us that the discipline of border studies originated with the fields of physical and human geography, and political science, and that border scholars of the first half of the twentieth century saw borders/boundaries as the physical consequences of political power. They were hence, largely concerned with their description and categorisation for purposes of sovereignty and security. From the early 1960s, the field began to focus on the functional characteristics of borders and transborder contact. In the 1990s, border studies opened up to interdisciplinary approaches, and became interested in boundary-drawing practices and discourses (e.g., Berg and Van Houtum 2003). The field now lies at the "border" of cultural studies, ethnic studies, multicultural studies, and postmodern anthropology, and in addition to its traditional cartographic preoccupations, it is concerned with the contemporary conceptual questions of disciplinarity, identity, and cultural politics. Indeed, two very recent special editions of prominent cultural studies journals have focused on borders and border zones. They are the *European Journal of Social Theory* Volume 9 Number 2 from 2006, and the October, 2007 edition of *Globalizations*.

For many theorists (e.g., Ashcroft 2001), a major significance of boundaries and borders is that they were foundational to Eurocentric modernity's project of rationality and regulation. Once established, b/*orderings* of all types worked to fix stable systems of guaranteed boundaries that differentiated not only territories but also social spheres, categories like nature and culture, the rational and the irrational, the human and technological, and between the scientific and unscientific. Van Houtum et al. (2005) cleverly use the term "b/*orderings*" to encode both the demarcation and delimitation purpose of borders, and their functional role of creating order. As a verb, it also alludes to the continuous processes of boundary construction. Borders allowed what was inside to become known, understood, ordered, controlled whereas what was constructed as outside, to be left unb/*ordered*, unknown, threatening, wild or chaotic. Borders have also allowed modernity's subject to subsume and know the b/*ordered* object within the definitional bounds of foundational knowledge. Eurocentrism's normative construction of borders, and the belief in their territorial and conceptual binding power for shaping the world and its discourses, remains as its lingering legacy.

However, global contemporaneity has bought with it newer interpretations and more complex views of borders and space, and two significant ideas emerge that are useful for science education and TEK. The first idea posits the multiplicity and mobility of borders and their drawing (or continual reb/*ordering*), and is tied to the epochal, material and theoretical nature of the global world (Rumford 2006). Bauman (2001) and Beck, Bonass and Lau (2003) both point to the pluralisation of borders and the attempts to draw them as a key characteristic of contemporaneity. For example, Beck (1992) argues that in reflexive modernity (a term he prefers to contemporaneity or postmodernity or indeed Bauman's (2000) liquid modernity), as the available a priori categories have declined and generalised rules no longer apply, each case becomes contextual and criteria have to be developed, and then judged on their merits by all actors involved. It is only then that "the existence of boundaries (can be established) whose artificial character is freely recognized, but which are recognized as legitimate boundaries all the same" (Beck et al. 2003, p. 20). Specifically he argues that:

1. Boundaries cease to be given and instead become choices. Drawing boundaries becomes optional.
2. Simultaneous with that, there is a multiplication of the plausible ways in which boundaries can be drawn, as well as the ways in which they can be brought into doubt.
3. The existence of multiple boundaries changes … the nature of boundaries themselves. They become not boundaries so much as a variety of attempts to draw boundaries. (p. 19)

In short, as fast as one can draw a boundary or a border, someone else is coming behind and rubbing it out!! Shields (2006) notes that as boundary drawing is less taken for granted, we must be prepared to accommodate the increased contestation that must result. Similarly, Bauman (2001) identifies the messy flux of the boundary-drawing process itself where things are "set against each other, compared, scrutinized, criticized, tested, valued or de-valued" (p. 138) and left to battle it out in "a vast theatre of boundary wars – a battleground of endless "reconnaissance skirmishes" … (where) … there is no plausible finishing line… each successful challenge throws open new battlegrounds and prompts further challenges" (p. 141).

Beck et al. (2003) apply this thesis specifically to the boundaries of the sciences, and argue that as a consequence of the critiques of science studies and the inclusion of previously excluded knowledge such as TEK, the authority for scientific boundary drawing has moved beyond the scientific academy itself. "The boundaries of knowledge – that is, the boundaries between scientific and unscientific, between science and politics, and between experts and layman – have now been drawn in several places at the same time" (p. 20). Gieryn (1999) has famously written on this point arguing that the sciences face a permanent commitment to boundary work and the ceaseless policing of borders as a condition of contemporaneity. Hence, for Beck et al. (2003), the legitimising of all knowledge, particularly science, under the messy complexities of contemporaneity, only occurs when communally agreed (including non-expert) procedures and criteria produce constantly revisable, reflexive and practical knowledge that distinguishes better solutions from worse. Clearly, Beck et al.'s (2003) view differs to those who would legitimise knowledge on solely epistemological grounds. Hence, Beck et al. (2003), and Bauman (2001) view contemporary "boundaries … as fluid as the power balances whose projections they are" (p. 141).

The second significant idea to emerge from the border studies research is the reconceptualisation of the spatiality of borders and boundaries. In this view, borders become zones or interfaces (also called hybrid, liminal and interstitial spaces) where potentially contradictory discourses overlap and discrepant kinds of meaning-making converge, encoding unpredictability at the edges of stability. The border "reveals that it is a sort of virtual and semiotic force field, which translates, connecting and disconnecting the codes of adjacent systems and forms willy-nilly" (Shields 2006, p. 229). In these zones, all types of paradoxes, incommensurabilities, incoherencies and contradictions can be tolerated or held in tension. It includes ideas about situated, localised or placed-based knowledge that acknowledge their traditional origins as well as the ways historical and contemporary conditions have altered that traditional knowledge into hybrid forms.

Shields (2006) discusses this internal dynamism and flux with border spaces both material and abstract, concluding that it is the productive performance within the space that is generative of many possibilities. Hence, borders he argues are active translation technologies, which mediate between the adjacent fields. "In other words, interfacial boundaries have their own specific rules and semiotic orders, distinct from the fields or systems which they lie between (p. 230)."

This idea of a dynamic border zone has been postulated by others, most notably by postcolonial scholar Homi Bhabha with his idea of hybridity and hybrid spaces (see Bhabha 1994). Bhabha, also a literary scholar, has drawn on an astonishing breadth of theoretical, philosophical, literary and art texts to advance his thesis on hybridity. Historically derived from the crossing of biological species, the term was used during colonial times to discourage miscegenation. As part of the recent cultural lexicon, hybridity can mean anything from the uncritical celebration of cultural syncretism to more politically transgressive interpretations. Bhabha argues the transgressive view as an emergent "interstitial perspective" that is at "once a vision and a construction" that allows for difference without an assumed or imposed hierarchy (Bhabha 1994, p. 7). For Bhabha (1994), hybridity is a required concept to convey the complexity and messiness of cultural difference. Interestingly, Nederveen Pieterse (2001) describes the historically usual state of hybridity, by which he means, the common practices of mixing that have always existed in all human knowledge and practices.

Like Shields (2006), Bhabha (1994, p. 7) views border situations as "not part of the continuum of past and present," but where identities are performed and "create a sense of the new as an insurgent act of cultural translation." Those who live border lives are empowered argues Bhabha (1994), to actively intervene and transform their knowledge and practices into new and unexpected hybrids that are never total and complete, and always in the act of becoming, open to change, and desirous of pursuing errant and unpredictable paths. Clearly, this type of discussion, which highlights the mobility of borders and the dynamic nature of the border place or zone, has strong implications for how science education has conceptualised borders and border crossing within its discourses to date.

Border Drawing by Appellations

> It is not always easy to detect progress in Australia's dealings with its indigenous people. It requires a long view back and a long view forward. Sometimes the view is not clear. (French 2007, n.p.)

One example of the need for more complex views of borders comes in the ostensibly simple task of naming Indigenous Australians because when one names something, it places it within linguistic or semantic borders. Arguably, the *Ur*-act of language is appellation (or naming), or indeed setting up the boundary, for until something is named, it doesn't really exist. This is similar to Rodger's (2008) argument above that "(s)pace is conceptually nothing and everything until borders are formed (thereby) creating a bordered space or place" (p. 23). Hence, we are immediately confronted with the fluid nature of language, and the constant ebb of meaning, hue and connotation with which all attempts at labelling is imbued. Western science's intercession into questions of what it is to be an Aborigine began with the anthropologists' now thoroughly discredited typological model of racial classification. Within this scheme, Australian Aborigines were profiled as "Australoids" due to their physical appearances and language families. Indeed, Gardiner-Garden (2000) suggests that over the decades since white settlement, there have been over 67 attempts at definitions or categorisations (or indeed, bordering) of Aboriginal people.

More recently, Bin-Sallik (2008) along with Eve Fesl from the Gabi Gabi people of southwest Queensland and Lowitja O'Donoghue from the Yankunytjatjara tribe of northwest South Australia (a twice-named Australian of the Year and the inaugural chairperson of the now dissolved Aboriginal and Torres Strait Islander Commission), calls for the use of the term "Aborigine." Fesl (1986) notes that historically, the use of Aboriginal as a noun (most commonly with a small "a") rather than the adjective it should have been, attempted to erase Indigenous Australians' identities and cultures, categorising them being a non-existent people. "The word 'aborigine' refers to an indigenous person of any country. If it is to be used to refer to us as a specific group of people, it should be spelt with a capital 'A', i.e., 'Aborigine'" (n.p.). Lowitja O'Donoghue agrees, fearing also that the more recent appellation of "Indigenous Australians" can rob traditional peoples of their identities due to some non-Aboriginal people co-opting the term to identify Australia as their birthplace (Salna 2008).

From an Australian legal perspective, which is often used as the ultimate arbiter of such matters within society writ large, a person is Aborigine if they meet the requirements set out in a specific body of case law. One statement of this definition is to be found by Justice Dean in *Tasmania v The Commonwealth* (1983), "A person of

Aboriginal descent, albeit mixed, who identifies himself as such and who is recognized by the Aboriginal community as an Aboriginal" (p. 243). While the implications of this three-limbed test are discussed in detail elsewhere (e.g., Plevitz and Croft 2003), this legal approach to difficulties of naming seemed to countenance a genetic or self or community enacted Aboriginality. Justice Dean's view required as a precondition, a test of biological descent, albeit a descent made hybrid by many generations of miscegenation. This was problematic for many of those living Bhabha's (1994) bordered lives who lacked records to prove their Aboriginal ancestry. This lead to Justice Merkel, in 1998, defining Aboriginal descent as technical rather than biological, thereby eliminating a genetic requirement. The definitional difficulties however don't end here as the other two parts implicitly entrain the possibility of an individual renouncing his/her Aboriginality (who identifies himself as such), or being cast out from the definitional pool by his/her peers (who is recognized by the Aboriginal community as an Aborigine), but maintains their own Aboriginality.

Hence, though semantic and linguistic appellations by their very nature are attempts to subsume and homogenise, in the naming we are given a false sense of a unitary concept where there is, in fact, not one. Rather, these multiple attempts at Aboriginal appellation and their ensuring debates call to mind Bauman (2001) and Beck et al.'s (2003) discussion of the very arbitrariness of boundaries and their drawing. As we attempt to fix and unfix, Bauman's (2001) view seems very apt here when he describes the messy flux of the boundary-drawing process itself where things are "set against each other, compared, scrutinized, criticized, tested, valued or de-valued" (p. 138) and left to battle it out in "a vast theatre of boundary wars – a battleground of endless 'reconnaissance skirmishes' … (where) … there is no plausible finishing line… each successful challenge throws open new battlegrounds and prompts further challenges" (p. 141).

So, we plough on recognising the quagmire of borders, boundaries and their definitional spaces. It is hoped that by using some of the names here as synonyms, the act of slippage only reinforces the view of boundaries in flux. Nonetheless, as Aborigine is the term selected by the people themselves, it is the term most commonly employed in this chapter. However, the irony of the preferred term coming from the Latin *ab* meaning "from" and *origio* meaning "origin" or "beginning" does not escape us!

Border Spaces and Aboriginal TEK

We turn now to our second example of the complexity of borders and we look at the layered border zones/spaces in a story of TEK taken from Dennis Foley's 2001 ethnographic text, *Repossession of Our Spirit: The Traditional Owners of Northern Sydney*. As a Koori man matrilineally connected to the Gai-mariagal people whose traditional lands lie around the northern harbour and beaches of Sydney, and whose father is a descendant of the Capertee/Turon River people of the Wiradjuri, Professor Foley is, in many ways, an excellent example of someone living Bhabha's (1994) bordered life. A research academic at the Australian Institute of Social Inclusion and Wellbeing at the University of Newcastle (TAISIW), Foley is also a

Fulbright Scholar and Endeavour Fellow who successfully inhabits the interstitial spaces of western academia and Aboriginality. His academic interests cross several disciplines to include indigenous business practices and entrepreneurship, as well as indigenous epistemology, literature, history, and education. He is also a visual artist. Dennis Foley wrote the story of his family and his people of whom he is now one of the few remaining custodians, as many believe there are no surviving Aboriginal descendents in what is modern day Sydney. While others have written of the region, Foley (2001) claims that "there is no literature that tells our story from our mouths or is accurate in its presentation of our people from our perspective" (p. 1).

Within *Repossession of Our Spirit,* Foley (2001) arranges the content by geographical place. Under each "localised" heading, his text weaves together history, indigenous ecological practice, law and spiritual messages, as well as some strong political commentary on the current status-quo. This approach fits with Snively and Corsiglia's (2001) definition of TEK described above. More significantly though, Foley's (2001) content organisation attempts a "walking journey" and as such, to replicate an indigenous knowledge transmission system of "walking country, story and song" or the walking through a landscape to reveal information at certain sites for purposes of learning and sharing. It does this within the highly ritualised western knowledge transmission system of the book form, which in itself, is a bordered object, held between covers with margins on pages and organised in section and chapters (Rodgers 2008). Hence, *Repossession of Our Spirit* is, as well as occupies, a liminal space or border zone where the discrepant codes of the adjacent systems of the western textual tradition and indigenous walking story converge and attempt to make new meaning.

We have selected one of Foley's (2001) descriptions of the physical interface between modern landmarks and TEK places of significance to his people for further exploration. This extract features the Rookwood Cemetery not far from the 2000 Sydney Olympics Site at Homebush, and Sydney Grammar School and St. Joseph's Convent both found in the city of North Sydney:

> Rookwood Cemetery covers a traditional burial land.… Most of the early churches and cemeteries were built on (Aboriginal) sacred land. The power of spirituality within these Christian enclaves is not that of the conquering colonialist, I would suggest that it is rather the sedentary and dominant power of the traditional owner's beliefs that makes these places so powerful. St Joseph's Convent and the Sydney Church of England Grammar School … are examples of Catholic and Protestant institutions located on prime real estate that is also a sacred site of spiritual enrichment thousands of years before our European brothers sanctified it. (Foley 2001, p. 19)

This passage is interesting for a number of reasons. Firstly, we see how colonisation works to create hybrid spaces, where there exists a "layering" of knowledge and spiritual practices that are simultaneously enacted on the same geographic space. This "layering" of histories generates the liminal or interstitial spaces as described above where the potentially contradictory discourses of western and Aboriginal spirituality overlap and all types of paradoxes, incommensurabilities, incoherencies and contradictions can be tolerated or held in tension (Shields 2006). Given the morphology of the landscape with prominent ridges and rocky outcrops, it is perhaps not surprising that both knowledges selected these significant spaces for their important sacred practices.

Secondly, in western land systems, the general position is that to have property in something is to be possessed of a set of rights and interests in relation to a thing owned. The mere assertion of ownership is insufficient – the proprietary or interest claimed must be both identifiable (i.e., evidenced by physical possession or legal title – a dichotomy of control/recognition) and enforceable (either actually or legally). The prerequisite enforceability leads the law to speak of property as a legally endorsed concentration of powers or rights over things and resources – termed rights *in rem* (meaning in Latin: in a thing). Owners are deemed to have, at a minimum, a right to exclude others; but regularly encompass others, such as the right to use of the property, the right to dispose of or transfer the interest, and the right to benefits flowing from control (Cohen 1954). Importantly, these rights are thought, in almost all circumstances, to extinguish prior rights of others – whence the Eurocentric notion of *absolute beneficial ownership*. But as Foley's (2001) example above shows, none of these western legal property rights hold for the Gai-mariagal peoples' views of their sacred places. Rather, an awareness of TEK and border theory suggests that indigenous understandings of space are far more intuitively inclusive of the hybridity and interconnectedness:

> Indigenous peoples do not view their heritage in terms of property…but in terms of community and individual responsibility. Possessing a song or medical knowledge carries with it certain responsibilities to show respect to and maintain a reciprocal relationship with the human beings, animals, plants and places with which the song, story or medicine is concerned. (Daes 1993)

This reciprocal relationship is a sacred one, which means for Sutton (2003), that Aboriginal rights *in rem* flow ultimately from rights *in animam* (from the Latin: in spiritual things).

In Victor Hugo's *Notre Dame de Paris* (The Hunchback of Notre Dame) (Hugo 1831/1993), when faced with the demise of the old ways by the rising power of the Church, Archdeacon Frollo asks himself: *Ceci tuera cela?* (Will this murder that?). Foley's (2001) response to the same question regarding the position of European Catholic and Protestant institutions built over Aboriginal burial grounds is a resounding negative: "The shadows of the stone are the footprints of the spirits; the raindrops and the streams are the tears and the blood of the land. We are alive, the land is alive. No colonial power can ever rob us of this" (p. 118).

Implications for Science Education

> Many feet now walk our shores, people of all lands of many races. Let us hope that we can walk in this land and respect it as one – if we do, we call this "yennibu" (to be as one). (Foley 2001, p. 119)

Our main purpose here has been to draw attention to the need for a more complicated view of borders, border zones and border thinking that better reflect the intricate interconnections within contemporaneity, and are hence, necessary to address science education's theoretical shortcomings that have seen borders typically represented until now as unproblematic lines between cultures and knowledge that need to be crossed. Such an approach would acknowledge the increasing awareness of shared historical processes, cultural reciprocity, and the diasporic tendencies of the globalising world around more complex and multiple conceptualisations of western science and indigenous knowledge and culture (TEK). It would argue cultural production to be as much caught up with the injustices of contemporaneity, and the future, as it is with the past. And it recasts culturally diverse students' homogenised identities into multiple, mobile and provisional constructions, more accurately attune to conditions of living and learning under the indeterminacy of the transforming global world. All of these are necessary if we are to make real progress towards epistemological and other forms of justice to indigenous people and non-western scientific knowledge.

The paucity of new discourses and methodologies in science education in terms of border theory must be addressed so that science education can engage in dialogues about key issues that are practically and intellectually urgent, and that will advance it as a discipline.

References

Aikenhead, G. S. (2001). Integrating western and Aboriginal sciences: Cross-cultural science teaching. *Research in Science Education, 31*, 337–355.

Ashcroft, B. (2001). *Post-colonial transformations*. London: Routledge.

Bauman, Z. (2000). *Liquid modernity*. Oxford: Polity Press.

Bauman, Z. (2001). The great war of recognition. *Theory into Practice, 18*, 137–150.

Beck, U. (1992). *Risk society: Towards a new modernity*. London: Sage.

Beck, U., Bonass, W., & Lau, C. (2003). The theory of reflexive modernisation. Problematic, hypotheses and research programme. *Theory, Culture & Society, 20*, 1–33.

Berg, E., & Van Houtum, H. (2003). *Routing borders between territories, discourses and practices*. Aldershot: Ashgate.

Bhabha, H. (1994). *The location of culture*. London: Routledge.

Borrows, J. (2005). *Practical reconciliation, practical re-colonisation?* (Land, Rights, Laws: Issues of Native Title, AIATSIS, Vol. 2, paper no 27).

Carter, L. (2010). The armchair at the borders: The "messy" ideas of borders and border epistemologies within multicultural science education scholarship. *Science Education*, 94(3), 428–447.

Cohen, F. (1954). Dialogue on private property. *Rutgers Law Review, 9*, 369–70.

Connor, M. (2005). *The invention of Terra Nullius*. Sydney: Macleay Press.

Conrad, J. (1902/1999). *Heart of darkness.* New York: Penguin.

Daes, E. (1993). *Discrimination against Indigenous peoples: Study of the protection of the cultural and intellectual property of Indigenous people*. NewYork: United Nations Commission on Human Rights.

Escobar, A. (2007). Worlds and knowledge otherwise. *Cultural Studies, 21*, 179–210.

Fesl, E. (1986). "Aborigine" and "Aboriginal." *Aboriginal Law Bulletin*, 20(1). Retrieved July 15, 2009, from http://www.austlii.edu.au/au/journals/AboriginalLB/1986/39.html

Foley, D. (2001). *Repossession of our spirit: The traditional owners of Northern Sydney*. Canberra, ACT: Aboriginal History Inc.

French, R. (2007). *Plus ca change, plus c'est la meme chose?* The 2007 Amendments to the Native Title Act. Retrieved July 15, 2009, from http://www.fedcourt.gov.au/aboutct/judges_papers/speeches_frenchj22.html.

Gardiner-Garden, J. (2000). *The definition of Aboriginality*. Parliament of Australia. Retrieved July 15, 2009, from http://www.aph.gov.au/LIBRARY/pubs/rn/2000-01/01RN18.htm

Gieryn, T. (Ed.). (1999). *Cultural boundaries of science: Credibility on the line*. Chicago: University of Chicago Press.

Hugo, V. (1831/1993). *The hunchback of Notre Dame.* Oxford: Oxford University Press.

Li, H.-L. (2003). Bioregionalism and global education: A reexamination. *Educational Theory, 53*, 55–70.

Newman, D. (2006). Borders and bordering towards an interdisciplinary dialogue. *European Journal of Social Theory, 9*, 171–185.

Plevitz, L., & Croft, L. (2003). Aboriginality under the microscope: The biological descent test in Australian law. *Queensland University of Technology Law & Justice Journal, 3*, 1–17.

Read, P. (1981). *The stolen generations: The removal of Aboriginal children in New South Wales 1883 to 1969*. NSW: Department of Aboriginal Affairs New South Wales Government.

Rodger, N. (2008). *Judging books by their covers: An examination of books as auratic objects in the digital era.* Unpublished Honours thesis (Batchelor of Communications), RMIT University, Melbourne.

Rumford, C. (2006). Theorizing borders. *European Journal of Social Theory, 9*, 155–169.

Salna, K. (2008) Call us Aboriginal – ATSIC chair. *The Australian*. May 1, 2008.

Shields, R. (2006). Boundary-thinking in theories of the present: The virtuality of reflexive modernisation. *European Journal of Social Theory, 9*, 223–237.

Snively, G., & Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science Education, 85*, 6–34.

Sutton, P. (2003). *Native title in Australia: An ethnographic perspective*. Cambridge: Cambridge University Press.

Van Houtum, H., Kramsch, O., & Zierhofer, W. (Eds.). (2005). *B/ordering space*. Aldershot: Ashgate.

Chapter 30
Considering the Consequences of Hybridity: Protecting Traditional Ecological Knowledge from Predation

Deborah J. Tippins, June George, and Stacey Britton

Deb: In this age of globalization, where lives depend on multiple and constant interconnections, Lyn Carter and Nicolas Walker problematize the notion of borders and border crossings in light of how they have traditionally been conceptualized in science education. In their chapter, they share theoretical and practical insights that challenge us to rethink the idea of borders in the context of traditional knowledge and justice. Drawing on examples from Australian indigenous cultures, they prompt us to consider the ways in which emerging ideas about borders and border spaces contribute to the discussion surrounding ecojustice.

Carter and Walker begin by describing physical and functional conceptualizations of borders, and the ways in which these have reinforced polarities and contributed to normative constructions that attempt to legitimize a "belief in their territorial and conceptual binding power for shaping the world and its discourses" (p. 4). They emphasize the need to complicate and extend a pluralistic notion of borders that take into account the complexity of our twenty-first century world. In their discussion, they highlight the fluid, contextual nature of borders, and the merit and criteria by which they are judged, the many possible ways that borders can be drawn and called into question, and the dialectical relationship between the multiple existence of borders and the very nature of drawing these borders. Their discussion of ideas that are emerging within contemporary border studies research emphasizes notions of pluralism and hybridity. These ideas are particularly relevant in juxtaposing conceptualizations of borders and border crossing alongside conceptions of ecojustice.

The world is a web of relationships, which necessitate openness to pluralism. The need for diversity is essential if we are to protect communities from enclosures and move forward new ideas. Because communities are diverse and their boundaries are fluid, we need to complicate the notion of borders within specific communities,

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_30,

including communities of practice. An examination of the assumptions and root metaphors that are deeply entrenched in the experience of the "commons" is a starting point for doing so. Within the context of diverse intergenerational communities, citizens, including youth and teachers, can serve as mediators and actors in deciding what counts as legitimate knowledge.

The notion of hybridity is important in Carter and Walker's discussion of the spatiality of borders and boundaries. They point out that the tensions created when potentially contradictory discourses overlap in hybrid spaces can be generative in nature. Indeed, for indigenous peoples, these hybrid spaces already exist and we need to draw on them. Carol Brandt, for example, in her work with Navajo college students, describes these hybrid spaces as "locations of possibility" (Barnhardt et al., 2008). Carter and Walker note Pieterse's historical description of hybridity as "the common practices of mixing that have always existed in all human knowledge and practices." Yet, at the same time, while reflecting on the way in which hybrid spaces and the changing knowledge and practices they entail contribute to a more dynamic envisioning of borders, there is a paradox. In the natural world, if we hybridize too much, through the introduction of genetically modified organisms, there is an inherent danger that the hybridized spaces of species might actually become more terminal.

June: Some parallels can perhaps be drawn between the notion of hybridity and that of "collateral learning" espoused by Aikenhead and Jegede (1999). Both point to attempts at mixing with outcomes that can be fluid. The degree of mixing or the performance in the interstitial spaces will depend, at least in part, on the background of the actors. But even in discussing hybridity, we may be putting borders around actors that might not be entirely appropriate. For example, the western-trained scientist who is from an economically marginalized country might perform differently in the interstitial spaces when dealing with indigenous knowledge than a western-trained scientist, from a more economically advantaged country, who may have had little exposure to indigenous knowledge systems. Further, indigenous knowledge systems in different contexts may themselves have undergone some mixing over time, making the situation even more complex.

Deb: Your comments point to the complexity surrounding notions of hybridity and border crossing. Carter and Walker argue that the border crossing idea is not complex enough to bring both contemporary western science and Aboriginal thinking together. They maintain that it is necessary to bring them together if Aboriginal thinking is to be given higher status, particularly in light of their struggles to dissolve or challenge an affirmation of western science. The inherent assumption is that Aboriginal science will be recognized as legitimate if it is hybrid. I think it is important to reorient the conversation surrounding traditional ecological knowledge (TEK) to focus on an important distinction that has largely been missed, namely, the vulnerability of knowledge that is associated with the creation of hybridized space. Hybridized spaces implicitly create difference and subject knowledge to hierarchies (and Aboriginal knowledge may not fare well in the process). And as pointed out previously, in the natural world when we hybridize too much, the hybridized spaces in nature become threatened.

A Question of "How to Get Back"

Stacey: This discussion of borders and indigenous knowledge reminds me of one of the many outings I had while living and teaching in a rural community in Alaska. It was the Saturday of Easter weekend, clear blue skies with the sun shining brightly for 10 h or so a day, the wind blowing the bits of snow around that had been compacted because of the extreme cold. My good friend and co-teacher, a hunter and native to the North Slope, had offered to take me out and show me the tundra. I won't bore you with the great details of layering myself, making sure I had my camera batteries charged, and waiting for my friend to show up on the snow machine. What I will share is the joy of bouncing over solid packed snow, moving at speeds I had not experienced in such a cold climate. I have vivid memories of stopping frequently so my friend could point out significant features of the landscape, waving at a neighbor who was heading into the mountains for a day of hunting, and my curiosity at the rifle strapped across the front of my friend. In this part of the world, during this time of the year especially, being able to protect oneself from predators is important; polar bears come in early and hungry. As we flew across the flat land, miles out of town, the wind getting colder and stronger the further we traveled, we hit a bump. My friend stopped and I thought he was pointing out the "igloo" type wooden structure to our left. In actuality, he had stopped because the under-carriage of the snow machine had broken. It could not be fixed on the spot, there was no tow truck, and there was no ride back into town. We had a tense period of waiting, contemplating actions we could take, and discussing how to get "back."

I wonder if part of this notion of hybridity in relation to borders could be connected to the idea of how we get back. The connectedness that is often seen in native populations that utilize modern technologies alongside traditional methods is what would be referred to as hybridity; that ease in combining modern with old. While I know my friend was completely prepared for any event, I have to wonder if our reliance on modern tools and ideas has made us complacent. The example I have shared is clearly skewed heavily toward a perceived reliance on modern conveniences that are relatively new to this culture and community; a community that is supported by the land and survives because of knowledge and appreciation for the power of their surroundings. If we make border crossings and the notion of mixing cultural ideas so common that we become immune to the innate knowledge of survival and awareness – how do we get "back?"

Protecting Ourselves from Predators

Deb: Stacey, your account of the Alaskan tundra experience highlights the ways in which hybridized space becomes vulnerable. Carter and Walker assume that knowledge is not vulnerable because it will be carried forward by elders. They address this point in their description of the elder who was asked whether Aboriginal knowledge would be lost through the introduction of western knowledge systems. Although the elder responded that there was no danger of losing this knowledge because it was a part of him, what about today's youth? They possess a matrix of complex cultural identities – they may eat Chinese food, listen to hip-hop music, or speak Spanish in the home. Can we rest assured that the youth of today will carry forward the knowledge of their elders, particularly when it may not be part of their postmodern identities?

In many ways, the importance of protecting oneself from predators when journeying out onto the tundra mirrors the dangers of predation embedded in eurowestern ideology of *capitalism*. Eugene Hunn (1989) notes that TEK can provide independent alternatives to the global market syndrome. At the same time, he reflects on the irony of "exploiting TEK to support a global system that is deeply implicated in its destruction." We can see parallels in your description of the broken-down snow machine and imminent threat of predators with the story of Jacob in the recent hit movie *New Moon*. A Native youth, Jacob knows about the cultural and historical legacies of the werewolf, paleface, and vampire. Yet, he struggles to acknowledge his own genetic potential to be a werewolf. When Bella brings Jacob an old motorcycle, she wonders whether he will have the skills and knowledge needed to repair it. But Jacob reassures Bella, telling her not to worry, knowing that he has a deep-seated knowledge of mechanics that will enable him to work on the motorcycle. Jacob's mechanical skill is a hybridized knowledge, perhaps passed down and developed over a short time span. It stands in stark contrast to the thousands of years of cultural history that carries with it the legacies of the werewolf, paleface, and vampire, and in turn creates a tension for Jacob as he struggles with being a werewolf and his desire to work on the motorcycle. Beyond the storyline of *New Moon*, the very creation of the movie reflects the ways in which hybridity poses vulnerabilities for today's youth. When asked to play parts in the movie, youth become vulnerable to stereotypes in the media, which work against the protection of indigenous knowledge.

Stacey: I agree with your thoughts about the recent hit movie *New Moon*; underlying the actions taken by Jacob, the book and movie presents a culture that has existed for countless generations – at least in fiction. Elders of the group are those who share knowledge about what happens within individuals upon reaching a particular age, and what must be done to protect the group as a whole. Culture is depicted as something transferred through generations as oral stories, just as traditional ecological knowledge is passed through generations as personal accounts and stories that, while appearing fanciful, actually indicate important knowledge for survival.

Hybridity always involves a combination of two different backgrounds, with the outcome often uncertain and undefined by the creators. The hybridization of TEK with traditional Eurocentric science is often impossible because the knowledge held by individuals is unique to a given area – it is only transferable between people, not geographic location. Encouraging knowledge in border crossing and attempts at hybridization does not guarantee the appreciation of local knowledge; more often, it involves merging traditional knowledge with currently accepted "science," which diminishes the value of cultures with unique oral histories.

The village in which I worked during my time in Alaska was a traditional whaling community, comprised of subsistence hunters who utilized the land and sea for survival. Stories were told about the International Whaling Commission's call for all hunting of the bowhead whale to cease after scientists completed a population count indicating that numbers were so low that continued hunting would cause extinction. Many villages in Alaska are located along waterways to make food collection easier, so when the locals were told of the extremely low numbers of bowhead whales they were in disbelief. Not only did they question the scientific count because it would eliminate a major food source, they questioned the count because they had seen firsthand more whales than were recorded. Through communication with the commission and discussion of their experience with the bowhead population, scientists looked once again to the waters of the Bering and Chukchi Seas. What they found was a population much larger than their initial count tallied; they found this because local populations had established a different connection with their surroundings and often demonstrated a greater awareness for what actually exists and supplies the livelihood for their communities. As Ellen and Harris (2000) point out, native populations have provided needed information about the natural world for centuries. Yet Williams (2002) notes that this knowledge is often assimilated into constraints that may not allow for credit to the source.

In terms of teaching science, this was an ideal community – the students often taught me. In the grand scheme of science education, what does hybridity and border crossing mean? Champagne and Abu-Saad (2006) argue for indigenous communities who feel that their children should be educated in the ways of the world but not at the possible loss of local awareness and appreciation for their own cultural knowledge. They emphasize the need for communities to be included in planning for education. Teachers are ultimately responsible for learning, but in order to maintain the native knowledge network that exists within a community, local elders and other community members must be involved in the education of students. Typical elementary and secondary settings are not always readily accepting of outside influences, but in native communities, the only way to increase student participation and community involvement is to realize that schools are not sacred grounds, accessible to only teachers and their students. The community must be involved in education in order to prevent assimilation and further movement from TEK, which can be detrimental to the culture and way of life that many work to protect from the encroaching influence of culture as portrayed in today's television, print, and internet-based society.

June: I am intrigued with Stacey's point about the likely fate of "innate knowledge or survival." I can think of several possible outcomes of efforts that encourage hybridization: (i) As Stacey suggests, hybridization might result in one becoming "immune" to innate knowledge of survival and such knowledge might eventually be lost if people are not engaged in the act of drawing on it; (ii) The making bare of such knowledge to those who wield power opens up possibilities for exploitation, thus rendering those who possess the indigenous knowledge vulnerable (as Deb points out); (iii) Hybridization is allowed to work in informal settings. In my own experience in a developing world context, I have encountered people who engage in the mixing of different ways of knowing, often unconscious of the fact that they are drawing on different forms of knowledge. Thus, scientific words and phrases are drawn into everyday conversations and are all mixed up with traditional sayings and explanations. Since this typically happens in the informal sector, there is little resistance to it; (iv) There is resistance to attempts at hybridization. Again, in my community context (Trinidad), that is what is happening in the formal education system. There is little attempt to draw on students' backgrounds and traditional knowledge in the formal science classroom. Indigenous knowledge is sometimes incorporated in areas such as language arts, fines arts, and so on, but hardly ever in the science classroom. This does not mean that students and teachers are ignorant of indigenous knowledge. What is more likely to occur is that teachers and students draw on the indigenous knowledge in some aspects of their everyday lives (and the extent of this varies). But their indigenous knowledge is kept separate and apart from formal school knowledge since it is believed that it is formal or academic science knowledge that has the power to take one to "higher" places in the society.

Deb: June, it is not surprising to hear that indigenous knowledge and understandings of the world are, for the most part, relegated to informal learning contexts in your country – indeed, this may be the case in many parts of the world. Attempts to include this knowledge in the school curriculum may, in some cases, serve to only reinforce eurowestern narratives. A case in point is Carter and Walker's description of Australians as … "the first human inhabitants of the Australian continent. Their occupancy is believed to be somewhere in the region of 50,000–70,000 years, making them this planet's 'oldest continual living culture.' " While traveling and backpacking in Australia, I became familiar with the stories of the Wandjina creation spirits. Reflecting the collective memory of the Wandjina people of the Kimberly region of western Australia, these stories and the rock paintings that depict them, offer a very different account of the inhabitation of Australia – one embedded in the story of aboriginal creation, renewal, and transformation from spirit being to human form. Most tribal people worldwide believe in creation narratives and have always lived in the places where they are indigenous. Vine Deloria Jr. (1997) made this point repeatedly in his work, lamenting on the attempts of those working in the "scientific tradition" to derail tribal creation stories because science can't make sense of it. As a result, schools may unconsciously try to melt difference to make us "all the same," and in the process, privilege certain histories while devaluing others. As Joe Kincheloe (1999) points out, in our postmodern world, it is imperative to "celebrate difference and enhance our realities by these differences, making them equally valid" (p. 189).

Some Final Thoughts on TEK as the Embodiment of Diversity

Carter and Walker challenge us to consider the consequences of diversity, plurality, and hybridity in a rapidly globalizing world, particularly for science education. In doing so, we are convinced of the need for vigilance in protecting the diversity of communities in which TEK is produced. Lest we be accused of romanticism, we maintain that TEK, like many biological species, is everywhere endangered through the dispossession of communities and lifestyles rooted in ancestral lands. For science education, TEK is the embodiment of cultural and biological diversity – an essential voice that can enable citizens to raise new questions, create different ways of connecting information, and consider new perspectives on the world.

References

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomena. *Journal of Research in Science Teaching, 36*, 269–287.

Barnhardt, R., Tippins, D., & Brandt, C. (2008). Locations of possibilities in tertiary science education: Responding to the voices of four Navajo women. *Cultural Studies of Science Education, 3*, 703–730.

Champagne, D., & Abu-Saad, I. (2006). Introduction: Seeking common ground through education. In I. Abu-Saad & D. Champange (Eds.), *Indigenous education and empowerment: International perspectives* (pp. 1–11). Lanham: AltaMira Press.

Deloria, V., Jr. (1997). *Red earth, white lies: Native Americans and the myth of scientific fact*. Golden: Fulcrum Publishing.

Ellen, R., & Harris, H. (2000). Introduction. In R. Ellen, P. Parkes, & A. Bicker (Eds.), *Indigenous environmental knowledge and its transformations: Critical anthropological perspectives* (pp. 1–33). Australia: Harwood Academic Publishers.

Hunn, E. (1989). Ethnoecology: The relevance of cognitive anthropology for human ecology. In N. Freilich (Ed.), *The relevance of culture* (pp. 77–92). New York: Bergen & Garvey.

Kincheloe, J. L., Steinberg, S. R., & Tippins, D. J. (1999). *The stigma of genius: Einstein, consciousness, and education*. New York: Peter Lang.

Williams, D. R. (2002). Social construction of arctic wilderness: Place meanings, value pluralism, and globalization. *Wilderness in the Circumpolar North: Searching for compatibility in ecological, traditional and ecotourism values,* USDA Forest Service Proceedings RMRS-P-26 (pp. 120–132). Ogden, UT: US Department of Agriculture.

Chapter 31
On Critical Thinking, Indigenous Knowledge and Raisins Floating in Soda Water

Christopher Darius Stonebanks

> With few exceptions, my experiences within biology classrooms served primarily to stifle my inherent interest in what was to me a fascinating subject. Talking with my students in the biology lab classes I teach, I have found that my experience is far from unique.
>
> *Kellog 1998, P.ff 212*

Introduction

In the same spirit of Kellog's autobiographical approach to capturing the general impression of science education, let me be completely honest at the outset of this chapter on my own forays of these classrooms: As a primary school student, I enjoyed moderate success receiving second prize in a science fair, an attempt at animal behavior science. The experiment was an unsuccessful attempt to train my one-eyed hamster to push a button for food. Upon retrospect, it is pretty clear to me that I probably won the fair through a rodent that evoked both sympathy and adorable appeal from the fair judges. In secondary school, I plugged along with varying uninspired successes, finding myself in advanced biology only through a probable timetable schedule error. From primary to secondary education, my science education experience was noteworthy only in that it was so unremarkable.

However, this trend changed in CEGEP (a college system in Quebec, Canada designed to act as a buffer between secondary school and university), thanks to one professor who did not even teach in the (traditional) science department. My interest was sparked through a political science professor, of (east) Indian origin, who

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_31,

challenged my knowledge of my own cultural history and the contributions of Islamic civilizations and Iran (both pre and current Islamic eras) to many fields, including science. Walking up and down the fixed aisles of the class he once asked, "who can tell me where our current, modern hospitals came from, where did they originate?" A few answers suggesting European origin and especially ancient Greece were forwarded. Smiling, he moved among the seated students, "no," he said and paused for a moment.

"Christopher?"

Surprised that he asked me, I responded: "I don't know."

"You should!" he retorted, "it's your history, your heritage!"

> Even as the great Muslim physicians live and die, more lasting memorials to their medical wisdom will rise across the cityscapes. These new structures will be virtually unknown anywhere else in the world and will not be replicated in any significant way for centuries to come. (…) they will be driven by egalitarian message of the Prophet, to care for the poor, the sick, and the less fortunate. These buildings will be called hospitals and pharmacies. (…) In the Muslim East, hospitals will be known as *bimaristan*, literally "sick places", later shortened to "*maristan*". And rather where people go to die, they will be places where people go to be treated and to recover from a variety of ailments and injuries, including mental illness. (Morgan 2007, P. 211)

He was right, I should have known. But his accusation was not (entirely) one of my own shortcomings. Rather, the driving force of much of this professor's class was that this knowledge was purposefully or not, kept from us. By the time I entered the university, the opportunity to re-enter science was lost. As I made my way from undergraduate studies to a professor of education, science education and its relationship with hegemony, critical thinking, and Indigenous ways of knowing, became increasingly evident. It became apparent through my teaching that I should expose this hegemony as much as possible. Surprisingly, or at least unexpected to me, the most effective lesson I teach on stimulating thought and dialogue in the area of critical thinking and multiple ways of knowing is through science education.

Subject areas such as science education become particularly important because they are so often considered value neutral and lead students to believe that science falls outside of the considerations of critical pedagogy. Perhaps this disregard creates an illusion that neutrality achieved in science education can lead the way for other academic areas to disguise themselves of the burden of cultural considerations. For example, a common occurrence in my multiculturalism undergraduate classes comes in the form of protests from (wonderful) science education preservice teachers who say that "diversity and cultural" considerations have little or nothing to do with their discipline. My concern is not simply with schools in Canada or the United States, but in recognizing the prevailing global influences of eurowestern education systems and their impacts on indigenous knowledge and education. With the ongoing legacy of imperialism and colonialism and the imprint of eurowestern modes of education on indigenous communities around the world (Stonebanks 2008a, 2008b), concerns for engaging in these discussions take on an interconnected, global meaning as we attempt to fulfill critical pedagogy's call to reveal the causes of human suffering and become conscious of the idea that this call cannot be addressed in isolation from others.

In particular, this chapter focuses on Malawi and the James Bay Cree communities of Canada and a conversation I had with the late Joe Kincheloe (influential critical pedagogy scholar, prolific author, and Canada Research Chair of McGill University's Department of Integrated Studies in Education). While in the James Bay Cree village of Mistissini, I spoke with Joe about a science experiment I had carried out in a preservice teacher education course on curriculum development, also related to his work. The experiment, which will be described in greater detail at the end of this chapter, was developed by the University of Alabama's Integrated Science Program (1991) with the intention to teach young students about the importance of careful observation through an authoritative yet exuberant demonstration of "water lice" actively cleaning polluted water. Although developed for elementary-aged children, this experiment is carried out with preservice teachers in connection with the ideas of "Teacher as Researcher" (Kincheloe 2003), "Ideology and Curriculum" (Apple 2004) and "Student as Researcher" (Steinberg and Kincheloe 2005) to demonstrate the depth that we tend not to engage in critical thinking when faced with figures and institutions with authority capital – even in contexts promoted as critical and/or constructivist. I hope the conversation detailed here with Joe will add some depth to two areas of concern that we often discussed regarding critical pedagogy: Critical thinking, indigenous knowledge, and their place within all schools.

Talking About Critical Thinking and an Ice Box Full of Neutral Knowledge

"Christopher, what's that?" Joe asked while pointing to a cooler that I pulled out of my car. Joe was obviously not confused by an ice box chest, rather it was the large warning pasted on the top of the cooler that he referred to. In large bold letters it read:

Caution: Contains Benign Live Animals
Keep at room temperature (18°C (64°F) to 23°C (73°F))
For Laboratory Observation only: Do not release
Dispose of through standard "Hazardous Waste" process

Canada Post markings suggested that this box had made some kind of journey and indicated that its origins were from a university in the United States. The cooler in the back of my car, belying the warning, had actually contained drinks for the 10-h drive to the James Bay Cree community of Mistissini in Northern Quebec. Joe, his wife Shirley Steinberg (a professor, critical pedagogy scholar and prolific author as well), and I were in the community in the fall of 2008 to begin our community-based research on the nature and function of schools in the community and the manner in which, if at all, indigenous knowledge influences curriculum.

"That …" I responded to Joe, "… is how I attempt to get students to get a better understanding of the works of Michael Apple, Shirley Steinberg, and Joe Kincheloe!"

Ever intrigued and *fascinated* (as he would often say) with the manner in which people taught and what they taught, Joe broadly smiled and said, “tell me”, and so I did.

> A central theme of Teachers as Researchers involves (…) the ability to identify and trace the effects of ethnocentrism within the Cartesian-Newtonian-Baconian tradition. Over the last few centuries, the western belief in the superiority of such frameworks of knowing has been assumed and widely accepted in western societies (…) Knowledge producers who operated outside of the boundaries of Cartesian science were viewed not only as inferior but uncivilized. (…) In this ethnocentric view, ‘true knowledge’ can only be produced by a detached, disinterested, external observer who works to ignore background (contextual) information by developing objective research techniques. (Kincheloe 2003, p. 11)

Despite multiculturalism courses and their cross curricular applications into areas like science education being touted as “par for the course” in many departments of education across Canada and in the United States, we are still left with the realities of a field that has a deep impact on minorities and indigenous knowledge. One of these significant realities is that an 80% White (Clark and O’Donnell, 1999) preservice teaching population (in my own local anecdotal observation, much higher) remains consistent, coupled with a prevailing sense that the role of teachers is to reproduce their own culture and knowledge (Semali and Kincheloe 1999) while civilizing others (Cavanagh and Harper 1994). This ideology creates a barrier for any real meaningful inclusion and does much to safeguard the *powerbloc* (Kincheloe and Steinberg 1997).

Stemming from Fiske’s (1993) use of the term, Kincheloe and Steinberg (1997) define the “powerbloc” as power wielders who hold access to valued resources (information, truth, cultural capital, wealth, media, etc.). To maintain power, education needs to be controlled to guarantee that children are schooled to accept existing societal structures, including the continued subjugation of indigenous people (both mind and body), locally and abroad. There is privilege associated with these systems of powerbloc, which is considered universal and not exclusive to indigenous people. While teaching in McGill University’s Office of First Nations and Inuit Education, which is a teacher education program serving (and often taught within) indigenous communities, it was common for students to ask if I taught courses to them, with the same rigor and expectations that I did in the “regular” teacher education program, delivered on McGill’s campus, in the Department of Integrated Studies in Education. My answer was always an emphatic “yes!” Inevitably, my students would follow with the ensuing question: why then, are their teaching certificates only valid in First Nation and Inuit schools? In a course that I taught in Cree territory, students were asked to search the internet for natural science lesson plan resources, and analyze them for their potential use. Then, they were directed to modify them for teaching in their particular context. One student inquired if students in McGill’s “regular” program had to do the same. When I responded with a “yes,” the following question was somewhat rhetorical as to whether other instructors did the same. If so, then why did non-Native teachers in the community do so little to modify their comprehension of subjects to the Cree context? Are their “ways of knowing” so inferior, compared with non-Native counterparts, that their knowledge had to be corralled on a reserve, whereas teachers from powerbloc origins are allowed to be universal purveyors of a true knowledge?

In communicating these anecdotes to Joe, and as a prelude to my "Live Animals" lesson, I commented that although dialoguing with Cree students about the differences in the value of knowledge between indigenous and nonindigenous contexts is one of experiences for them, the conversation is altogether different with preservice teachers who are entrenched in the powerbloc themselves – a struggle that Joe knew all too well. In my curriculum development class, we discuss these concepts of knowledge and truth and their relationship to power early, with writings of Kincheloe, Steinberg, and Apple taking center stage. Although, superficially, many students take quickly to the Kincheloe and Steinberg position of "teacher and student as researchers" (as this rightly does much to elevate the status of "teacher"), the arguments regarding the ethnocentrism of knowledge, especially its relationship to power are often the greatest challenges for both explanation and understanding. Apple's work, in particular, with his analysis on conflict as it relates to hegemony and science curriculum can cause considerable apprehension; for it is a subject that these students' experiences dictate has been and should be presented in the most "textbook" of fashion:

> One of my basic theses is that science, as it is presented in most elementary and a large portion of secondary classrooms, contributes to the learning by students of a basically unrealistic and essentially conservative perspective on the usefulness of conflict. Scientific domains are presented as bodies of knowledge ("thats" and "hows"), at best organized around central fundamental regularities as in the many discipline and inquiry-centered curricula that evolved after the "Brunerian revolution," at worst as fairly isolated data one masters for tests. Almost never is it seriously examined as a personal construction of human beings. (Apple 2004, p. 82)

Using science education as example in which eurowestern schools far too often detach the process of scientific discovery from the struggle and conflict in humans who exist in a time and space, Apple questions why these characteristics of science are so often absent from the science curriculum. The "context" of the knowledge that Kincheloe refers to, is absent from the inquiry, leaving students with the type of rote memory engagement in science subjects that serve only a few.

> Epistemologically speaking, science is a field dominated by empirical *research*. Yet, within science classrooms, students are not often encouraged to participate in the process of making knowledge through the application of scientific principles (i.e., through their own research). Rather, science is often taught by the transmission model of teaching, in which students are bombarded with vast quantities of information produced by experts. (…) Student success is then determined not based on their ability to ask careful questions by applying the method of science to problems within society or their own lives, but by regurgitating predigested and decontextualized facts and by reproducing predetermined results in contrived laboratory settings. (Kellog 1998, p. 213)

Some students will protest these ideas, perhaps arguing that "true knowledge" does exist and is absent from the trappings of human subjectivity, while others state that their classrooms will be open to constructivist learning, in a secure environment that allows children to question everything (even if it contradicts the teacher's intentions). In repeating these experiences with preservice teachers, Joe nodded in agreement, with his "been there, done that" smile. So, with all of this precursor information expressed, I explained to Joe why I had an ice box full of "benign live animals."

After class discussions on the readings of Apple and Kincheloe have been completed for about a month's time, the course reading take us to the next subject-specific discussion in science education. I assign a reading on animal behavior observation, and for example, how the large milkweed bug responds to stimuli of light. It is a good lesson idea, but if carried out superficially, does fall into the category of students making observations that will already be predetermined by the teacher. Often, students come to class hoping that we will carry out the experiment, giving them another valuable tool to add to their teaching toolbox, and when they see me enter the class with my ice box, their enthusiasm matches any elementary classroom in which I have ever taught in. Quickly, I tell the students that they are in for a treat, because I read about a really interesting scientific study being carried out at a major University in Alabama, USA, by the "Distinguished Professor of Caveat Emptor, Dr. Robert Murray," from the "Department of Micro & Marine Biology," regarding the amazing use of "water lice." Enthusiastically, I wave a letter from Dr. Murray, making sure students see that it is postmarked. I have a student read it aloud:

Dear Dr. Stonebanks,

Thank you very much for your interest in our work in developing natural methods in water cleansing. The University of St Barbara's Department of Micro & Marine Biology is committed to organic ways in solving some of the greatest problems in water pollution and we think that our "Water Lice" project will do just that.

As I am sure you are aware from your own initial research in this work, the Water Lice is a completely misunderstood insect that has tremendous benefits for the environment. Because they have the name "lice" attached to it, people think this insect feeds off of blood, rather, it feeds off of impurities in impure water. We at the lab think they should be called "Water Cleaners"! Our project has done so well we have used the Water Lice to clean many of the stagnant and unsafe waters in the residential areas of New Orleans after the tragic events of Hurricane Katrina (they even filmed our efforts in an upcoming edition of Discovery Channel's Dirty Jobs).

We will send you (by Fed Ex) three jars of contaminated water at three different stages. By the time you receive the package your class at Bishop's University should see the following:

Jar #1: Adult hatched Water Lice actively cleaning contaminated sewer water; water is unsafe to drink.
Jar #2: Fully mature Water Lice approximately three days into their cleaning process; the water should be mostly clean.
Jar #3: Approximately seven days into their life cycle the adults are gorged and die naturally and have laid microscopic eggs at the bottom of the jar; the water is now safe to drink and the water lice are edible to all animals (even for humans if you want to try!).

I have attached some photos for you and your students. I hope you find this information useful and I look forward to doing work with you.

Sincerely,

Dr. Robert Murray
Department of Micro & Marine Biology
Distinguished Professor of Caveat Emptor
University of St Barbara
Montgomery, Alabama, USA

As a student reads the letter, I place some jars on a table at the head of the class and hand out an "observation sheet" for the students to fill in. The screen at the front of the class has an endless looping of images showing highly magnified insect eggs, insect larvae, a close-up of an intimidating looking water insect with a series of menacing-looking mandibles behind a suction-cup like mouth, along with a photo of Mike Rowe from the Discovery Channel network's show, "Dirty Jobs" where he is holding up a jar filled with dirty water. The students get close to the jars, some staring intensively at the contents, and others giving a quick look and then shuddering due to some degree of entomophobia. All of the students work intently on filling in the handout. I watch and observe, and I wait to see what my many brilliant students who have demonstrated a working knowledge of critical thinking in the past, high regard for multiple ways of knowing and a commitment to individual perspectives, will do. After all, I have been assured so often by these students that they "get it": understand the nature of power, constructivism, and critical thinking. The preservice teachers are energetic, earnest, and they have no idea what will soon be revealed to them.

Writing this chapter and reflecting on explaining this lesson to Joe, I cannot help but think of what we have lost in Joe. Of course, the loss of Joe as a husband, father, brother, friend, mentor is overwhelming, but the academic world will also not be the same without his exhaustive energy, his genius, and his deep dedication to social justice. With Joe's unexpected and tragic death in 2009, we are left to continue the many research projects to which he was so strongly committed. In Mistissini, we were working on the development of a participant action research project that would examine the all-too-common disconnect between eurowestern/dominant knowledge and indigenous knowledge. But our research was not to end in this community. Our hope was to establish research connections between indigenous communities, taking the all-too-familiar problem of decolonizing schools and creating truly inclusive environments for those students in which schools have never really served. From the geographical location of Mistissini to other indigenous communities, our discussions included interconnectedness with the indigenous communities in the United States, Australia, New Zealand, and so forth. My recent trip to Malawi to establish research connections for critical pedagogy and indigenous knowledge in public schooling is an extension of that work, and I often thought about the discussion I had with Joe during that time in Malawi.

From Mistissini to Malawi

In the spring of 2009 I travelled to Malawi and Tanzania under the guidance of Doug Miller, retired teacher and current coordinator of the Makupo Development Project, and Francis Jumpe, a resident of Makupo, Malawi. The purpose of this trip was to develop research contacts, explore experiential learning possibilities for university students, and as I told a very surprised Malawi customs agent, *to learn*.

"Why are you visiting Malawi?" the customs agent asked.

"To learn about your country and its education system," I responded, perhaps a little too eagerly.

"Oh, very good." he said as he stamped my passport and sent me on my way.

Perhaps this time was the most expedient pass through customs (Canada and the United States included) that I ever have experienced. On this trip, we were primarily concerned with looking for research connections with academics, teachers, activists, political leaders, and/or any stakeholders in education who had an interest in delving into how indigenous knowledge is utilized in schools. I was earnest in expressing to these individuals that I knew there was much to learn about Malawi itself. To my surprise, the Malawi customs agent expressed that he was not shocked a foreigner carrying a Canadian passport had something to learn from his country; rather, it was a pleasant acknowledgement that if you were indeed open to it, there is much to experience. This was a response that we often received from those we met and it was also coupled with a hope of reciprocity, that is, that these individuals also hoped to dialogue and discover from our knowledge as well. Not limited to academics, people from all walks of Malawian society had something to say about the state of education and its relationship to life in Malawi.

The 1,400 m Mount Kasungu stands as a predominant geographical feature in the Kasungu region landscape of Malawi. Driving past it on the main highway, the first visual you are taken in with is not only the size of the mountain itself, but also how the bare slopes reveal the deforestation that has occurred. Deforestation in Malawi is due to wood being the principle source of fuel within economic reach of the vast majority of Malawians and a colonial history in which "colonial power structures did not capitalize on Malawi's natural resources. Instead, colonists introduced domesticated crops deemed of value to Europeans (e.g., tobacco, tea, sugar, cotton), but not to Malawians" (Kalipeni and Feder 1999, p. 38). For many of the Malawians I spoke with, there is a loss of biodiversity with indigenous plants also used as traditional medicines, namely, the "old ways of knowing" that were once reliable, trusted, and valued. Needless to say that deforestation on Mount Kasungu is nearly complete, with significant-sized mature tress standing only in areas beyond the physical reach of humans. I was told by locals that Kasungu was a strategic site of resistance, or natural stronghold, which allowed a local chief to repel an invasion by a rival tribe. Spiritually, it also is the site of pilgrimage, with the ascent and prolonged time and prayer at the peak of the mountain being considered a holy experience.

Indigenous Knowledge and "the Old Ways of Knowing"

A guided educational tour near Cape MacLear, on the shore of Lake Malawi, brought us closer to thinking about Mount Kasungu again. We would investigate whether the same educational, sustainable tourism approaches could be reproduced in this central, rural region of Kasungu. A few weeks earlier, I visited the Cape MacLear National Park, a freshwater fish sanctuary designated a UNESCO World Heritage Site for its diversity of cichlids and its research on the evolution of the species. We were fortunate to receive a hiking tour of the park by local guides who had started to delve into a new form of sustainable, educational tourism because, as the senior guide of the two expressed, the alternative "party" tourism, the faux beach resort Caribbean/reggae tourism, had "taken too much out of him," both physically and spiritually. What follows is an entry from my personal journal entitled "Gramsci's organic intellectual is alive and well and working in Cape Maclear" that recounts that journey:

> The plan was for our guides to take us up the mountain of Nkunguni (little ant) for an educational outing combined with a bit of much-needed exercise. Our first description by (the first guide) was that it would be a thirty-minute hike up the mountain and thirty-minute hike down. Once (the second guide) joined us the next day and explained it would be a two-hour walk up the mountain, we realized that the focus on the exercise might overshadow the education. Reality hit us hard past the gates of Lake Malawi National Park as we saw the graves of the missionaries who were part of Dr. Robert Laws' Livingstonia missionary, established in 1875 and abandoned shortly thereafter due to the high rates of Malaria. Our guides tell us it was the plan of Dr. Laws to place the missionary at the top of the mountain, to ensure that the missionaries were both strong of body as well as mind and spirit. However, their graves at the base do not inspire. Twenty minutes in, up the sharp incline of the mountain, and it wasn't just the feeling of being on a relentless stair-climber, but it was the altitude difference that started causing havoc on the muscles of the non-Malawians on this excursion. We've all heard of the benefits of high-altitude training for athletes and the difference and advantages it gives once they acclimatize (if they are not indigenous to the context) to it … experiencing it first hand is humbling. My thigh muscles were screaming in pain and the familiar feeling of lactic acids building up after multiple hockey games on a tournament weekend … that sitting-on-the-bench-don't-send-me-out-there-coach kind of pain. Periodically, (the second guide) would stop and show us various plants and explaining their medicinal uses. I wish I could say that I paid complete attention to the knowledge he was sharing, but every time he stopped, it was a chance to try and get some oxygen in my body. Halfway up the mountain, the muscles cramped and said, "no mas"; the legs couldn't do it. Being a professor is an exceptional privilege, but this was a life lesson that I need to spend more time exercising and less on the computer. Our senior (second) guide, an expert motivator, knew exactly what to say. An earlier conversation revealed that he was Yao and Muslim; the Yao tribe, converts to Islam through their interactions with the Zanzaberi Arabs, and whose history, unfortunately, includes the capture and selling of Malawians for the slave trade. So, Amwenye (Malawi term for anyone who is Arab, Iranian, Pakistani, Indian, etc.) and Yao joked about our shared history, with our Chewa colleagues laughing and wagging their disapproving fingers at us. Halfway up the mountain I expressed that I couldn't continue. "My Muslim brother, I know you have the strength." "How much further to the top?"I asked. "An hour more" he replied. "An hour?!!" "Okay, half an hour", he negotiated. Wow, this guy can modify time! I'm motivated, and continue the climb and at the peak, I see why the hike was worth it. At its pinnacle we stop

> for water, bananas, and peanuts and (the second guide) continues to explain his work in educational tourism and his relationship with a university in the UK in the areas of Physical Geography, Human Geography, and "old ways of knowing" (indigenous knowledge) concerning heath science. He tells us that students from Europe are now coming to people like him for education on not just the region, but in the areas of study itself. I'm exhausted, but pleased to hear that such forays are being developed and hope the relationship is reciprocal; we have so much to learn, but I'm not clear, beyond monetary compensation, on what he is getting back. (Stonebanks personal log, June 1, 2009)

Our guides were, in many ways, engaged in an organic intellectual counter-hegemonic educational activity, in the Gramscian "… conception, as intellectuals who are organic to the 'subaltern' groups aspiring to power" (Mayo 2008, p. 427). Recognizing that the economics, tourism, and way of life of pseudo-"Club Med/Sandals like, often foreign owned, hotel tourist spots" on the lake were not entirely beneficial to the community, a group of locals began the process of reclaiming regional expertise, resources, and knowledge in a manner that was sustainable and educational. Returning to the village of Makupo, we looked up to Mount Kasungu and discussed whether the same pursuit of regional knowledge, economics, and lifestyle could be reproduced here. However, Glasson captures the challenge of reinvigorating the spirit of this notion:

> Despite spending their whole lives in Malawi, most teacher educators had never visited a wildlife park in their own country. (Glasson et al. 2006, p. 670)

Many of the villagers within Makupo had never been to Mount Kasungu, not because they lacked interest or the desire to go, but rather because the hour-long walk to the mountain itself was a luxury of time many villagers could not afford.

An earlier trip with villagers to the Kasungu National Park, a 20-min drive from their village, offered a luxury few could afford but were willing to do. Sitting with these villagers, we discussed what knowledge our guides from Cape MacLear were able to share: animals to the uses of indigenous plant life for medicinal purposes and the changing relationships of local people with the land. With these villagers, we tried to reproduce the recreation knowledge from our previous guides up the mountain, but discovered that it was quite a daunting task, not easily reproduced, as if some kind of "quaint and primitive" understanding of a world is embedded beyond local comprehension (Semali and Kincheloe 1999). In contrast, as Maurial (1999) explains, this deeply embedded knowledge is a complex process:

> Indigenous knowledge is peoples' cognitive and wise legacy as a result of their interaction with nature in a common territory. Indigenous peoples, with a common history of colonization by western culture, constantly regenerate this knowledge. (p. 62)

Moreover, it is "not static; external sources or knowledge have an impact on it" (George 1999, p. 82) and is subject to its own natural growth, as is any knowledge. Given the depth of the kind of information we were seeking, no one thought or suggested this first trip to the mountain would result in anything but an opportunity to observe for the sake of generating questions for a later date, which is exactly what we experienced on that day. The most interesting aspect of this excursion was the conversations and preparations for these questions that I now want to focus on for this chapter. Few individuals from the village had been to the mountain and few were sure what we would find or knew how to make sense of it in the manner in which our Cape MacLear guides could or, perhaps most importantly, what a person from the west associated with schooling, and really wanted to gain from the types of knowledge that could be learned from this relatively small part of Malawi.

Christianity, Commerce and Civilization

Happily, three men from Makupo expressed an interest in participating in the endeavor of climbing the mountain for education purposes. One of these men was recently accepted to teacher's college. In our conversations about the forthcoming trip, we took the opportunity to talk about his future prospective professional aspirations and his experiences in school, that is, what he anticipated to learn at teacher's college, and what he hoped to accomplish as a teacher in Malawi's schools. Perhaps, since he was a bit shy around a professor of education who he knew met with the principal of the teacher's college to discuss his application, he responded in a way that was somewhat *robotic* (his answers seemed to be aimed at pleasing me).

I have always been fascinated with people's mechanical, automated responses about schooling, because they are so telling of things we either uncritically take for granted or are often not aware of. So I asked this teacher bluntly, "what do you think is the purpose of schools?" He considered the question briefly and said, "schools bring civilization to the people of Malawi."

"Civilization?" given any of the definitions for the term, in my brief time in Malawi – civilization – was not exactly what I thought was Malawi's most pressing need, especially given this young man's comprehension of what it meant.

His description was an essentially romanticized eurowestern view of missionary educators "bringing light into the darkness of Africa" and diametrically opposed to our collective assignment of going to the mountain to reclaim a knowledge for the villagers that had been almost wiped out by colonialism. Given this "civilization" apprehension of things for the teacher, I remained especially curious. Had my political science professor been there with me, he would have challenged the teacher on his answer and made him question "his history, his heritage." Much like the Cree communities, or my devaluing of my personal history and heritage, his answer spoke volumes of the impact of eurowestern dominance and influence on knowledge and its colonial impact across imposed borders.

A statement from Sicherman (1995) embodies this point clearly:

> The Europeanizing of the students had long been a goal of educators in East Africa. Acting on the premise "that European civilization...is the highest known scheme of relationships," teachers who knew "little of the African, his language, and his mind" were given "full authority over African boys and girls." (p. 25)

Sicherman's examination of Kenyan author Ngũgĩ wa Thiong'o's experience of an elite Kenyan colonial education, in which "(t)he motto of the school, 'Strong to

Serve'" was to create, in Ngũgĩ wa Thiong'o's own analysis "of his headmaster's goal – 'efficient machines for running a colonial system'" (p. 11). Among Ngũgĩ wa Thiong'o's prolific writing is *Decolonising the Mind: The Politics of Language in African Literature* (1986), where the argument is made for African authors and artists to reject imperialist languages and recreate in their own native tongue. This call to action is a direct assault on the concerted efforts of the Europeanizing civilization that was imposed upon him during his youth. Turning back to the young preservice teacher, I wondered if the "civilization" he and his peers had received really had made a positive difference in their lives. This brought to mind the preservice teachers I worked with in Cree communities who would initially respond in class to questions based on what they thought was expected of them as opposed to what they *knew* (Stonebanks 2008b). I wanted to ask, in what way do you see this endeavor of imparting "civilization" on the people of Malawi as beneficial? Has it worked? One answer to these questions that could be inferred from the history of colonization in this area of Malawi was the source of the preservice teacher's influences:

> David Livingstone has been both missionary icon and missionary villain in the past. For many he was the epitome of mission pioneering and for others an imperialistic missionary paternalist with few if any fruit. (Conradie 2007, p. 144)

One needs to only spend a short time in Malawi and possess a slight passing interest in history to connect the historic figure of David Livingstone – missionary, abolitionist and medical doctor – to the education system. Livingstone's influential "3-C's," namely, Christianity, Commerce and Civilization, are synonymous with his name and with the development and current condition of Malawi. Despite that, Nkomazana (1998) objects, noting that Livingstone has been unfairly "attacked" by critics in recent times "for having led the way for European colonization of Africa" (p. 45). Livingstone is a contentious and misunderstood figure. From a purely anecdotal observation, it can be noted that that Livingstone is also a cherished figure among the people of Malawi and he is admired for good reason:

> Livingstone saw the problems of slave trade and illiteracy to be among the greatest blocks to Christian progress and economic progress in Africa. The introduction of education, he thought, would prepare African people for development and would also provoke African initiatives in the development of their natural resources. Livingstone believed that the development of agriculture and industry would raise people's standards of living and eventually overcome their greatest enemy, "slavery." (Nkomazana 1998 p. 45)

Missionary villain or hero, Conardie (2007) recognizes that, although distorted in Livingstone's own opinion, "(h)is ideas and vision for the fusion of Christianity and commerce was used to morally justify and glorify British Empire. (…) Civilization had been used to impose the will of the Imperial powers to conform to the example of 'Civilized Europe' in order to produce goods for the 'Mother country' … Civilization therefore became synonymous with colonialism and oppression" (p. 145). The young preservice teacher's response to my questions about schooling suggested that there remains a residual of effect of Livingstone's efforts in Malawi. Twisted or misunderstood, as some may argue, the legacy of Livingstone remains firmly entrenched in the highly Europeanized Malawian schools. Certainly, the young preservice teacher's perspective was similar to other answers that suggested that "the majority of Malawians remain caught up in the notion that theirs is an obscure, insignificant identity that has nowhere but Europe and America to look to for education and modernity" (Sharra 2002, p. 4).

Picking up on my silent, but less than receptive response to his answer, the young preservice teacher asked me what I thought the purpose of schooling was. I pointed to my Kincheloe influenced, purple silicone, wristlet band embossed with Kincheloe's favorite saying, "Life is good," and proceeded to talk to the young man about the notion of schools being one place where we can end, or at least ease, human suffering. For a month and a half, I had been travelling across Malawi trying to develop an initial understanding of the country and observe but primarily listen to people's perspectives on the state of education. Of course, it is common and correct to state that Malawi's people are overwhelmingly kind and its land beautiful, but, as Glasson et al. (2006) notes, there are other elements in regard to human suffering that are difficult to overlook.

"But, You Know, We are Very Poor"

> Across south central Africa, Malawi, and her people, are known as the "Warm Heart" of Africa. Sadly, however, the gentleness of the Malawian people and the vast beauty of the Malawian countryside do little to hide the desperate environmental conditions of Malawi, as well as the impoverished living conditions of most of its inhabitants. (Glasson et al. 2006, p. 661)

Poverty and poor health is abundant in Malawi. Many people openly voice that the youth of Malawi have little economic opportunity and many note that health-related issues ranging from HIV/AIDS to poor quality of drinking water make waterborne diseases, such as typhoid and cholera, an ongoing concern. The World Health Organization puts the "healthy life expectancy" of the average Malawian at 35, as compared with 69 for a U.S. citizen and 72 for a Canadian.

While sitting outside with a village elder, I commented on the fantastic clarity of the night sky, unpolluted by artificial light and remarked how lucky the villagers were to actually be able to see this inspirational sight that has now been lost for so many of us living in highly industrialized societies. The village elder, nodded in agreement, looking up at the sky and responded, "but, you know, we are very poor." Putting my "rose colored glasses" aside, for the vast majority of people living in Malawi, life is extremely difficult.

> For many people from traditional cultures in developing countries, living in poverty and on the brink of survival in environmentally degraded conditions is the norm. Therefore, understanding indigenous science and technology or how scientific knowledge is understood and applied in everyday life contexts may have important implications for curriculum reform in primary science and environmental education in developing African countries. (Glasson et al. 2006, p. 663)

Foremost in my observation of and conversations with academics and activists was that the education system in Malawi is predominantly "traditional" in nature, with a classic teacher-centered format being the standard pedagogy. Qualified primary school teachers work in classrooms with a ratio of 1:108 (Director– Education Methods Advisory Services 2005), working as hard as humanly possible, but in, what Nsapato (2005) refers to as a “sick education system” (p. 3). In defining that public education should be a fundamental right of children, public education should be able to provide to its stakeholders, as Nsapato writes, an opportunity where they are able to “live a reasonably useful and beneficial life” (p. 1). During a meeting with distinguished scholar, historian Dr. D. D. Phiri commented quite sadly that globally, a few people in power are critical of education as a fundamental system for children; especially when the system is obviously not working in some parts of the world (in terms of economic improvement).

Recognizing the limited ability for affordable education to the majority of Malawians, Phiri created the Aggrey Memorial School, to pursue his passion to provide education for as many people as possible. Whether Livingstone’s intention or not, his appeal at various British universities, in which he said, “I go back to Africa to try to make an open path for commerce and Christianity. Do you carry on this work, which I have begun? I leave it to you” (Phiri 2004, p. 115) must also mean that the legacy of his work set the wheels in motion for a system of education, which does not function to fulfill the most basic of needs for the majority of those in Malawi.

Consider the following quote: “What? Post-colonialism? Have they left?” (as cited in Tuhwai Smith 1999). This quote connects with Ngũgĩ wa Thiong’o’s analysis of education systems in Kenya as a bridge to develop people who will continue to serve a colonial system. This prophecy is fulfilled with the young preservice teacher in my presence who states that his people need to be civilized. What, in turn, can be said of our own “eurowestern” powerbloc dominated system that continues to influence with so much authority? Are these “eurowestern” powerbloc (Malawian) schools the bastions of critical thought that is so often professed by visitors, or a tacit accomplice to the global education system of hegemonic reproduction?

Critical Pedagogy and “Business as Usual”

> (O)ne of the greatest failures of critical pedagogy at this juncture of its history involves the inability to engage people of African, Asian, and indigenous backgrounds in our tradition. I call for intense efforts in the coming years to bring more diversity into our ranks for two purposes: (1) Critical pedagogy has profound insight to pass along to all peoples; and (2) Critical pedagogy has much to learn from the often subjugated knowledge of African, African American, Asian, and indigenous people. (Kincheloe 2007, p. 11)

The “our” tradition that Kincheloe refers to is that of critical pedagogy, stemming from the emancipatory work of Paulo Freire (2005). And if, in the context and purposes of this chapter at least, some of the central hallmarks of critical pedagogy are defined as developing an awareness of the political nature of education, which is grounded in social justice and equity with the ultimate desire to alleviate human suffering (Kincheloe 2008), then, much needs to be done both home and abroad. I write "home and abroad" because, as Kincheloe notes, a reciprocity (i.e., learning from each other) is needed to achieve Kincheloe's goal, no matter where one resides in the world. After all, if a primary school classroom in Canada or the United States carries out a natural science project about the Rainforest in South America (a common enough endeavor), can the learning truly be as complete as possible without, for example, mentioning the relationships, which deprived South American's of their forests? A significant issue is that because of consumerism in North America, the rainforests have become depleted. Moreover, can a classroom in Brazil truly understand the state and health of their rainforests without investigating their relationship with what (and why) they produce for export and evaluate the equity or sustainability of that trade relationship with North America? In trying to tackle some of these questions, another essential element of critical pedagogy arises, that is, education, which uncovers what is so often hidden within the curriculum and simply taken as "business as usual" in schools and affects people so deeply (Apple 2004).

> Schools do not only control people; they also help control meaning. Since they preserve and distribute what is perceived to be "legitimate knowledge" – the knowledge that "we all must have," schools confer cultural legitimacy on the knowledge of specific groups. (Apple 2004, p. 61)

From a critical pedagogy perspective, education is often analyzed in terms of how it serves the needs of colonialism and imperialism in all contexts, to develop a teaching and learning environment for schools in which potential injustices can be revealed and acted upon in schooling. To accomplish this goal, critical pedagogues call for the professionalism of teachers, which in turn, necessitates a new type of "accountability" that requires that educators become scholars and researchers (Shor and Pari 1999). The kind of accountability that is linked with critical pedagogy is unlike the standardized "top down" version that has been co-opted and twisted by those in power today to serve government needs. It is a form of accountability that empowers teachers to stand behind their teaching choices and to speak out against what is often mandated, enforced, and normalized from the top down.

> Two great rivers of reform are flowing in opposite directions across the immense landscapes of American education. One river flows from the top down and the other from the bottom up. (Shor 1999, p. vii)

Whereas Shor characterizes the top-down river as being an authority stemming from "… conservative agendas that support inequality", the bottom-up waters of knowledge derive from "…multicultural voices speaking for social justice" (1999). Shor and Pari's book, *Education is Politics* (1999), reports concrete examples of teachers who have moved from what Kincheloe (2003) refers to as the traditional "technicist" approach to education where teachers are highly controlled by those above them, to an approach where accountability is conceptually recaptured as a responsibility for teachers to embrace as Education itself. Education is a true profession when this sort of critical pedagogy is realized, which goes beyond a set of standards imposed from above. Education from above tends to claim neutrality and meritocracy while reinforcing inequality for all. In contrast, the bottom-up approach encourages teachers to be active, and participate in the evolution of the profession, from evaluating teaching methods to shaping school curriculum. From a critical pedagogy perspective, education is analyzed in terms of the limitations of serving the needs of colonialism and imperialism from schools in the economically privileged countries to schools in economically marginalized nations, building a teaching and learning environment in which potential injustices can thus be revealed and, to the extent possible, acted upon.

> but I think we need to examine the special fears teachers have about transforming themselves. I've heard teachers talk directly and indirectly about their fears. They worry about being fired if they practice emancipating education instead of the transfer-of-knowledge pedagogy. (Shor and Freire 1987, p. 53)

Revealing such injustices involves risk.

In as much as critical pedagogy has a good deal to offer all people, what *can be* learned *from* subjugated knowledge is often a clarity of perspectives that shatter eurowestern claims of objectivity and neutrality – critical questions that are often avoided in our schools.

> One of the class participants asked how people acquired farms in the United States. In response, the U.S. teacher researchers shared how land was taken from indigenous people who were forced to relocate to less desirable land. This sharing of the eco-justice issue of Native Americans being displaced from their ancestral land was remarkably similar to the diaspora of villagers in Malawi. The elite top-down approach from experts or the government for solving ecological degradation problems did not seem to resonate with the class. (Glasson et al. 2006, p. 671)

A straightforward, critical question asked in a class in Malawi, results in a dialogue that would leave many uncomfortable in our Canadian and U.S. schools. After all, the transfer-of-knowledge pedagogy has inadvertently perpetuated a eurowestern understanding of educators' role in the world, as purveyors of objective justice and disseminators of equity. For example, tackling ecojustice conditions with an acknowledgment of who has power and privilege being an essential part of the problem-solving process requires educators and learners to question what has been told to them and wade through the dirty waters to find, what can sometimes be, uncomfortable answers. And, of course mentioning "dirty waters" brings us back to the conversation with Joe in a village named Mistissini, I started this chapter with.

Raisins Floating in Soda Water

Always positive, inquisitive, and engaged, Joe listened intently, waiting to hear how jars full of dirty water and water lice connected with his work. I continued to describe the manner in which most (if not all) of the students would carry out the supposed inquiry-based assignment. With observation and a response sheet in hand, students would move uniformly from their desks to the jars, looking through the various stages of dirty waters and the "bugs," and dutifully complete their study assignment. Statements like "Gross!," and "That is so disgusting!" and "Cool!" are commonly expressed. When students get to the section of the handout that asks for their opinion on possible uses for the "water lice," most describe the water lice as a solution to the current blue-green algae problems that have been increasingly plaguing many drinking water sources in eastern Canada.

Nodding his head, Joe mentioned the social science research he had his undergrad students carry out on some of the water quality problems in Shreveport, Louisiana in the early 1980s. He recounted a lesson based on having his students realize the significance of carrying out primary research, including science research, for themselves, before embarking on such lessons with their elementary school students. In one of his articles on this practice, he comments,

> Indeed, the research background of most students was weak. Many confided that they had never before had to undertake a research project of any magnitude. This revelation illustrated a broader problem among elementary, and many secondary, school social studies teachers, that is, the inability to conduct research. It is no wonder that inquiry methodology has often not worked in the public schools – too many teachers do not have the research skills necessary to make it work. (Kincheloe 1985, p. 181)

For Joe, a key component to strong research is asking the fundamental question of how knowledge is produced, where it comes from, and who produces it (Kincheloe 2008)? In the water lice lesson, I do my best to make sure most of the key elements for unquestioned knowledge reproduction are included: The source of the knowledge is scientific, it is derived from a North American source (the pinnacle location of western/dominant knowledge), the author of the information is, from the sound of the name at least, from a powerbloc or White background (which may not be true of course). However, to confirm that my assumptions are valid, I have corroborated these assumptions through a Canadian television show. Only once, in the past 3 years that I have carried out this lesson did one exceptional student express doubt in what she was looking at. But, all it took to silence her observation of disbelief was her peers disapproving looks. With that peer pressure, she returned to her desk and robotically completed the assignment, filling in information that she was entirely unsure of.

From a scientific reality, this disbelieving student was right; students were not witnessing water lice cleaning polluted water. Rather, they were looking at raisins moving in various stages of carbonated soda water and with varying degrees of food colouring, creating the illusion of bugs cleaning water (for a description of this experiment see *Science as In?uiry* (Hassard 2000, p. 258). Even the students that I consider the "most critical," in a critical pedagogy sense of this term, expressed that they "got caught up" in not only the excitement, but with all of the prestige of the scientific source of the information as well. Concomitantly, I'm often asked if I carry out this little experiment to make my students "look bad." I am always prepared to say that my wife, Melanie, who is an elementary school teacher, caught me not thinking critically as well when she did this study in her class. We all need to think deeper and more critically, especially in an era where a PowerPoint presentation at the United Nations can be seen as a "slam dunk" for evidence and acquiescence for U.S. masses, leading the world's most powerful military force into Iraq and the death of hundreds of thousands (Denzin and Giardina 2008).

Listening attentively and periodically laughing along with the explanation of my own use of the water lice experiment, Joe expressed how I needed to publish and communicate this endeavor with our colleagues. Appropriately, having this conversation in the Cree village of Mistissini, we agreed that with the influence and imposition of "western" models of education with cultures and nations that have experienced the exploitation of imperialism and colonialism, sharing our attempts to make teaching truly critical and responsive is an important mission. This mission involves comprehending how knowledge is produced and whose knowledge is privileged as a global consideration of colonialism and imperialism. In the absence of critical dialogue, words like "global village" or "sustainability" have become passive school buzzwords instead of essential concepts worthy of careful and active consideration, with few exceptions.

What I hope can be further clarified for preservice teachers is the manner in which the politics of knowledge shapes schooling and how it validates some privileged narratives and reproduces the silences of the marginalized. Scientific knowledge, which is often portrayed as *the* only truth, which is apparently derived solely from the minds of the dominant power and culture, continues to subjugate those children who are learning inany different way. From a critical pedagogy perspective, it is not "science" itself that is in question, promoting some kind of anti-science stance, but rather what is being examined in order to serve the needs of those individuals in power. An important question is whether or not science leads to reducing human (and nonhuman) suffering. Such consideration could be made in all educational contexts if humane critical thinking is truly being put into practice.

Before beginning a social science class with preservice teachers, I spotted a "teachable moment" as a student prepared to bite into an unusual perfectly shaped, stunningly colored and grotesquely large apple and I said out loud for all to hear, "wait! Before you bite into that apple: do you want to know where it came from? What were the working conditions of the people who grew and picked it? Whose land did it come from? Was the fruit indigenous to that area? What chemicals were used in the growing process? Was the fruit genetically modified in any way? Do you want to ask these questions before you bite into that apple?" Unmoved, at least superficially, the student firmly said "no," and bit into the apple. Was she earnest or being humorous? I am not sure. But what I can be sure of is that she trusted the apple much more than she did the critical thinking she was being asked to consider in a course designed with readings of scholars like Kincheloe, and that other, Apple (2004).

References

Apple, M. (2004). *Ideology and curriculum*. New York: Routledge.

Cavanagh, S., & Harper, H. (1994). Lady bountiful: The white woman teacher in multicultural education. *Women's Education/Des Femmes, 11*(2), 27–33.

Clark, C., & O'Donnell, J. (1999). *Rearticulating a racial identity: Creating oppositional spaces to fight for equality and social justice*. Westport: Bergin & Garvey.

Conardie, S. (2007). David Livingstone's vision revisited; Christianity, commerce and civilisation in the 21st century. *Momentum*, *January/February*, 144–151.

Denzin, N., & Giardina, M. (2008). *Qualitative inquiry and the politics of evidence*. Walnut Creek: Left Coast Press.

Fiske, J. (1993). *Power plays power works*. New York: Verso Books.

Freire, P. (2005). *Pedagogy of the oppressed: 30th Anniversary of Pedagogy of the oppressed*. New York: Continuum Press.

George, J. M. (1999). Indigenous knowledge as a component of the school curriculum. In L. Semali & J. Kincheloe (Eds.), *What is indigenous knowledge?: Voices from the academy* (pp. 79–94). New York: Falmer.

Glasson, G., Frykholm, J., Mhango, N., & Phiri, A. (2006). Understanding the earth systems of Malawi: Ecological sustainability, culture, and place-based education. *Science Education, 90*, 660–680.

Hassard, J. (2000). *Science as inquiry: Active learning, project-based, web-assisted, and active assessment strategies to enhance student learning*. Parsippany: Good Year Books.

Kalipeni, E., & Feder, D. (1999). A political ecology perspective on environmental change in Malawi with the Blantyre Fuelwood Project Area as a case study. *Politics and the Life Sciences, 18*, 37–54.

Kellog, J. D. (1998). Exploring critical distance in science education: Students researching the implications of technological embeddedness. In S. R. Steinberg & J. L. Kincheloe (Eds.), *Students as researchers: Creating classrooms that matter*. New York: Routledge.

Kincheloe, J. L. (2003). *Teachers as researchers: Qualitative inquiry as a path to empowerment*. New York: Routledge Falmer.

Kincheloe, J. L. (2008). *Knowledge and critical pedagogy: An Introduction*. Dordrecht/London: Springer.

Kincheloe, J. L. (1985). Using primary research to teach elementary school social studies methods: Exploring Shrevport's water. *Social Studies*, *76*(4), n.p.

Kincheloe, J., & Steinberg, S. (1997). *Changing multiculturalism*. Buckingham: Open University Press.

Maurial, M. (1999). Indigenous knowledge and schooling: continuum between conflict and dialogue. In L. Semali & J. Kincheloe (Eds.), *What is indigenous knowledge?: Voices from the academy* (pp. 59–78). New York: Falmer.

Mayo, P. (2008). Antonio Gramsci and his relevance for the education of adults. *Educational Philosophy and Theory, 40*, 418–435.

Morgan, M. H. (2007). *Lost history: The enduring legacy of Muslim scientists, thinkers, and artists*. Washington, DC: National Geographic Society.

Ngugi wa Thiong'o. (1999). *Decolonizing the mind: The politics of language in African literature*. New Hampshire: Heinemann.

Nkomazana, F. (1998). Livingstone's ideas of Christianity, commerce and civilization. *Pula: Botswana Journal of African Studies, 12*(1 & 2), 44–57.

Nsapato, L. (2005). *Factors affecting the quality of basic education in Malawi.* Paper presented at the Malawi National Education Conference, Lilongwe, Malawi

Phiri, D. D. (2004). *History of Malawi: From earliest times to the year 1915*. Malawi: Christian Literature Association in Malawi.

Semali, L., & Kincheloe, J. (1999). Introduction: What is indigenous knowledge and why should we study it? In L. Semali & J. Kincheloe (Eds.), *What is indigenous knowledge: Voices from the academy*. New York: Falmer.

Sharra, S. (2002). *The heart of alien conquest: Constructing modern-global identity and marginality through language arts in Malawian classrooms*. (ERIC Document Reproduction Service No. ED477154). Retrieved July 9, 2009, from ERIC database.

Shor, I., & Freire, P. (1987). *A pedagogy for liberation: Dialogues on transforming education*. Westport: Bergin & Garvey.

Shor, I., & Pari, C. (1999). *Education is politics: Critical teaching across differences, K-12*. Portsmouth: Boyton/Cook Heinmann.

Sicherman, C. (1995). Ngugi's colonial education: The subversion … of the African mind. *African Studies Review, 38*(3), 11–41.

Smith Tuhiwai, L. (1999). *Decolonizing methodologies: Research and indigenous peoples*. London: Zed Books.

Steinberg, S., & Kincheloe, J. (2005). *Students as researchers: Creating classrooms that matter*. New York: RoutledgeFalmer.

Stonebanks, C. D. (2008a). An Islamic perspective on knowledge, knowing and methodology. In N. Denzin, Y. Lincoln, & L. Smith (Eds.), *Handbook of critical and indigenous methodologies*. Thousand Oaks: Sage.

Stonebanks, C. D. (2008b). *James Bay Cree and higher education: Issues of identity and culture shock*. Rotterdam: Sense.

Chapter 32
Rethinking Models of Collaboration in Critical Pedagogy: A Response to Stonebanks

Cory Buxton and Eugene F. Provenzo, Jr.

Introduction

Christopher Stonebanks raises a number of important questions about the meaning of critical thinking when it comes to teaching and teacher education and especially about the relationship between critical thinking and indigenous knowledge. Critical thinking and indigenous knowledge are both areas of concern for critical theorists, but Stonebanks raises the question of how these two areas of interest play out in teacher education – the "other hat" that many of us who are engaged in critical pedagogy as part of our scholarship wear. Stonebanks' answer to the question for his own practice is that it needs improvement. He believes that his answer may have implications for other teacher educators as well. Stonebanks makes the point that in the North American context, those of us who work in teacher education have largely settled with complacency when it comes to preparing our teachers for the culturally and linguistically diverse school settings where many of our predominantly White, middle-class, female teachers will find themselves working. We give our preservice teachers a course on multicultural education, we integrate diversity topics such as valuing students' "funds of knowledge" into our methods courses, and we look for some evidence through a project or lesson plan that our teachers have demonstrated the value of diversity in their classrooms. With those pieces in place, we hope that our graduates will go on to be culturally responsive teachers. After all, we ask ourselves, is there really more that we can do at this stage of these young people's development as teachers? As for the teachers themselves, once they have heard our "pitch" for the importance of multicultural education in several of their classes, they often begin to respond with some stock answers about teaching diverse learners that they think we want to hear, or "mechanically" as Stonebanks puts it. Stonebanks' examples of the "water lice" experiment and his exploration of

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_32,

education in the Malawian context challenge us to rethink our ideas about the roles of critical thinking and indigenous knowledge in teacher education.

Perhaps part of the way forward in reconsidering our own roles as teacher educators in economically advantaged nations can arise from closer collaborations between content area educators and foundations educators in our teacher preparation programs. The two of us (Buxton, a science educator with an interest in multicultural and multilingual learning contexts, and Provenzo, a social critic with an interest in the history of science) have been engaged in fruitful writing and teaching projects together for several years. We have experienced firsthand how our different training and backgrounds can be brought together in ways that push both our thinking and that of our students in new directions. Below, each of us shares our thoughts on ways that we might better support our teachers in becoming critical science educators.

Cory's Perspective

While I wholeheartedly agree with Stonebanks' critique of our shortcomings in teacher education when it comes to supporting our preservice teachers in developing critical thinking and leveraging their students' nonmainstream or indigenous knowledge, I will also confess to remaining more optimistic about the current generation of preservice teachers than some. It is true that they are the Web 2.0 generation who want to share the minutia of their lives with friends and perhaps even with total strangers via Facebook posts, Twitter tweets, and text messages, yet they may be even more isolated than past generations from direct contact with people from different socioeconomic, ethnic, racial, and religious backgrounds. They are also the first generation of teachers who have, themselves, come through school experiencing the new standards and accountability-driven teaching and learning as students. At times I feel that this has led to a degree of anti-intellectualism in many of these students, especially when they are asked to struggle with ambiguous topics. One of my biggest concerns about our current model of standards-based instruction is that it seems to promote uniformity of thinking and reaffirm the tendency students already have to focus on the "right answer" – what the teacher or test developer wants to hear – rather than promoting intellectual curiosity. Despite these concerns, I also find this current generation of preservice teachers to be idealistic and justice oriented, though perhaps in a somewhat different way than my generation.

This current generation of students has been required to do considerably more community service and service learning than past generations. While my generation may be more intellectually critical, this generation seems more comfortable taking action to directly improve individual's lives. We were more likely to protest policies, by building shantytowns and holding sit-ins to argue against institutional investments in Apartheid-era South Africa. They are more likely to do direct service, such as spending time volunteering in a soup kitchen, shelter, or after-school program.

Can we say which of these two behaviors is better suited to support the development of critical thinking and valuing indigenous and other nonmainstream knowledge systems? Surely, it depends on how we leverage those experiences.

When I recently addressed the topic of service learning in my undergraduate Social Studies Methods course, nearly every student had interesting stories to tell about their community service experiences, including several cases of international development work. In our current, top-down standards-based system, we tend not, however, to do a good job of connecting those service experiences to challenging intellectual goals. How do we leverage these young people's strengths and their own cultural resources, rather than falling into a deficit-based critique of their shortcomings or limitations? As a starting point, I would propose two approaches: a focus on critical media literacy to promote the issue of critical thinking and a focus on place-based education to promote the issue of indigenous and other nonmainstream knowledge.

Stonebanks alludes to the role that corporate advertising plays as an influence on today's young people and their identity formation. While advertising is certainly not new, it has reached a new level of sophistication in leveraging both technological and marketing innovations over the past decade. Youth are typically immersed in these advertising media but rarely have the opportunity to learn to deconstruct corporate messages. Critical media literacy, promoted by Goodman (2003) among others, is grounded in the idea that schools are missing a vital opportunity to engage students in intellectually challenging and socially valuable activities by critiquing modern media.

We currently have a substantial disconnect between youth language and communication, which are media rich, and school language and communication, which are media poor. However, the engaging media to which youth gravitate are also predominantly commercial in nature and are aimed at promoting consumerism and thus need to be critically examined and their messages deconstructed. Critical media literacy, as I have been practicing it with my preservice teachers, has three main components: (a) examination of the evolving technologies that promote and facilitate communication and by extension, promote marketing, and advertising; (b) examination of marketing and advertising strategies for conveying a message (such as through the use of emotion) and how these strategies are used in corporate marketing through the deconstruction of multimedia advertising; and (c) youth production of media that makes use of both modern technologies and advertising strategies to promote a message of the students' choosing on a topic related to social justice/social change. This critical media literacy can be readily connected to both teacher education and science learning. I have my preservice teachers produce and disseminate multimedia advertising to promote a service-learning project in which they are involved as part of a class assignment. For example, one group of students recently produced an ad campaign to promote a series of family science workshops for parents and students they worked with at a local middle school. Such an approach builds on my preservice teachers' strengths and acknowledges media as a dominant feature in their lives but adds a turn that emphasizes and promotes critical thinking.

The second approach I would propose is a focus on place-based education to promote the value of indigenous and other nonmainstream knowledge. Stonebanks' quote of Kincheloe is relevant here, "1) Critical pedagogy has profound insight to pass along to all peoples; and 2) Critical pedagogy has much to learn from the often subjugated knowledges of African, African American, Asian, and indigenous peoples" (Kincheloe 2007, p. 11). Having worked at different times in my career with various communities, such as an indigenous Mayan community in Guatemala, a historic African-American community in New Orleans, a migrant farming community in Colorado, and an immigrant Caribbean community in Miami, I have seen similarities across these contexts in how local knowledge is maintained in the community and marginalized in schools.

Place-based pedagogy, which can be formally traced at least as far back as Dewey's Chicago Lab school in the early 1900s, is actually rooted in the much older idea that learning occurs most naturally when it is focused on the intersection of people, their local environments, and an authentic purpose. While community-based learning frequently occurs at this intersection of people, place, and purpose, school-based learning is typically enacted as though it were completely natural to disconnect learning from the community, people, animals, plants, and purposes that might make it more authentic and meaningful to children who live in that context.

Exploring the connections between people and place is not, however, a politically neutral stance, given that environmental inequities are often rooted in racial, ethnic, and class-based injustices (perhaps, at least, partially explaining why schools largely stay away from this pedagogical approach). For example, in a place-based teacher education project I ran in New Orleans in 2002 and 2003 (Buxton 2006), 5th grade teachers at the lowest academically performing elementary school in the city engaged their students in a study of why poor New Orleans neighborhoods such as theirs flooded before wealthy neighborhoods (sometimes only a few blocks away) whenever there was a hard rain. The answer had to do with the fact that the early wealthy settlers built their homes on slightly raised vestigial sandbars (natural levees) that had developed before the Mississippi River was leveed, while the slave and tenant farmer housing was built on the lower land between the sand bars. This initial building pattern continued to the present day, with public and other low-income housing being built on the lowest ground in the city, a fact that teachers and students in my project discovered together through the study of topographic maps. Students then made posters to explain this example of institutionalized class-based injustice to adults in their community. When a new principal came to the school the following year, she shut down the project, telling me bluntly that the work we were doing was not sufficiently well aligned with the state science standards.

While perhaps not completely standards based, the place-based work in which the students and teachers were engaged had clear real-world implications. This injustice became starkly clear less than a year later when Hurricane Katrina wreaked havoc on the city with highly inequitable results. The neighborhood where my study had taken place was devastated while the wealthy neighborhood a quarter mile away sustained only minor damage. Asking questions such as who lives where and with access to what resources in a given community may naturally lead to social action projects that can draw attention to local knowledge. In turn, these actions taken to make a community a better place to live, such as the type of service learning projects with which the current generation of preservice teachers is quite familiar, can be made more powerful when they are combined with critical insights such as those that can be gained through studies of critical media literacy.

Thus, as a way to improve Stonebanks' ideas for teacher education, perhaps, a model of teacher education that highlights both critical media literacy and place-based pedagogy may be viewed as both engaging and meaningful for the current generation of preservice teachers. Such an approach could provide a way around more traditional multicultural education that quickly brings today's preservice teachers to the point of telling us that they "get it" when it comes to meeting the intellectual and academic needs of all our students.

Gene's Perspective

Like Cory, I essentially agree with Stonebank's perspective on the need for critical engagement in education. I also agree with Cory's concern that standards-based instruction tends to promote uniformity of thought and an emphasis on getting the right answer. As an historian of education with a background in the history of science, I am acutely aware of the fact that seemingly "right" answers are often wrong. Einstein broke the Newtonian paradigm. African-Americans, despite the arguments of early twentieth century psychologists, were not genetically inferior to the White population. Standards-based instruction (at least as practiced in most settings under No Child Left Behind) shows clear evidence of being neither scientific nor particularly effective.

Intellectual curiosity and courage, comparison, discovery, and, particularly, creativity impress me as what is mostly lacking from contemporary education, and, more specifically, science education. I come from a critical background similar to Apple, Kincheloe, and Steinberg. Substituting science lessons, as Stonebanks argues, supposedly grounded in critical thought, however, is not necessarily an answer to what needs to be taught in science classes in an ethnically and culturally diverse society. I am not convinced from Stonebank's account of teaching science through the study of water lice that very much is learned in the end – either in terms of scientific observation or politics. I would ask, based on this account, what is it that students have actually learned? Stonebanks does not make this clear. Why are they "brilliant" in their observations? How are they critical – either in terms of science or their social condition? How are they being creative?

While I can't argue against revealing hegemonic structures and the function of the "powerbloc" in the culture and how they relate to the construction of scientific knowledge, there is a point where one needs to learn science. If one is studying medicine, then of course, this should include a historical understanding of the role of Arab culture in the development of modern medicine. But clearly, this does not substitute for an understanding of medical practice. Like Cory, I subscribe to a Deweyan model of "learning by doing," of having instruction rooted in the life and community of the child. Yet there are specific concepts and ideas that must be developed in science that have little or nothing to do with politics, community, or culture. For example, the freezing temperature of water, how an electric motor works, the nature of cell division, and so on. The Deweyan approach is one that is also closely connected to the work of Piaget. Piaget talks about the child learning through a process of reinvention. In this context, Cory and I believe that an important means of learning science (although not the only means), is to have the learner reinvent the field for themselves, as well as by systematic experimentation and rediscovery. Students using this method would learn about a subject such as astronomy, for example, by making sundials and working astrolabes and doing measurements with them, building telescopes, and making the types of observations with them that Galileo and Newton did as pioneering scientists. Accompanying these types of activities can also include instruction on how to observe and draw scientific conclusions. In this context, I believe that Bruner's approach to science instruction as inquiry was essentially correct, although a greater emphasis on historical, political, and a philosophical context would have been useful.

I question what purpose underlies Stonebanks' model of instruction with the water lice project. It seems fuzzy to me, rooted in a belief in the need to represent diverse points of view, unbiased assumptions, and a model of personal discovery and critical thinking. What is there not to agree with?

Stonebank's account of his trip to Malawi is likewise problematic to me. In the village he visited, few of the teachers had been to the local nature reserve at Kasungu National Park. Although only a 20 min drive from where they lived, Stonebanks discovers that very few people from the village have actually visited the park, which seems to function to some extent as a tourist attraction. Stonebanks finds three villagers to go with him on an excursion to the park, one of whom is an aspiring applicant at the local teacher's college.

Stonebanks' potential future teacher, when questioned about what he thinks is the purpose of schooling, responds by saying it is "civilization." Stonebanks' suggests that "given any of the definitions for the term, in my brief time in Malawi – civilization – was not exactly what I thought was Malawi's most pressing need, especially, given this young man's comprehension of what it meant." My interpretation is that "civilization" might have meant a dependable job, status in one's community, a comfortable life, good health for himself and his family. According to Stonebanks, his vision was "diametrically opposed to our collective assignment of going to the mountain to reclaim a knowledge for the villagers that had been wiped out by colonialism."

Perhaps the Freirian (2007) notion of dialogue could help here. Stonebanks appeals to critical theory for guidance, and yet he seems to be wrestling with the functions of an educational tourist and missionary. I would argue that any person who visits another country or cultural group might spend as much time as they can to develop a deep knowledge of the people they are visiting and their cultures. The trap that many scholars find themselves in is not listening and observing enough and unconsciously promoting a western model of education for the people they are engaged with – one framed in the rhetoric of being "critical." As critical pedagogues, we have to remain constantly on the alert that we might be simply swapping a newer colonialist model for an older one – one clothed in the rhetoric of critical thinking and liberation.

Some ways of steering clear of the western model and rhetoric of being "critical" when faced with the challenges of getting to know another cultural group might include the use of generative words for discussion and the framing of issues (a Freirian notion), as well as a deeper understanding of social, physical, and economic forces, as critical factors shaping a region's history. I think Stonebanks would be well served to consider the work of ecojustice theorists such as Chet Bowers and Rebecca Martusewicz – particularly their belief that local and traditional knowledge is undervalued by many western educational theorists (2001, 2009). Their work, along with that of other ecojustice writers, has an important potential to extend and enrich the perspectives of critical educators such as Apple, Kincheloe, and Steinberg.

In conclusion, I would suggest that those of us who teach teachers, whatever their, or our, cultural backgrounds, need to carefully observe and listen to them. We need to understand their worldview, their insights, their limitations, and their wisdom. We need to learn from them and through our interaction with them, grow and develop a more complete understanding of the world in which we are immersed (so as to avoid prematurely changing it). We need to collaborate with our teachers in the development of meaningful curricula that go beyond traditional models of domination, as well as our own naïve and sometimes self-righteous perspectives. Focusing on traditional wisdom and knowledge, learning through discovery, and understanding our own assumptions can serve as a starting point. In so doing, we can better achieve the valued task of being truly "critical educators."

References

Bowers, C. A. (2001). *Educating for eco-justice and community*. Athens: University of Georgia Press.

Bowers, C. A., & Martusewicz, R. (2009). Ecojustice and social justice. In E. Provenzo Jr. (Ed.), *Encyclopedia of the social and cultural foundations of education* (I, pp. 272–279). Thousand Oaks/London: Sage.

Buxton, C. (2006). Creating contextually authentic science education in a "low performing" urban elementary school context. *Journal of Research in Science Teaching, 43*, 695–721.

Freire, P. (2007). *Pedagogy of the oppressed*. New York: Continuum.

Goodman, S. (2003). *Teaching youth media: A critical guide to literacy, video production, and social change*. New York: Teachers College Press.

Kincheloe, J. (2007). Critical pedagogy in the twenty-first century: Evolution for survival. In P. McLaren & J. Kincheloe (Eds.), *Critical pedagogy: Where are we now?* (pp. 9–42). New York: Peter Lang.

Chapter 33
"What Is Ours and What Is Not Ours?": Inclusive Imaginings of Contextualised Mathematics Teacher Education

Bal Chandra Luitel and Peter Charles Taylor

Introduction

How can we address the problem of culturally decontextualised mathematics education faced by Nepali students who, as citizens of the world's most recent democracy, are far from realising the positive contribution of mathematics education to the development of a socially just, egalitarian and pluralist society?

The school mathematics curriculum of Nepal carries a potent image of mathematics as a purely symbolic and abstract knowledge system largely disconnected from the daily lifeworlds of the vast majority of young people dispersed throughout this agrarian country with 92 distinct language groups and a multitude of worldviews[1] (Yadava 2007). Imported from the West[2] but with no explicit acknowledgement of its historic roots in Greco, Roman and Arabic traditions, this "world standard" system of mathematics education masquerades as being transcendental of culture while serving the academic interests of an elite few who aspire to make it to tertiary education and into professional life as doctors, engineers, health professionals, IT specialists, teachers, etc. Although these are positive and beneficial outcomes for any transitional society, such a restrictive academic focus may be exacting a very high cost on the cultural integrity of this richly multicultural society. Research suggests that "world standard" mathematics education in Nepal turns a blind eye to traditional mathematical practices and associated social values enacted daily by local communities, thereby serving as a powerful means of one-way

[1] Accessible via www.ethnologue.com (verified on 19/06/09).

[2] The West is a metaphor deriving from the historic perception of cultural separation of the Occident and the Orient. This separation has often been used to consider the Occident as superior to the Orient. Historically, the Orient is regarded as exotic, abnormal and irrational, whereas the West is depicted as normal, rational and natural (Said 1978).

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_33,

enculturation into a globalising western worldview (Luitel 2009; Luitel and Taylor 2007). In the process, mathematics education may be contributing by neglect to the tragic extinction of local knowledge systems characterised by holistic integration of mathematics, science and cosmology.

As we see it, the challenge for Nepal, and many other countries of non-western heritage, is not one of rejecting decontextualised mathematics education in some naive essentialist attempt to protect threatened cultural identities and practices from the rising tide of globalisation. To do so would be to deny, amongst other things, the importance of preparing Nepali professionals who can think globally and act locally. Rather, our vision is for a mathematics education of and for all the people of Nepal, a truly democratic mathematics education that promotes sustainable cultural pluralism by enabling young Nepalese people to reconcile the existential tension they experience as their own local cultural traditions are buffeted by the unrelenting and highly disorienting encounter with globalisation and its seemingly superior "world standard" practices and values. The first step in addressing the problem is to reveal the deeply hegemonic grip of this restrictive form of mathematics education on the hearts and minds of those who control the institutions of higher education, the sector that is instrumental in reproducing the extant culture of "world standard" mathematics, mathematics education and mathematics teacher education. The second step is to re-vision that culture via a scholarly process of utopic imagining.

We do so in this chapter by examining the lived experience of Bal (the first author) as a transformative mathematics teacher educator struggling to renegotiate and re-vision the "world standard" mathematics teacher education program of a Nepali university. Subscribing to Brickhouse and Kittleson's (2006) emphasis on the coexistence of multiple knowledge systems in science education, we also draw from the discourse on the inclusive nature of mathematics that allows different (and often contrasting) knowledge systems to develop empowering synergies in mathematics teaching, learning and assessment (e.g., Ernest 2004). We employ contemporary educational theories, logics and genres integrated within a multi-paradigmatic research design (Taylor et al., in press) to identify disempowering assumptions that may be contributing to the hegemonic stranglehold of culturally decontextualised mathematics education. Drawing on the research paradigms of interpretivism, criticalism and postmodernism, we weave together the methods of critical autoethnography and philosophical inquiry to construct a collage of storied, poetic, performative, visual and letter-writing genres (Knowles and Cole 2008).

The chapter is divided into two sections. In the first, we present Bal's composite story, based on his experience of working with educational leaders in Nepal, to illustrate how globalisation can manifest as a disempowering ideology in mathematics teacher education programs. In an open letter to the story character, Dr. Director, we examine critically the narrowly conceived metaphor of *globalisation as universalism*, focussing on how it promotes the ideology of *comprador intelligentsias* who serve the political interests of colonial masters whilst undermining the value of culturally situated knowledge systems. With the help of dialectical logic, we discuss the possibility of employing the concept of glocalisation as an inclusive space that may help to incorporate multiple knowledge systems in mathematics education programs.

The second section begins with Bal's composite story of his interactions with professors who subscribe to the philosophy of foundationalism as an orienting perspective of mathematics education programs. Via an open letter to the story character, Dr. Authority, we deconstruct the disempowering posture of foundationalism, especially its ideological and epistemological contribution towards decontextualism as an exclusive and invisible framework for mathematics education. More so, we explore possibilities for challenging an extreme form of foundationalism by introducing a healthy scepticism that opens up a space for conceiving a pedagogical vision of cultural inclusivity in which local and global knowledge systems can flourish interdependently.

This process of writing as inquiry (Richardson and St Pierre 2005) draws on a range of contemporary theories of education – *philosophy of mathematics,* postcolonialism, transformative education – for illuminating the decontextualised posture of mathematics education in Nepal. We apply fallibilistic views of the philosophical nature of mathematics to challenge the longstanding absolutist view embedded in mathematics education. Postcolonialism, a complex discourse useful for generating an inclusive and justice-oriented vision for education in transitional societies, enables us to explore competing political interests and perspectives, thereby working towards an inclusive vision of culturally contextualised mathematics education. Similarly, the theoretical perspective of transformative education serves as a timely reminder to foreground the purpose of mathematics education as the cultivation of selfhood and the development of full human capital informed by multiple knowledge systems arising from people's cultural practices and aspirations.

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FAREWELL TO UNHEALTHY GLOBALISATION: IMAGINING AN INCLUSIVE GLOBALISATION

"Being There: We Need A Globally Justifiable Teacher Education!" – Reminder of a Painful Moment(s)

"Namaste Sir," I greet with a usual smile, "Are you available for our meeting, now?"

"Oh..., we have a meeting? I have totally forgotten this,"bemused Dr. Director admits his forgetfulness, looking at the photocopy machine purposelessly. "Sir, I handed a document to you last week. Have you gone through it by any chance?" I persuade Dr. Director to focus on the issue that I want to discuss with him.

We do not speak for about a minute as Dr. Director looks for the document. I sit quietly, waiting for him to find my draft proposal for launching a 2-year mathematics teacher education program for secondary schoolteachers. "Well, yes I found it. I have made some notes here, by the way. It means that I have gone through it. Give *me 5 min so that I can have a quick look at my notes." Unsurprisingly, Dr. Director does not wait for my permission and starts scanning his own comments.*

It can be any day in the month of March 2005. Dr. Director is ready to talk about my proposal. I am sitting facing him, sharing the same messy desk that he has been using. "Well, you have worked out a structure already. Did you consult with Dr. Authority and Prof. Prescription? They both completed their advanced studies at The University of the West," speaks Dr. Director, demonstrating his age-old legacy of celebrating the western country where he completed his advanced studies.

"Not yet. I am planning to develop a complete draft and make it available to relevant professionals for their comments. Cannot I share the detail of the program with Dr. Authority, Prof. Prescription and other professionals after we complete the official rituals of the University of Himalaya?" I say, with an invisible resistance to Dr. Director's view of relying on people who prefer to stick to their old guns.

We do not speak for a while. Dr. Director looks somewhat serious and so am I. Perhaps, he is busy working out appropriate language to respond to my mild resistance. I am also thinking creatively to pacify my agitating self that interprets Dr. Director favouring a bunch of professionals who completed their advanced studies at The University of the West with a tendency to privilege a singular worldview. My agitating self keeps asking me: Why does he favour Dr. Authority and Prof. Prescription as there are many other professionals probably more productive than these relatively "out of touch from reality" professors?

"I don't know which courses you have done in your overseas studies. Thus, you need to outsource to The University of the West-educated professionals in the team otherwise it is hard for me to forward your proposal to the relevant committees of the university. And, you should know that our department uses exactly the same system used by The University of the West. You cannot deviate from the system because quality teacher education is possible only by following a standard global system of education," Dr. Director postpones his eulogy to the system of education of The University of the West for a moment and I console my resisting self to adopt a strategy of quiet criticality.

I don't know whether Dr. Director wants me to continue our conversation or leave his office. But I don't want to leave the meeting unresolved. As Dr. Director is busy responding to a caller, I am thinking about possible permutations of words that I am going to use to respond to his narrow view of globalisation.

"Sir, what should I do then? Please, show me the way. I have no problem meeting with Dr. Authority and Prof. Prescription. I am conceiving this to be a good Nepali teacher education program that can be helpful for improving mathematics classrooms of Nepali schools rather than a program that mimics foreign models in the name of globalisation. I believe that I have acquired relevant degrees in mathematics teacher education which help me find ways to identify key strengths and weaknesses of our mathematics education program and address them contextually. Overall, I regard myself as a learner rather than a perfect authority of the field," I offer a mild dose of criticality, as Dr. Director remains in the world of solitude.

Dr. Director does not speak for a moment, and then turns his chair toward the cupboard where he keeps some 12 books which he shows every now and then when we have an academic discussion like this. In the meantime, I plan to request some *suggestions from him so as to incorporate his genuine ideas. Genuine? Well, I cannot be as presumptive as he is. I may use some of his ideas, although he tries to justify them as being western originated. Let's see what the upcoming moments hold for me.*

"Do you have this one? This is a very useful book on student evaluation. I suggest you prescribe this as a textbook for the mathematics teacher education program. It includes ways of constructing different forms of standardised tests following universal methods. And, I think Nepali teachers need to know and implement such ideas to improve their teaching. I will give you this and another set of four books, today. They cover areas such as psychology, learning and evaluation. You can also borrow books from Dr. Authority and Prof. Prescription. Then, incorporate ideas from appropriate books prescribed by The University of the West. In this way the proposed program will produce quality teachers as well as provide our program with a basis for connecting globally. Remember, we need a globally justifiable teacher education program. And, we need to make globalisation the defining identity of our teacher education program."

Our meeting ends on a positive note so that we keep the channel open for discussion. At least this is good for now. It seems to me that I need to be strategic to get things done here. But the "real me" hates these things – acting as per the interests of the other, following unjustifiable bureaucratic procedures, leaving my professional judgement at the mercy of the other, and making my own vision invisible in the process. As I leave Dr. Director's office, a support staff, is ready to share my load of books which we put on the table in my office to check their bibliographical information. Unsurprisingly, all these books are published in the early 1960s and are probably out of print: Measurement and Evaluation, Psychological Foundations, Behavioural Foundations, Educational Testing, and so on and so forth...

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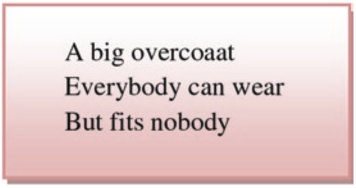
"Being Here: We Need Globalisation, But The Empowering One!" – Retrospection with Futuristic Agendas

Dear Dr. Director

The story, *Being There: We Need A Globally Justifiable Teacher Education,* represents one of our many meetings that took place in the year 2005. Most of the meetings seem to have ended with your suggestion that I need to make sure that our teacher education program is designed according to "global standards." Sadly, my contestations were not enough! Indeed, having had several meetings with you, I feel as if you are the truer representative of the west than our own country. Puzzled by such a narrow view of globalisation, I have decided to write this open letter explaining my critical view of hegemonic globalisation, thereby offering ways to conceive a more justifiable and empowering version that may help develop a vision for a contextualized mathematics teacher education program, particularly one that is inclusive of the multilingual and multicultural realities of Nepal.



Critiquing Globalisation as Universalisation

I prefer a mosaic of eclectic and multiplistic worldviews. Perhaps such a preference is linked with the realisation that my personal and professional situatedness is in a country, which hosts more than 90 language groups and unique and diverse cultural practices. Therefore, the idea of globalisation *as* hegemony *of a foreign worldview* does not convince me that such a powerful view is inclusive of knowledge systems arising from the lifeworlds of Nepali people. Arriving at this point, I have to say clearly that your view of globalisation arises from a host of exclusive concepts, ab/using[3] it to impose the worldview of a particular country or countries on our teacher education program. Here, I am going to unpack one such disempowering notion of *globalisation as universalisation* prevalent in mathematics education in Nepal.

The view of *globalisation as universalisation* seems to legitimate one particular worldview as being "superior and standard" whilst discounting other worldviews as being inferior, impractical and primitive (Bayart 2008; Robertson 1992). With this metaphor as centre stage, globalisation is considered to be the project of

[3] As a matter of convention, I have used the symbol '/' (e.g., un/certain, im/pure, un/wittingly) to represent a dialectical relationship between sometimes opposing entities, ideas and concepts. Dialectical logic promotes holism by combining opposing viewpoints, perspectives, entities and ideas. Although Hegel is widely acknowledged for the development of dialectical logic, recent explorations have demonstrated that there are more than one type of dialectical logic (Wong 2006).

homogenisation, an approach to reducing diversities by privileging a particular culture, worldview and ideology. However, I do not dismiss the positive aspect of universalism that arises from several wisdom traditions that promote inter-being and co-existence among dissimilar perspectives, views, ideas, people and ecologies (Hanh 2000). Ironically, in the context of mathematics education in Nepal, the narrow view of universalisation (equating one worldview with the universe!) appears to discount such an empowering view of co-existence by embracing universalisation as a project towards homogenisation with worldwide sociocultural convergence via the western Modern Worldview.[4] Such a worldview is oriented mainly by conventional logics (propositional, deductive and analytical), which promote many unhelpful dualisms, such as global versus local, western versus eastern, and rational versus non-rational knowledge systems, historically preserved through seemingly successive Greco–Judaic–Christian traditions. Here I agree with Edwards and Usher (2000) who maintain that "privileging of certain position as universal has functioned as a legitimated device, a means of drawing and maintaining boundaries of the valuable and the useful" (p. 71). Perhaps, the notion of valuable is associated with those knowledge systems, which help our teachers inculcate their cultural capital, whereas the notion of useful is taken to bolster the legitimacy of the narrow view of *globalisation as universalisation*. Thus, your suggestion of importing one particular model of teacher education and then fitting our teacher education program in that framework may not be helpful for conceiving a contextually valuable model that can transform our mathematics teachers from transmitters of one particular form of mathematics to facilitators of multiple forms of mathematics.

Frogs in the garden
Butterflies' funeral
Normalcy perpetuates

Let me share with you possible disempowering implications of the narrow view of *globalisation as universalisation* for teacher education in Nepal. This one-size-fits-all approach appears to position us at the receiving end of the production, legitimation and distribution of knowledge, thereby un/wittingly being passive recipients of such knowledge in the name of universalisation. In my view, the notion of sameness is exaggerated as if there are no marked differences between our context and the western context in which such knowledge is seemingly generated, although the western knowledge system does draw on other knowledge systems, such as the algebra of Islamic writers, the Devenagari decimal numeral system of Indians and the numerical methods of Chinese scholars (Almeida and Joseph 2007). For example, one of the books you gave me mentions different types of tests, such as personality tests, intelligence tests and aptitude tests, as if there is a single best method of measuring and predicting our personality, intelligence and aptitude (e.g., Freeman 1962).

[4]The Western Modern Worldview promotes a restricted way of knowing, being and valuing imbued in reductionist thinking, instrumental actions and mechanistic ontology (Taylor 2008).

But these tests are less likely to be useful for mathematics teachers in developing holistic and meaningful assessment strategies that account for the culturally situated intelligences of their students (Sternberg 2007). Furthermore, as I am critiquing your suggestion of prescribing only books published in the west, I am also aware of my own practice of using literature originating in the western context. Indeed, my critique is not so much about the books themselves, but about the possible singular worldview embedded in them and their uncritical use by our teachers and teacher educators.

One big machine
Mass production
One shape and size fits all

An old man speaks
Of his past un-reflexively
High chance of imposition

Second, this narrow view of globalisation also harbours the unhelpful duality of universalism versus contextualism. Etymologically, the term "context" arises from the Latin word, *contextus,* meaning woven or connected together. Thus, the notion of contextualism refers to the view that knowledge and knowing are always context bound, no matter where and how they are produced (Stanley 2005). I argue from a poststructural perspective (drawing on Brown 2007) that the notion of contextualism is about promoting intertextuality between varying cultural products and lifeforms. Thus, my emphasis is not on the exclusive hegemony of any standpoint; rather I am trying to unpack the idea of contextualism so as to challenge the perpetual duality of contextualism *versus* universalism promoted by the metonymy[5] of *globalisation as universalisation*. My deep-seated desire is to create an inclusive space that allows both universalism and contextualism to operate in synergistic ways.

Weed's encroachment
Local flowers begin to die
Dictionary changes

Comprador Intelligentsia OR Transformative Attitude?

Dear Dr. Director, arriving at this point of my letter writing journey, I request that you think about possible answers to this question of mine: Do you want us to be comprador intelligentsias or agents for transformation? In recent years, post-colonial thinkers have articulated the notion of globalisation through a host of reflexive, reciprocal and mutual relationships between local and global, contextual and

[5]Metonym is a metaphor in which part of a concept is taken to represent the whole concept. In the case of globalisation, which is a multifaceted concept (comprising conversation, exchange, discourse, etc.), often only one of its aspects (Westernisation) is taken to represent the whole concept (Lakoff and Johnson 1980).

universal, and many other seemingly opposing attributes (Bhabha 1994). From a post-colonial perspective, the notion of comprador intelligentsia represents an intermediary person who serves the interests of his/her colonial master rather than his/her own people (López 2001). Indeed, we (you and I) both may have this attitude within us to varying degrees. On the contrary, I envisage that the notion of a transformative attitude entails dispositions of going beyond restrictive legacies, hegemonic worldviews and dualistic logics (O'Sullivan 2002).

A wholesale company
appoints a representative
Comprador rules the local market!

In my mind, a comprador intelligentsia supports and stands for uncritical importation of ideas from his/her colonial master(s), and acts as the key person to serve the interests of westernisation in the name of globalisation. In the case of teacher education, such a blind importation may result in uncritical use of the western Modern Worldview as the orienting framework for mathematics teacher education programs, thereby conceiving a dualistic view of knowledge (as object) and knowing (as subject) (Dunlop 1999). On the contrary, an agent who works for transformation advocates contextual adaptability and synergistic possibility of any worldviews and knowledge systems, thereby striving to maintain a critical and inclusive outlook, with the intention to promote an agentic view of mathematics teacher education.

Second, a comprador intelligentsia is often locked in the world of reformation. In my view, the world of reformation constitutes a network of perspectives that are less likely to encourage critical reflection, authentic and change-oriented vision and meaningful participation of actual beneficiaries. Furthermore, reformation becomes a process of acting from within a pre-existing distorted framework, thereby undermining its interaction with the outside (social, cultural and political contexts) (Mezirow 2005). It is highly likely that a reform process will be locked in the narrow framework of "re-forming schools through curriculum change" without looking to broader possibilities for helping them shift from a singular worldview to multiplistic worldviews. On the contrary, a transformative agent acknowledges that such a reformist view may be necessary but is insufficient for changing mathematics teacher education in a sustainable way. She/he is likely to acknowledge the disempowering posture of any pre-existing distorted framework, thereby making it visible by bringing many other frameworks to exist in the process.

Staying away from the edge
Confirming the order
Sign of a good follower

Third, a comprador intelligentsia is an attitude that flourishes well with the help of control and hegemony (Juan 2007). As a comprador is taken to represent the person who plays the role of intermediary, the notion of intelligentsia gives the connotation of a learned, knowledgeable and trained person. As a result, comprador intelligentsias are able to impose their ideas on teachers and teacher educators who are believed to be less learned or lacking "advanced degrees" from western universities. On the contrary, the person who works for a transformative endeavour in teacher education is aware of possible hegemonic and control-propelling situations, thereby acting for empowering changes in the landscape of mathematics teacher education.

Fourth, I envisage that without a disempowering global order (such as *globalisation as universalisation*), the comprador intelligentsia-attitude will fade out from the field of mathematics teacher education (McLaren 2005). For a comprador intelligentsia, global order provides him/her with a much-needed framework to condemn local practices and knowledge systems for allegedly being primitive. Let me share an experience with you. Once I was talking with a teacher educator about possibilities of including culturally contextualised pedagogies such as sitting with grandmother, knowing how to plough and learning through perpetual engagement.[6] His response was that these pedagogies are not proven enough to be valid for our formal education system. Unlike this dismissive posture towards our culturally generated knowledge systems, a transformative attitude is likely to act inclusively, thereby creating meaningful synergies between local and global orders. Informed by such views, transformative perspectives can be a deconstructive Trojan horse to the comprador intelligentsia-attitude (Bowers 2005).

[6]In rural Nepali contexts, children learn various skills from their grandparents. As sitting with grandmother entails a pedagogy of care and empathy, it has a possibility of being used as a transformative pedagogy (of care) in mathematics education. Similarly, knowing how to plough can be used as a special form of pedagogy that includes a task with dissimilar subtasks and subskills. Another popular saying: if you engage constantly in the *field*, plants will recognise you, can also be used as a pedagogical referent for learning through engagement in contexts.

The sun in the winter
looks like the moon
Has it lost its essence?

Ants collect and store food
A lazy caterpillar
makes them learn new techniques

Fifth, another disempowering feature of the comprador intelligentsia attitude is to privilege the "realist agenda" (McLaren 2003) of mathematics teacher education. Here, realist agenda refers to the hegemony of positivistic unidimensionality in perceiving reality. Such a unidimensionality is characterised by the ethos of detached observation of context, thereby privileging the standpoint of the observer. Coupled with literalist language games and limited (i.e., often confirmatory) application of "sense organs," positivistic unidimensionality is an obstacle to accounting for the layered nature of reality. Thus, the realist agenda is not sufficient for representing various dimensions of reality embedded in the schooling context because it narrowly conceives of what can be counted as real. On the contrary, having embraced a transformative attitude, we shall not adhere to superficial realist agendas, rather we shall look for agendas that are unique to our contexts. To do so, a transformative agent can use multiple sources and referents to account for different perspectives and interests of actors associated with teacher education.

Glocalisation: A Transformative Vision of Inclusive Teacher Education

Dear Dr. Director, as I have critiqued your narrow views of globalisation *as universalisation*, I am morally bound to present an alternative vision. You may speculate ironically that I will argue for a contextualisation that is guided exclusively by easternisation (sic) and localisation. Well, as I have argued already, I am not in favour of promoting unhelpful dualisms as they do not provide us with expanded opportunities to think and act in multiple ways; instead, I opt for an inclusive way of conceiving our teacher education program via a vision of "small glocalisation", which is taken to represent the dialectics of global and local processes, meaning that glocalisation represents a continuous interplay and interactivity between globalisation and localisation (Kloos 2000).I do not claim that my view of glocalisation is a grand-narrative; rather it is likely to rescue inclusive views of globalisation from the longstanding western orthodoxy that often uses an exclusive lens to insert strategically its worldview in the name of universalisation (Swyngedouw 2004). Given this conception, I have generated five empowering features of glocalisation: (a) glocalisation can be regarded as an expression of dialectical relationships between local and global practices; (b) it can be used to construct spaces called *glocals*, which have the potential to generate empowering synergies between localisation and globalisation (Doherty 2008); (c) it is likely to help us contest any form of hegemony prevalent in mathematics teacher education; (d) glocalisation possibly offers an inclusive and agentic vision for teachers and teacher educators to think and act creatively; and (e) it can help preserve and promote a positive image of *globalisation as conversation* (Henry 1999).

Water and soil
Creation of mud
A sculptor muses

Indeed, the exclusive view of globalisation can help us or our teachers realise the disempowering limitations of a hegemonic worldview. On the other hand, extreme advocacy of localisation cannot empower our teachers to apply multiple referents to their pedagogical creativity. However, dialectical logic embedded in glocalisation can help us create synergistic spaces of interdependent, reflexive and co-arising relationships between global and local processes (Kloos 2000). Precisely speaking, such spaces help us realise how objectivity and subjectivity, global and local, transcendental and cultural, universal and contextual, and western and non-western exist side-by-side (Robertson 1995). Therefore, in designing a teacher education program, the synergistic hybrid of glocalisation can offer us a basis for: (a) incorporating knowledge systems arising from local cultural practices; (b) linking with knowledge systems arising from multiple worldviews; and (c) conceiving meaningful pedagogies of mathematics for diverse cultural contexts (Globalism Institute 2003).

Finally, glocalisation is an expression that can promote a positive image of *globalisation as dialogic* relationships between different cultures and worldviews, thereby paving the way for transforming mathematics teacher education from hegemonic legacies to an egalitarian and liberating enterprise. I envisage that such an empowering image of globalisation will be helpful for morphing the hegemonic legacy of monological pedagogies into change-oriented participatory pedagogies. By employing such pedagogies, Nepali mathematics teachers are likely to: (a) encourage students to search for different forms of mathematics (e.g., ethnic number systems, different basket patterns, multiple mythological symbolisms) for present and future uses; (b) help students explore local classifications/categories of mathematical knowledge (e.g., *sets* of objects in a traditional Nepali kitchen, *algebraic* patterns in traditional potato farming method) and their interactivity with official mathematical categories; and (c) develop emergent pedagogies that promote interactivity between different mathematical knowledge systems.

Dear Dr. Director, I hope that you have now started thinking about incorporating some of the ideas I have suggested in this letter. Perhaps, my discussion of two narrow views of globalisation has helped us think more creatively about embracing an empowering image of *globalisation as conversation*. I hold the view that changing ourselves from comprador intelligentsias to transformative agents makes it possible to incorporate synergistic visions in our teacher education program, thereby liberating our mathematics teacher education from disempowering single-minded perspectives. Hoping to hear your comments in the near future,

Sincerely yours
Bal Chandra
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Deconstructing Foundationalism: Proposing a Healthy Scepticism for Inclusive Mathematics Teacher Education

"Being There: Follow the Foundation of Mathematics Education!" – Encountering a Hard Fence on the Way

It can be any day in the month of April 2005. I am about to make a phone call to Dr. Authority about possibilities of sending my proposal to him and receiving his review comments on it. After spending nearly 10–15 min, I finally find Dr. Authority's number and dial it: 4xxxxxx.

"Hello"

"May I speak to Dr. Authority?"

"May I know your name?"

"I am Bal Chandra, from the U of Himalaya"

"Hang on a minute. Dr. Authority is coming."

"Who am I taking with?"

"Namaste Dr. Authority! This is Bal Chandra from the University of Himalaya. We are developing a 2-year mathematics teacher education program. And, I am seeking your help in this regard."

"Well, I cannot commit myself as a tutor as your department outsources many part-time academic staff members. I am too old to do that. What specifically do you want from me?"

"At this stage could you please read my proposal for the program and provide us with your critical suggestions within a week?"

"Well. How thick is the document? If it is 15 to 20 pages I can provide you with comments and suggestions within a week."

"Yes Dr. Authority, it's a 13-page slim document, and I will send someone to your place today."

"Ok. That is a good idea."

"Thank you. Namaste."

"..."

I read the proposal three times to check if there are any typos and grammatical errors. It has taken a precious three mornings to make sure that the document is in order. I give one hard copy to our mailperson to send to Dr. Authority's residence. I call Dr. Authority that evening to make sure that the document reached his place.

A week has passed since Dr. Authority received the document. I call him again to make sure that I am receiving his feedback in the stipulated time.

"4xxxxxx"

"Hello. Who is speaking?"

"Namaste Sir! This is Bal Chandra again. Have you finished reading my proposal?"

"Thankfully, I finished yesterday evening. I could not read during the daytime of this and last week as I was attending various cultural programs organised by family and friends. The life of a retiree! Another problem is that I cannot read for more than half an hour in one sitting. By the way, are you ready to hear my comments?"

"Well, yes. But let me call you from another room. The noise here is appalling."

"Before sharing my comments, let me ask you one straight question: Which system are you following here, one that is followed by The University of the West or one that you have brought from the university where you completed your advanced studies?"

I am saddened by meaningless questions again. What should I do next, just hang up the phone and forget about launching the new teacher education program. But I feel the presence of a consoling self that says: Don't walk away. There is more to it.

"Yes I have completed postgraduate studies from a country different from where you undertook your advanced studies. But Sir, this is not a program based on the systems of either Country West or the country where I completed my postgraduate studies, this is an attempt to develop a good teacher education program that can help improve Nepali mathematics education."

"I am asking this question because you missed some important concepts in the proposed course of mathematics education. A friend of mine told me some years back that mathematics teacher education departments of universities other than Country West are not serious about following the foundation of mathematics education. I have also heard recently that some universities of Country West have left this recently and started questioning the foundation. But, they are in a minority. Your program does not follow the foundational framework. You have included much non-"mathematics education" stuff in the course outline. I suggest you pay special attention to the logical and psychological aspects of the foundation. For me, the sociological aspect is not that important because it brings unnecessary stuff to mathematics education. Let me make clear that the logical aspect of the foundation is helpful for preserving the analytical rigor, deductive power and purity of mathematical algorithms whereas the psychological component helps teachers understand and make use of valid, objective and proven theories of learning. And, such theories of learning are the ultimate source of pedagogy for our mathematics teachers."

Is he bringing his nearly three-decades old experience of doing his doctoral studies at The University of the West into the conversation? I know he is talking about the foundation that I came to know during my M Ed studies. It is hopeless. It promotes transmissionist pedagogy. Well, I am not interested in having arguments on meaningless issues. But can I avoid this in the present situation? Can I ever escape from such naive questions and comments?

"Sir, could you please suggest the sources that I can read to incorporate the foundational aspect in the course?"

"Well, I have a book published some years back. If you want to have a look, I can send it with your mailperson when he comes to collect my written comments on your proposal. Please take it seriously that the foundation of mathematics education has become our identity, it is an indubitable concept, we have internalised it, and it is a perspective that helps orient our teachers to the importance of the logical structure of mathematics and an appropriate pedagogy for it."

I tighten my mouth for a while. It is amazing that silence can be a sustainable means of resistance. I read in a book that one of Buddha's popular methods was silence, and that helped him to avoid unnecessary debates and unempathetic exchanges.

"Thank you for your comments. I will look into them when I receive a written copy of your comments. By the way, do you want to share any other urgent comments? I have a meeting with students."

"I have already expressed my urgent comment. The second one is the way you have written the course learning objectives, which are vague and not measurable. For example, how can you measure understanding? Again, we have internalised "behavioural objectives" as a fundamental aspect of teacher education. Please be mindful of this. As far as other comments are concerned, I will send a written copy of them. But pay attention to following the foundation of mathematics education as a basis for designing your teacher education program. And, it has been our identity as most of the teacher education departments use foundationalism as the orienting framework of mathematics education."

"Thank you for your precious time, Sir. It is my pleasure talking to you over the phone. By the way I will send our mailperson today or tomorrow to collect your written comments. Thanks once again. Bye."

I play a diplomatic language game. Indeed my "thankyou" to Dr. Authority is not for his comments but for his agreement in ending the conversation. But one question keeps on popping into my mind: How to transform the identity of our teacher education program from foundationalism to non/foundationalism?

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"Being Here: Let Us Question the Indubitable Foundation!" – Persuading Through Heart and Mind

Dear Dr. Authority

I am writing this letter to share my perceptions about your view of the foundation of mathematics education. I hope that this open letter can be a helpful means for elaborating my critical views about your notion of the foundation of mathematics education, thereby offering an inclusive vision for incorporating both of our views in sofar as they help develop visions for contextualised mathematics teacher education. Our conversation depicted in the story indicates that you seem to regard the foundation of mathematics education as an indubitable and unchangeable framework only through which we can develop a mathematics teacher education program. My recent reviews of literature suggest that foundationalism is a tendency to hold the view that (a) all knowledge arises from non-inferential knowledge or justified belief (Fumerton 2005), (b) "knowledge must have a foundation and that the rest of what is known must rest on (i.e., derive its justificatory status from) that foundation" (Aikin 2007, p. 579), (c) "epistemically basic beliefs must be certain, incorrigible, or infallible" (Hopp 2008, p. 196), and (d) the only way that we can sufficiently justify our beliefs or knowledge is to show how they depend on or rest on or arise from some basic beliefs (or "foundations") that do not need justification and are beyond scepticism (Carr 2006). Are you thinking along these lines? Or do you have a different definition?

Aftermath of a big quake
Person 1 asks,
Was the foundation not strong enough?
Person 2 says,
The foundation was too strong and rigid
Person 3 opines,
A flexible foundation could minimize the damage

A frog slips into a pond
No route visible to the outside
Locked in forever

Informed by different views about foundationalism, I am charting the journey of letter writing through three themes. First, I present myself as a critic of anti-scepticism embedded in the project of foundationalism. The second part of this letter challenges the decontextualisation of knowledge and knowing embedded in your narrow foundationalism. Finally, I critique mimetic and transmissionist pedagogies that arise from your exclusive view of foundationalism, thereby offering alternative visions of inclusive pedagogies for contextualised mathematics teacher education program.

Welcome Healthy Scepticism

Dear Dr. Authority, let me start this part of the letter by sharing an experience in 2004 when I worked with a teacher educator who had recently graduated from a teacher education program of a university in Nepal. I invited him to collaborate with me to facilitate a 3-day teacher education workshop on teaching geometry for high school teachers. I asked him to share his workshop plan with me and I prepared myself with the same. His plan to facilitate the teaching of proof in geometry could not offer any new insights into creative pedagogical aspects; rather it entailed a plan for teaching teachers about the basic concepts associated with proofs of some theorems. I shared with him my plan of including a narrative of my experience of learning geometry (e.g., Drake and Sherin 2006) and of involving teachers in a two-stage play about different types of geometry. In all my workshop activities, my plan was to help teachers maintain some degree of scepticism in their thinking and actions. But my collaborator came next day to express his inability to use such activities because he believed that it was an irreparable sin to be critical about mathematics whilst being a mathematics teacher educator. After several attempts, I convinced him to use some props that could help teachers think about boundary conditions of geometric proofs being employed in our school curriculum.

I am not generalising that this case represents an attribute of all mathematics teacher educators who have been oriented according to your narrow foundationalism. But this encounter suggests that the non-sceptical posture embedded in the foundation of mathematics education does not help mathematics teachers and teacher educators go beyond the narrow structural boundary of mathematical knowledge (Hersh 1997). Here, the notion of narrow structural boundary means the unhelpful myth that mathematics is always structured in a singular, objective and incorrigible way. How can you expect innovation if you educate teachers to be mute followers? Thus, I argue that healthy scepticism helps mathematics teachers renew their pedagogical praxis and knowledge about mathematics.

You may raise a question here: Which version of scepticism do I want to promote in mathematics teacher education programs? In my mind, scepticism (or doubt) and belief presuppose each other, for there is no scepticism or doubt where there is no belief. Perhaps a healthy scepticism is an expression generated through dialectical relationships between believing and being sceptical at the same time (Bell 2005). With the help of dialectical thinking, I prefer to promote a "middle way"[7] that neither rejects foundationalism totally nor prevents prospective teachers from questioning the so-called indubitable foundation of mathematics education. How can your logical and psychological foundations fit within my vision? As far as the logical aspect (e.g., Kuroda 1958) of the foundation is concerned, prospective teachers and teacher educators will be able to realise the limitations of conventional logics (e.g., propositional, deductive and analytical) and the linear hierarchical structure (of mathematics)[8] embedded in mathematics education. And, there are possibilities that your conventional logical structure of mathematics can be modified and adapted together with emergent structures arising from knowledge systems embedded in local cultural practices.

Dear Dr. Authority, it seems to me that another key element of your foundation is behaviourism, which promotes a mechanical view of learning as a linear combination of stimulus and response. An immediate implication of this school of thought in mathematics education is that learning is possible only through repetition, practice and drill (Hilgard and Bower 1977). Do you really believe that the phenomenon of learning can be explained only this way? Here, I am hinting at yet another possible "foundation" that promotes largely cognitive approaches, which regard learning as an exclusively mind-centric activity (Shuell 1986). You may think that I align myself exclusively with cognitivism. On the contrary, I hold the view that these theoretical labels do not help much in conceiving the contingent, contextual and emergent nature of the phenomenon of learning. Therefore, a healthy scepticism helps raise questions about the adequacy of your and others' foundations in capturing the experiential landscape of learning.

[7]In eastern Wisdom Traditions, Middle Way has served as a perspective to articulate ontological and epistemological spaces that allow us to conceive the relative nature of sometimes opposing ideas (Nagarjuna et al., 1990).

[8]Smitherman (2005) calls these logics 'narrow analytics,' which are subservient to reductionist Newtonian science, which promotes dualism and narratives of stability.

Similarly, I hold the view that an extreme form of scepticism is not helpful either, for it becomes another foundation of one's thinking which does not make sense of anything but scepticism. My notion of healthy scepticism entails three major steps: *engagement*, critical reflection and *renewal*, as bases for acting wisely in our pedagogical contexts. In the first step, our teachers' authentic engagement is pivotal for generating personal practical knowledge about their pedagogic contexts. Being encouraged to view their pedagogical engagement from critical and reflective eyes, teachers will be able to identify gaps between their beliefs and actions, between theories and practices, and between justified and emergent knowledge (Kenyon and Randall 1997). For me, such gaps offer an authentic source for renewal of my personal pedagogical thinking and actions (Granger 2006).

Dear Dr. Authority, I envisage that by embracing healthy scepticism, we will be able to humanise your extreme foundationalism that often places a set of beliefs and knowledge systems outside of the human domain of practice in the name of the non-derivability principle (Polkinghorne 1992). In my mind, bringing those knowledge systems and beliefs to the domain of critical reflectivity can help transform our teacher education program as a forward-looking endeavour. The effort of humanising your foundational view entails: (a) introducing a multi-perspectival view (historically, epistemologically and logically) of mathematics education (e.g., Almeida and Joseph 2007); (b) questioning disempowering features of the foundation; and (c) envisioning multiple foundations for incorporating knowledge systems and pedagogies arising from people's practices in the teacher education program.

Deconstructing Decontextualisation

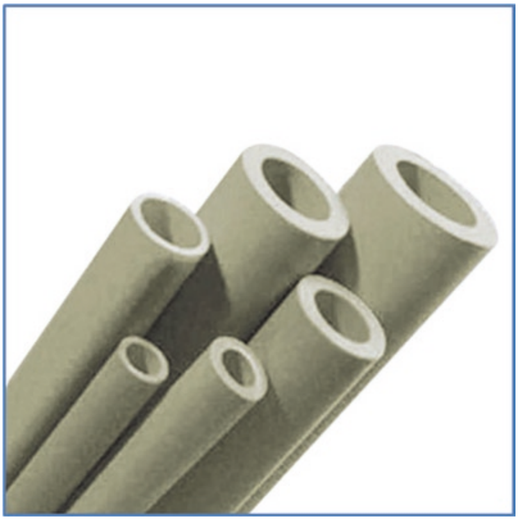
Dear Dr. Authority, your idea of embracing an extreme form of foundationalism is likely to continue promoting a decontextualised mathematics education. According to my recent exploration, foundationalism *rests* upon a realist ontology and objectivist epistemology with regard to valid knowledge systems being independent of political, cultural, social and spiritual influences (Fumerton 2005). Indeed, it is really hard for me to believe in the perspective that knowledge is (or can be) free from those influences because imagining knowledge that is free from human influence is to imagine the world without soulful humans or populated by machine-like humans. Which would you prefer, machine-like teachers or teachers with souls, feelings and sense of being in time and context?

> Frogs in the garden
> Butterflies' funeral
> Normalcy perpetuates

Your foundationalism is less likely to be compatible with knowledge systems arising from people's practices, rather it seems to privilege a form of mathematics that is exclusively algorithmic, abstract and disembodied, as you indicate that the logical aspect of the foundation of mathematics education is required to preserve the analytical rigor of mathematics. If you want to incorporate logic as an aspect of your foundation, why don't we include different forms of logics instead of privileging conventional logics (i.e., propositional, deductive and analytical) that promote a decontextualised nature of mathematics? I argue that whilst conventional logics help generate "objective" mathematical expressions, alternative inclusive logics (e.g., poetic, narrative, metaphoric and dialectical) help understand those mathematical expressions through "earthly embodied language," which represents a radical shift from an exclusively disembodied objectivist epistemology to an eclectic and embodied epistemology that allows us to cultivate relational, interdependent and inclusive pedagogical visions for mathematics (Jardine 1994). With alternative inclusive logics at centre stage, we can challenge the rigid unidimensionality of conventional logics that best serve the legacy of cold, disembodied and technicist rationality, thereby cultivating inclusive rationalities that are capable of explaining the complex and mutual relationship between official mathematics and mathematics situated in people's practices.

Altering Mimetic and Transmissionist Pedagogies

Dear Dr. Authority, whilst undertaking my first master's studies in 1996/1997, I came to know about a similar foundation of mathematics education that you suggest incorporating in our mathematics teacher education program. My experience suggests that perspectives associated with such foundationalism seem to promote mimetic and transmissionist pedagogies. You may argue here that transmissionism is an essential pedagogy for teachers to transmit mathematical knowledge in a rigorous way, ascertaining its exact reproduction (i.e., miming). However, guided by inclusive metaphors of *teaching as facilitating* and *learning as constructing* (Sfard 1998), I am going to critique key features of transmissionist and mimetic pedagogies arising from exclusive foundationalism.



Dear Dr. Authority, I envisage that an exclusive foundationalist view is not helpful for breaking the vicious circle of mimetic and transmissionist pedagogies. Does behaviourism (your psychological aspect of the foundation) not treat students as animals ready to be fed, as most of the behaviouristic experiments have been done with animals (Harzem 2004)? Let me share one instance that has some bearing on this question. It can be sometime in September, 1999 when I was involved in a teacher training program. I had written a training manual on teaching equations by using fictive stories (Raymond and Leinenbach 2000). My plan was to help teachers promote student-centred learning. After several orientation sessions on using those stories in the classroom, some of the trainee teachers used this approach in their teaching and it turned out to be effective. In the meantime, I invited a mathematics teacher trainer who was working in the Ministry of Education of Nepal to share this experience. After the class observation, he commented that the teachers did not teach essential "basic facts" about equations apart from entertaining students with some humdrum activities. Might the teacher educator not be using a foundational view in making such comments? His comments seem to be a result of your foundationalism-oriented mathematics teacher education program that largely promotes mimetic and transmissionist (e.g., rote-learning, drill, and blind practice) pedagogical practices.

Thus, I argue here that mimetic and transmissionist pedagogies embedded in narrow foundationalism do not help conceive mathematics in multiple ways as they seem to promote only one type of knowing, that is, *conceptual knowing* (Egan 1997). Why does your foundationalism promote only this type of knowing? Perhaps, it is because of the hegemony of the behaviouristic paradigm that you can measure the extent to which conceptual definitions are recalled, theorem proofs are reproduced, formulae are remembered and algorithms are unquestioningly replicated. Is this pedagogy sufficiently helpful for bringing meaningfulness to mathematics education? Perhaps, such mimetic and transmissionist pedagogies can be a key factor in the rampant underachievement in school mathematics as reported by recent national studies (EDSC 1997, 2003).

Dear Dr. Authority, I would like to invite you to consider this proposal. Rather than living for a single foundation or theory or philosophy, let us try to live for meaningful pedagogic transformation. In my mind promoting multiple ways of knowing (and learning and teaching) helps rescue mathematics education from such a narrow pedagogy of transmission. Here, my notion of "multiple ways of knowing" is about accounting for conceptual, reflective, critical and imaginative knowings imbued in the view of multiple intelligences (Eisner 2004). The notion of reflective knowing is about accounting for autobiographic moments in the impulses of learning, thereby helping students to connect mathematics with their personal experiences. I envisage that reflective knowing entails the very act of unveiling implicit and explicit mathematics embedded in students' everyday lifeworlds. Critical knowing is an orientation towards examining disempowering forces that promote dogmatic dependence (e.g., privileging the absolutist view of mathematics as a body of Platonic knowledge) and unfree existence (e.g., treating students as means to another end) in people's lives. One possible use of this type of knowing is: to facilitate our students to conceive that sociocultural reality is also about power that often creates disempowering relations between different groups of people. Whilst students use mathematics to solve problems arising from the world around them, they are likely to unpack such relations (e.g., uneven wealth distributions, unjustifiable resource allocation) surrounding the context in which the problem is related. In my mind, imaginative knowing empowers students to cultivate various forms of futuristic visions by using mathematics they study. I envisage that such a vision-making process entails: (a) a discourse on the usefulness (and limitations) of mathematics for their present and future lives, (b) the centrality of multiple logics (e.g., metaphorical, poetic and dialectic) in articulating present and future possibilities, and (c) opportunities to explore the nature of the values embedded in the mathematics they study.

Dear Dr. Authority, arriving at the final point, I would like to request again that you help me humanise the foundationalist view of mathematics education by employing dialectical logic to incorporate positive aspects of foundationalism and scepticism in mathematics teacher education. I believe that by creating synergies between the positive aspects of foundationalism and scepticism, we will be able to conceive inclusive pedagogies with an image of teachers as awakened facilitators and students as creative thinkers and active citizens. Drawing from Sri Aurobindo and McDermott (2005), I envisage that embracing an image of *teacher as an awakened facilitator* helps mathematics teachers to think of alternatives to imposing mathematical definitions, theorems and formula *as though* they are the infallible apparatus of ever-developing mathematical knowledge systems. Perhaps, mathematics teachers need to develop themselves as awakened beings, thereby living by the ideals by which their students can be enlightened.

Sincerely yours

Bal Chandra

Conclusion

With the initial aim of deconstructing the hegemony of exclusive notions of globalisation and foundationalism in mathematics teacher education programs and constructing transformative visions for addressing them, this chapter has presented auto-ethnographic explorations aided by philosophical inquiry. In the first section, we articulated a key disempowering feature of globalisation as universalisation. Whilst recognising the positive meaning of globalisation as conversations between competing interests and perspectives, we envision the concept of glocalisation that offers a space for incorporating sometimes opposing views, perspectives and notions related to mathematics teacher education. In the second section, we critiqued the hegemonic influence of foundationalism in mathematics education. More so, we identified ways to include both foundationalism and scepticism for transforming mathematics teacher education from a closed (and clogged) program to an open and more democratic enterprise. We envisage that such an enterprise is likely to promote dialectical logic as a means for establishing symbiotic relationships between scepticism and foundationalism, for foundationalism gives rise to scepticism, and *vice versa*. With the help of such inclusive envisionings, mathematics teacher education programs in Nepal are likely to: (i) promote both local and global knowledge systems in their curricula, (ii) dispel the myth of the superiority of one type of knowledge system over another, and (iii) encourage prospective teachers to conceive their pedagogies in holistic and inclusive ways.

References

Aikin, S. F. (2007). Prospects for skeptical foundationalism. *Metaphilosophy, 38*, 578–590.

Almeida, D. F., & Joseph, G. G. (2007). Kerala mathematics and its possible transmission to Europe. *The Philosophy of Mathematics Education Journal, 20*. Retrieved December 15, 2009, from http://www.people.ex.ac.uk/PErnest/pome20/

Aurobindo, S., & McDermott, R. A. (2005). *The essential Aurobindo: Writings of Sri Aurobindo*. New Delhi: Jaico Publishing House.

Bayart, J. F. (2008). *Global subjects: A political critique of globalisation*. Cambridge: Polity Press.

Bell, W. (2005). Creativity, skepticism and visioning the future. *Futures, 37*, 429–432.

Bhabha, H. K. (1994). *The location of culture*. London: Routledge.

Bowers, C. A. (2005). Is transformative learning the Trojan Horse of western globalisation? *Journal of Transformative Education, 3*, 116–125.

Brickhouse, N. W., & Kittleson, J. M. (2006). Visions of curriculum, community and science. *Educational Theory, 56*, 191–204.

Brown, T. (2007). The art of mathematics: Bedding down for a new era. *Educational Philosophy and Theory, 39*, 755–765.

Carr, W. (2006). Education without theory. *British Journal of Educational Studies, 54*, 136–159.

Doherty, C. (2008). Local time, global space and glocal identities in transnational education. In L. Dunn & M. Wallace (Eds.), *Teaching in transnational higher education: Enhancing learning for offshore international students* (pp. 160–170). New York: Taylor & Francis.

Drake, C., & Sherin, M. G. (2006). Practicing change: Curriculum adaptation and teacher narrative in the context of mathematics education reform. *Curriculum Inquiry, 36*, 153–187.

Dunlop, R. (1999). Beyond dualism: Towards a dialogic negotiation of difference. *Canadian Journal of Education, 24*, 57–69.

EDSC. (1997). *National achievement level of grade three students*. Kathmandu: Educational Development Service Centre.

EDSC. (2003). *National achievement level of grade five students*. Kathmandu: Educational Development Service Centre.

Edwards, R., & Usher, R. (2000). *Globalisation and pedagogy: Space, place and identity*. London/New York: Routledge.

Egan, K. (1997). *Educated mind: How cognitive tools shape our understanding*. Chicago: University of Chicago Press.

Eisner, E. W. (2004). Multiple Intelligences: Its tensions and possibilities. *Teachers College Record, 106*, 31–39.

Ernest, P. (2004). Postmodernism and the subject of mathematics. In M. Walshaw (Ed.), *Mathematics education within the postmodern* (pp. 15–33). Greenwich: Information Age Publishing.

Freeman, F. S. (1962). *Theory and practice of psychological testing*. New York: Holt, Rinehart & Winston.

Fumerton, R. (2005). Foundationalist theories of epistemic justification. In E. Zalta (Ed.), *Stanford encyclopaedia of philosophy*. Retrieved December 15, 2009, from http://plato.stanford.edu/: Stanford University

Granger, D. A. (2006). *John Dewey, Robert Pirsig, and the art of living: Revisioning aesthetic education*. New York: Palgrave Macmillan.

Hanh, T. (2000). *The path of emancipation: Talks from a 21-day mindfulness retreat*. Berkeley: Parallax Press.

Harzem, P. (2004). Behaviorism for new psychology: What was wrong with behaviourism and what is wrong with it now. *Behaviour and Philosophy, 32*, 5–12.

Henry, M. (1999). Working with/against globalisation in education. *Journal of Education Policy, 14*, 85–97.

Hersh, R. (1997). *What is mathematics, really?* New York: Oxford University Press.

Hilgard, E. R., & Bower, G. H. (1977). *Theories of learning*. Englewood Cliffs: Prentice Hall.

Hopp, W. (2008). Husserl, phenomenology, and foundationalism. *Inquiry, 51*, 194–216.

Institute, G. (2003). *Globalism Institute, RMIT*. Melbourne: RMIT.

Jardine, D. (1994). On the ecologies of mathematical language and the rhythms of the Earth. In P. Ernest (Ed.), *Mathematics, education and philosophy: An international perspective* (pp. 109–123). London/Washington, DC: Falmer Press.

Juan, E. S., Jr. (2007). Globalised terror and the post-colonial sublime: Questions for subaltern militants. In R. Krishnaswamy & J. C. Hawley (Eds.), *The post-colonial and the global* (pp. 157–165). Minneapolis: University of Minnesota Press.

Kenyon, G., & Randall, W. (1997). *Restorying our lives: Personal growth through autobiographical reflection*. Westport: Praeger.

Kloos, P. (2000). The dialectics of globalisation and localisation. In D. Kalb, M. van der Land, R. Staring, B. van Steenbergen, & N. Wilterdink (Eds.), *The ends of globalisation: Bringing society back in* (pp. 281–298). Lanham: Rowman & Littlefield.

Knowles, J. G., & Cole, A. L. (Eds.). (2008). *Handbook of the Arts in qualitative research: Perspectives, methodologies, examples, and issues*. Thousand Oaks: Sage.

Kuroda, S. (1958). An investigation on the logical structure of mathematics (I). *Hamburger Abhandlungen, 22*, 242–266.

Lakoff, G., & Johnson, M. (1980). Metaphors we live by Chicago: University of Chicago Press.

López, A. J. (2001). *Posts and pasts: A theory of post-colonialism*. New York: State University of New York Press.

Luitel, B. C. (2009). *Narrative explorations of lived mathematics curriculum: An epic journey*. Saarbrücken, Germany: VDM Verlag.

Luitel, B. C., & Taylor, P. (2007). The shanai, the pseudosphere and other imaginings: Envisioning culturally contextualised mathematics education "http://www.springerlink.com/content/120017" Cultural Studies of Science Education "http://www.springerlink.com/content/120017", *2*(3), 621–655.

McLaren, P. (2003). Critical pedagogy and class struggle in the age of Neoliberal globalisation: Notes from history's underside. *Democracy & Nature, 9*, 65–90.

McLaren, P. (2005). Critical pedagogy in the age of neo-liberal globalisation. In P. McLaren (Ed.), *Capitalists and conquerors: A critical pedagogy against empire* (pp. 19–74). Oxford: Rowman & Littlefield.

Mezirow, J. (2005). An overview on transformative learning. In P. Sutherland & J. Crowther (Eds.), *Lifelong learning: Concepts and contexts* (pp. 24–38). London: Routledge.

Nagarjuna, A., Bhattacharya, K., Johnston, E. H., & Kunst, A. (1990). *The dialectical method of Nagarjuna: Vigrahavyavartani* (3rd ed.). New Delhi: Motilal Banarsidass.

O'Sullivan, E. (2002). The project and vision of transformative education: Integral transformative learning. In E. O'Sullivan, A. Morrell, & M. O'Connor (Eds.), *Expanding the boundaries of transformative learning: Essays on theory and praxis* (pp. 1–12). New York: Palgrave.

Polkinghorne, D. E. (1992). Postmodern epistemology of practice. In S. Kvale (Ed.), *Psychology and postmodernism* (pp. 146–165). London: Sage.

Raymond, A. M., & Leinenbach, M. (2000). Collaborative action research on the learning and teaching of algebra: A story of one mathematics teacher's development. *Educational Studies in Mathematics, 41*, 283–307.

Richardson, L., & St Pierre, E. (2005). Writing: A method of inquiry. In N. Denzin & Y. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed., pp. 959–578). Thousand Oaks: Sage.

Robertson, R. (1992). *Globalisation: Social theory and global culture*. Thousand Oaks: Sage.

Robertson, R. (1995). Glocalisation: Time-space and homogeneity-heterogeneity. In M. Featherstone, S. Lash, & R. Robertson (Eds.), *Global modernities* (pp. 25–44). London/New Delhi/Thousand Oaks: Sage.

Said, E. W. (1978). *Orientalism*. New York: Pantheon Books.

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher, 27*, 4–13.

Shuell, T. J. (1986). Cognitive conceptions of learning. *Review of Educational Research, 56*, 411–436.

Smitherman, S. (2005). Chaos and complexity theories: Wholes and holes in curriculum. In W. E. Doll, M. J. Fleener, D. Trueit, & J. St. Julien (Eds.), *Chaos, complexity, curriculum and culture: A conversation* (pp. 153–180). New York: Peter Lang.

Stanley, J. (2005). *Knowledge and practical interests*. New York: Oxford University Press.

Sternberg, R. J. (2007). Who are the bright children? The cultural context of being and acting intelligent. *Educational Researcher, 36*, 148–155.

Swyngedouw, E. (2004). Globalisation or "glocalisation"? Networks, territories and rescaling. *Cambridge Review of International Affairs, 17*, 25–48.

Taylor, P. C. (2008). Multi-paradigmatic research design spaces for cultural studies researchers embodying post-colonial theorising. *Cultural Studies of Science Education, 3*, 881–890.

Taylor, P. C., Settelmaier, E., & Luitel, B. C. (2010). Multi-Paradigmatic transformative research as/for teacher education: An integral perspective. In K. Tobin, B. Fraser, & C. McRobbie (Eds.), *Second International handbook of science education*. Dordrecht: Springer.

Wong, W.-C. (2006). Understanding dialectical thinking from a cultural–historical perspective. *Philosophical Psychology, 19*, 239–260.

Yadava, Y. P. (2007). *Linguistic diversity in Nepal: Perspectives on language policy*. Paper presented at the international seminar on constitutionalism and diversity, Nepal.

Chapter 34
Responding to Glocalisation and Foundationalism in Science and Math

Dawn Sutherland and Denise Henning

Dear Denise,

I just returned from Thailand. It was an interesting experience teaching a science methods course for Canadian pre-service teachers completing their education degree overseas. Something interesting happened while I was there. As part of the course, my students were required to create a portfolio of cultural and local examples from Thai culture that would help create early and middle years' science experiences that were more locally relevant. When I explained the assignment, students just stared at me, and asked, "why would we want to do that?" You see, my Canadian students realized very quickly that one of the purposes behind Thai students attending English schools in Thailand is to become more aware of eurowestern culture. So, both my past and recent experiences help me relate to Drs. Luitel and Taylor's chapter on the impact a non-critical presentation of global (really eurowestern) education has on non-eurowestern educational systems.

Do you remember when we first met? I felt I had to work so hard to earn your trust as a non-Aboriginal researcher in Indigenous science education. We had to have many conversations and meetings to talk about what Indigenous science education is and how important personal stories and local community are to learning. It was only after several meetings that we realized we were both very grounded in our own culture and localities, yet able to respectfully discuss Aboriginal issues from our unique viewpoints and examine them from a broader perspective. Perhaps this is what Luitel and Taylor are talking about when describing glocalisation, that it is the ability to see the interplay of dominant agendas in your own worldview, a worldview that is a result of local and global influences, and the worldview of others.

While reading Luitel and Taylor's chapter, I reflected on the feasibility of creating a contextualized and inclusive mathematics and science teacher education program. I would have liked to see some examples of the teacher education program that the authors claim addresses glocalisation and foundationalism. I can see

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_34,

how the contextualised and inclusive approach to mathematics education as described by Luitel and Taylor may be feasible with an adult population. However, I struggle to see how the idea of glocalisaton – the interplay of local and global – can be incorporated into the First Nations and North American Indian elementary or middle years classrooms, the student populations with which I am most involved. Based on our research with Manitoban First Nation communities, identity and the incorporation of locality were identified by science teachers as essential components of a successful science program in these Indigenous settings (Sutherland and Henning 2009). These teachers we spoke with identified the need to teach from a localized perspective first, one that includes Elders, language, culture and the opportunity to go onto the land. It is only after this localized instruction takes place that students should be asked to compare eurowestern science and local Indigenous knowledge. This is what can facilitate a discussion and exploration of the similarities and differences between these two knowledge systems. Perhaps the latter part of this instructional strategy is an example of glocalisation, but it could not occur without first establishing a grounded knowledge of one's sense or understanding of place.

I believe that all educators think they are providing a transformative education to their students. I don't think they would remain in the field of education if they did not believe they were having a positive effect. However, there are different operational ideas of what constitutes "transformation." For example, the director's views on the importance of eurowestern curricula in a mathematics teacher education program are just a different opinion on what constitutes transformation in teacher education. Luitel and Taylor describe their transformative vision for mathematics teacher education as a glocalisation approach. I know that I have had my share of frustrating conversations with educators who uphold the foundations of eurowestern science. Therefore, I can relate to the narrative that is depicted in Luitel and Taylor's paper. At the same time, I also know how difficult it is to try to change their opinions. I am not convinced that writing a letter to the Director is the best use of time. Why not write the letter to teachers and ask them for their input on this transformative model for math education? Thus, initiate the change from the grassroots.

I wonder what you think about the idea of glocalisation as discussed in the paper. I really don't want to get into a discussion of the term itself. I am not much for creating technical language to identify an idea; this is primarily an academic tradition that results in excluding others from participating in a conversation. I think this is a trap the authors and the supervisors have fallen into where both participate in rhetorical practices that have historically excluded local approaches. To me, there is an irony to the letters and the "analysis" because the writers create a terminology that may advance themselves as individuals through academia by creating a different foundation, the right foundation. I think what is missing from the whole chapter is the voice of the teacher.

Luitel and Taylor make the distinction between globalisation and "localisation" and argue that as an approach, the latter would exclude other perspectives. However, I don't see it this way. The overwhelming message we received from the Securing Aboriginal Goals in Education (SAGE) conference (a conference that encouraged Aboriginal science educators to discuss successful programs that integrate science and Indigenous knowledge) was that students first need a firm grounding in their language, culture and Indigenous teachings. It is only after students have developed a strong sense of identity that they are ready to experience a more critical-based education. To me, this means that in science education, the incorporation of Elders, language, culture and land-based experiential learning are paramount in the early to middle years of education; in the older grades, students may experience a more global approach to science.

It is the re-affirmation of the phrase "Local is Global" and the incorporation of prioritizing the local as a pedagogical framework that will help students eventually understand global contexts. What did we find when we asked educators involved in teaching Indigenous students science? We found that in the Canadian Indigenous context incorporating language, culture, Elders, traditional knowledge and experiential learning into all aspects of learning are foundations that can help ground Indigenous students. Students can examine more global ideas with an ability to evaluate "foreign" ideas from their own Indigenous worldview.

My question for Luitel and Taylor is: what does a glocalised curriculum look like? And was Dr. Luitel's proposed program one such example? I see the intent and the value to the discussion but would like to invite teachers to sit at the table. I am curious about your understanding of glocalisation. How does it relate to your situation, as a leader at a post-secondary institution that has a mandate and its very foundation is to create pedagogy and curriculum grounded in local Indigenous knowledge?

Sincerely,
Dawn

Dear Dawn,

I am happy that you have had a safe return from Thailand. I know how much you enjoy this summer program, and the opportunity to work with pre-service teachers in the Thai context. This work you are doing is so important to creating an awareness within graduating teachers that there are multiple learning styles that require teaching that is "outside the box" of Eurocentric thinking which has, since European contact era, informed the foundational approaches to education. I am always amazed at how much of an epiphany it is when educators realise that "non-eurowestern" approaches can have a greater impact or relevancy on learning experiences, particularly for Indigenous learners. Quite honestly, I found Luitel and Taylor's paper interesting. Yet I was also very concerned that the realisation of the cultural and local experiences, from the authors' perspective, was discounted as a narrow viewpoint and equated with a predominant eurowestern worldview.

I do remember our first interactions and how we had to work through some of the lived experiences from our respective pasts to ensure trust as friends, researchers and writers. These interactions brought us both to the realisation that we value Indigenous concepts of relationship or kinship, which, from my lived experience, is a process that most non-Aboriginal people do not have the patience for, particularly, non-Aboriginal academics.

I agree with you that some specific examples from Lutiel and Taylor's program would have brought some insight for me as well. From my perspective, locality, identity and contexts are vital when we have to consider something that was constructed in a very different time and place and has taken on some sort of generalisable impact. I sometimes wonder, "have educators even thought to question that?" I believe this is an important role that non-eurowestern approaches to education bring to this discussion. I think Luitel and Taylor missed this point in their writing. I think that we should stop and question eurowestern approaches to education and consider the local for its own sake because there are all these other ways of thinking about teaching and learning, especially with mathematics and science.

I believe that in order to grasp issues that are imperative to our understanding of local Indigenous knowledge in North America today, it is vital to have information about and reflection upon the past in order to breach the cultural borders and educate about the relevance of intercultural acceptance in our contemporary world. Indigenous scholars like Waziyatawin and Yellow Bird (2005) reflect upon how "the relationship between the coloniser and the colonised [which] is so deeply entrenched in the United States and Canada, most of us have never learned how to actively challenge the status quo" (p. 1). According to these Indigenous scholars and other Indigenous research on colonisation, almost every system (government, school, university, church, corporation, etc.) has been and is currently established to continue the oppression of "difference" and maintain the privilege of the colonisers.

In regards to your perspectives on transformative education, it's so very clear for me, as an educator trained and "brought up" so to speak from a foundational viewpoint of eurowestern approaches and concepts, the decolonising experiences I have been embracing as an Aboriginal scholar and researcher has transformed my life and worldview. These decolonising experiences challenge our current knowledge and understanding of education, which is based on a view of colonisation where White is considered "normal" and others [or non-White] are considered "different," and which is more often than not, considered "lesser."

My thoughts on the idea of glocalisation obviously come from a very real lived approach for the most part. The eurowestern tradition and current knowledge of global education is seen as the "foundational" approach to math and science. This approach, many educators suggest, must be firmly planted in elementary students in order for there to be sustainable success in the middle and secondary years of schooling. However, when crossing from that space of European or "normal" into that space of "difference" or Indigenous, we must assess whose foundations is being referred to in relation to educational success. Truly, the eurowestern approaches continuously have not worked in providing a sustainable and positive educational experience for indigenous learners. From this vantage point, Luitel and Taylor and I are in agreement. I have been empowered by going back to more pre-contact traditional approaches and presenting them for the value they bring to learning and teaching. In line with your thoughts on "the traps that the authors and the supervisors have fallen into," I believe that this chapter has crossed cultures as I discussed above; however, these scholars, in trying to give name to their discoveries, reinstate a eurowestern approach by using the term "glocalisation" to make it more palatable to scholars within the academy.

Dawn, I would agree with you on your realisation of exclusion of other perspectives in Luitel and Taylor's ideas regarding the kind of impact a non-critical presentation of global (really eurowestern) education has on non-eurowestern education. This perspective is in fact counter to what the SAGE conference participants and Aboriginal science educators believe constitutes positive educational outcomes – a strong foundation in cultural teaching grounded in language. According to these educators, a grounding in land-based experiential learning approaches that make learning real and a part of the everyday lifeways of Aboriginal learners is vital to principles of Indigenous learning. Students need to know who they are and that their identity is something to be proud of and recognized as important by educators in order to participate in a lifelong learning process. In fact your statement that "students can then examine more global ideas with an ability to evaluate "foreign" ideas from their own Indigenous worldview," encapsulates the findings from the SAGE conference.

Regardless of how I have interpreted the writing of Luitel and Taylor, it is my hope that the implementation of their approach provides learners with a positive mathematics educational experience. As always, by embracing the local as having its own value to the education of the local learners, learners can then critically evaluate the eurowestern foundations they will ultimately encounter.

In closing, I am always hopeful when researchers move away from the eurowestern approaches of foundationalism to that of a community-based, reciprocal and land-based approach that creates a living–learning environment for science and mathematics education. Perhaps including the voices and ideas of local community and teachers in the creation of inclusive and contextualised science and mathematics curricula will further the ideas of Luitel and Taylor.

Warmest regards,
Denise

References

Sutherland, D. L., & Henning, D. (2009). Ininiwi-Kiskanītamowin: A framework for long-term science education. *Canadian Journal of Science, Mathematics and Technology Education, 9*, 173–190.

Waziyatawin, A. W., & Yellow Bird, M. (2005). For indigenous eyes only. Santa Fe: School of American Research Press.

Chapter 35
Australian Torres Strait Islander Students Negotiate Learning Secondary School Science in Standard Australian English: A Tentative Case for Also Teaching and Assessing in Creole

Philemon Chigeza and Hilary Whitehouse

Introduction

> My grandfather taught me that the river is the river and the sea is the sea. Each has its own complex patterns, origins and stories, and even though they come together, they will always exist in their own right. Non-indigenous Australians cannot be expected to learn or understand the lessons of my grandfather, but simply to respect that they are central to my identity. (Patrick Dodson writing in *The Australian* 13.09.96)

At the opening of the 42nd Australian National Parliament in early 2008, the Prime Minister of Australia, Mr Kevin Rudd, pledged to build new educational opportunity for indigenous children of Torres Strait Islander and Aboriginal descent. The discourse used was that of "closing the gap" on both opportunity and academic achievement. The persistent difference in educational achievement and attainment between indigenous Australians (Aboriginal and Torres Strait Islander people) and non-indigenous Australians (immigrants to the continent since 1788 and their descendents) is a problem with many complexities, including tolerated failure on the part of state and federal governments over many decades to vigorously address persistent educational disadvantage. Australia has been described as a "high quality–low equity" country in that Australian schools, while operating under high-quality policy frameworks, have found it difficult to address equity issues in teaching, learning and assessment effectively in practice (Klenowski 2009).

We consider "the gap" in relation to indigenous school science education in Australia. In this chapter, we discuss the findings and implications of a study conducted in two grade 9 science classrooms in a wholly indigenous school in far north Queensland, Australia. We document the complex reality of students from the

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education Vol. 3, DOI 10.1007/978-90-481-3929-3_35,

Torres Strait Islands, who are not native English speakers, coming to the Australian mainland to go to school and how they were able to engage, or not, with learning non-indigenous science wholly taught and assessed in Standard Australian English. We investigate what Klenowski (2009, p. 5) calls the "mismatch between home and school language" that impacts indigenous student achievement in literacy and numeracy. We have learned that when achievement is measured through a monochromatic lens, students' lack of fluency in the dominant language adversely affects their achievement in science.

> The effort to master the future cannot be undertaken in reality until the conditions indispensable for ensuring it a minimum chance of success are provided. (Bourdieu 1984, p. 73)

In approaching our study from a socio-cultural perspective (Giddens 1979), we take up the idea of culture as praxis and position student research participants as agents of their own culture(s). We examine language in particular, as language is at the centre of cultural practice. We reflect Bourdieu's position that language and culture are unthinkable without the other. According to Jenkins (2002, p. 152), Bourdieu insisted, "that language cannot be analysed or understood in isolation from its cultural context and the social conditions of its production and reception." Winford (2003, p. 35) reminds us that languages are not "merely systems of rules … they are also vehicles of social interaction and badges of social identity … shaped by socio-cultural forces." As such, our perception, even faith, in any language, including that of Standard Australian English, the language of formal education in Australia, is "conditioned by social practice, social relationships and attendant ideologies" – meaning any linguistic prejudices we hold can be seen as a matter "of race or class or ethnic prejudice in a subtle guise" (Winford 2003, p. 35).

Standard Australian English is a derivative of a dialect from the southeastern part of the United Kingdom. The fact this dialect derivative became the language of formal instruction and assessment in twenty-first century Australian schools, in a continent with about 600 original languages from 250 language groups at the time of British settlement in 1788, is a matter of power and politics and not a matter of linguistics (Tripcony 2000). Bourdieu argued any "standard language" is only one of many versions, socially highly specific and "generally bound up with a history of state formation" (Jenkins 2002, p. 153). The state of Queensland (and, more recently the nation of Australia with the development of national curriculum) is responsible for generating a standardised science curriculum for students in grades 8, 9 and 10. Of course, the language of curriculum, instruction and assessment is "standard" Australian English. Bourdieu took a wide view of sociology, and he considered it quite reasonable to analyse language, culture and education together, as we do here, because, "they are all concerned with the manner in which domination is achieved by the manipulation of symbolic and cultural resources and with the collusion of the dominated" (Jenkins 2002, p. 153). Bourdieu argued language serves practical ends, institutional as well as social, and there is an explicit relationship between language and how people exercise control over others (Snook 1990). Language practice is an instrument of action.

We draw on the cultural sociology of Bourdieu for what it offers our study interpretations with regards to language/culture/education, and also for his stance that theory and research are mutually implicated. We view agency and structure as a dialectic, in that structure influences human action, and humans actively change the social structures they inhabit (Jenkins 2002). Bourdieu's (1986) field theory reconciles objectivism and subjectivism as a dialectical relation between agency and structure. We have employed his concepts of habitus, cultural capital and cultural field as a means for attempting to understand the potential cultural conflict experienced by indigenous students learning non-indigenous science. We will discuss the terms as we unfold our study narrative, however we present a formula (Bourdieu 1984, p. 101) that provides a useful heuristic for summarising (but not analysing) the major concepts at work. (Habitus × Capital) + Field = Practice, where (Habitus × Capital) informs the concept of agency, the idea that individuals are equipped with the ability to understand and control their own actions, regardless of the circumstances of their lives. The notion of agency is central to our discussion of the negotiation of language and culture in the science classroom.

The Authors' Social Trajectories

As habitus is central to our theoretical frame, it would only be proper to start with a brief introduction to "us," Philemon and Hilary. Habitus refers to a set of dispositions created through a conjuncture of structure and personal history and includes a person's (multiple) understanding(s) of the world. We are both science educators, both immigrants to Australia, researching with a group of Australian indigenous adolescents whose culture(s) we can respect but not expect to fully understand. Philemon is a black, non-indigenous Australian who grew up in rural Zimbabwe in southern Africa and taught mathematics and physics in rural and urban schools in Zimbabwe. He immigrated to Australia in 2002 where he moved to Gordonvale and to Djarragun College, the school where this study takes place. Philemon still thinks in his first language, Shona. The English(es) Philemon acquired – his secondary education was conducted in southern African version of English, he has always taught in dialects of English and he wrote his Ph.D. in a version of Standard Australian English – has not replaced the different logic employed in thinking in his home language, Shona. Since cultural capital is associated with culturally authorised attributes and skills and, importantly, includes forms of language, Philemon has managed to acquire different forms of language and cultural capital as he negotiated the fields of his home and schooling. As a researcher, Philemon continually switches between different language and knowledge systems, making him an expert field negotiator, which allows profound personal insights into Bourdieu's concept of cultural fields as sites of struggle over particular forms of capital (Mahar et al. 1990). Hilary is a white, non indigenous Australian who grew up in California (United States), immigrated to Australia with her family as a teenager, and thinks wholly in English, though she still has trouble spelling Standard Australian English. She spent several years teaching in secondary schools before completing a Ph.D. and subsequently teaching science education and environmental education at tertiary level.

Philemon and Hilary ("we") rely on each other to interpret what the other does not understand. To give one example: Hilary is direct while Philemon is circumspect. To be direct is considered rude in the mind of a Shona-thinking person. Hilary, still thinking like a Californian, thinks writing and speaking around a point, without getting to or making the point, appears impolite. Consequently, we have held many illuminating conversations while working together that led to "us" adopting the position of thinking and writing in dialectic. What we present here is a narrative of our continuing conversations and recursive investigations into Philemon's classroom practice: how his students negotiated learning formal school science, and how we thought about and analysed his research findings.

Classroom Research with Torres Strait Islander Students

Philemon taught and conducted classroom research with 44 grade 9 Torres Strait Islander student participants for his doctoral research project. Australian indigenous people include Aboriginal people, from all across the Australia continent, and Torres Strait Islander people who originate from the Torres Strait Islands and from Cape York in far north Queensland. There were Aboriginal students in Philemon's research classrooms, but after much agonising, these students were not included in this particular study for one practical reason, that of irregular school attendance. All the Torres Strait Islander students who participated in this study were boarders at Djarragun College. Many parents from remote communities make the decision to educate their children at boarding schools as this means their children will attend school every day and have access to sports and the general social advantages of being a boarder. Djarragun College has been a boarding college since its inception in 2001 and its students are a mix of boarders and day students. Many of Philemon's Aboriginal students were day students and consequently their attendance was not as regular as the Torres Strait Islander group. Philemon made the decision to try to eliminate school attendance as a confounding variable in this research for the reason that school attendance is shown to strongly influence indigenous educational attainment in Australia. Additionally, Philemon wished to investigate practices other than attendance when researching with his students. All year 9 students participated in the classroom learning activities; however. formal data were collected only with Torres Strait Islander boarders who had their parents' and guardians' permissions to be included in the study during the research cycles in 2006, 2007 and 2008. This was a very personal project for both of us. For Philemon, it was a matter of desire to teach his students well. For Hilary, it was a matter of desire to support Philemon as her Ph.D. student. It became a journey into the epistemology and ontology of the students and our own as the students, initially positioned as subjects of research, taught us a very great deal about the socio-cultural praxis of science education in Australia. Our thoughts about the nature of science education, language, place and culture are what we discuss with you in this chapter.

"Under-Achievement" on Benchmarked Science Assessments

Patterns of so called "under-achievement" by Australian indigenous students (both Aboriginal and Torres Strait Islander) on benchmarked science assessments have been consistently reported in several studies. For example, the OECD Program for International Students Assessment (PISA) 2006 results showed that 40% of Australian indigenous students performed below the OECD "baseline" and the Third International Mathematics and Science Studies (TIMSS) reported Australian indigenous students have significantly lower average scores than non-indigenous students. The 2006 Australian National Year 6 Science Assessment Report found only 49% of Queensland students were at or above a nominated proficiency standard, compared with the Australian average of 54%. Indigenous students, whose first language is not English, and who live away from the major population centres in regional, rural and remote areas of the country, were least likely to meet the national science proficiency standard for year 6.

Following what were called "poor" results in the 2008 National Assessment Program – Literacy and Numeracy (known as NAPLAN), the Premier of Queensland, Anna Bligh, commissioned Professor Geoff Masters, Chief Executive Officer of the Australian Council for Education Research, to review Queensland curriculum and educational standards. Masters (2009) reported indigenous students from the Torres Strait and Cape District performed among the lowest five per cent of students nationally. The report suggests that by grade 9, the average "gap" in achievement level of students in literacy, numeracy and science between non-indigenous Queensland students and indigenous students living in very remote parts of the state is the equivalent of 6–7 years of schooling. There are factors beyond remoteness underlying these statistics, including the much lower socio-economic status of Australian Aboriginal and Torres Strait Islander communities in general as well as a very high proportion of indigenous students for whom English is a second or third or fourth language (Tripcony 2000). We argue here that one of the strongest factors in generating continuing inequity in terms of secondary school science achievement is that the Queensland science curriculum is taught and assessed using Standard Australian English at the expense of every other language possessed by Aboriginal and Torres Strait Islander peoples (Malcolm 1998). What we think is being measured by standardised national and state achievement tests is not indigenous students' understanding of scientific concepts, but how well students are able to take the test in a second or third or fourth language they may not be able to speak, write or even be able to think well in at all.

Torres Strait Islander Students' Cultural Resources

Torres Strait Islander people identify themselves as a sea people and the movement of the seas and the winds order their lives. Traditional activities are determined by two different seasons – the dry time of southwest winds from April to August and the rainy time of the northwest winds from December to March. Although these seasons are shifting now with global climate change, the winds still determine the sailing, fishing and gardening seasons as they have for millennia (Sharp 1993). The original languages spoken in the Torres Strait Islands are Kalaw Lagaw Ya, a related dialect Kalaw Kalaw Ya and Meriam (Shnukal 1996).

The sophistication of island and mainland Australian indigenous languages has long been underestimated. As Malcolm (1998, p. 119) remarks, Australian languages, "far from being limited or primitive [are] extremely complex and highly sensitive communication resources, alongside of which, in some respects, languages such as English appear to be quite blunt instruments." During the nineteenth and twentieth centuries, the arrival of other groups to the Torres Strait Islands including South Sea Islanders, Japanese, Malay and European settlers created a Pidgin English from which grew a Creole language, known as Broken, Pizin, Blaikman or Torres Strait Creole (Shnukal 1988).

Pidgins and Creole are considered contact languages; they arise in areas where people of different languages have had to interact and verbally communicate usually for trading and commerce purposes. There are many social and historical reasons for the formulation and evolution of these languages. Holmes (2000) describes a pidgin as a "reduced language" that results from extended contact between people with no languages in common. A pidgin is no one's native tongue. A Creole, by contrast, is an established complex language of relatively recent appearance, usually with pidgin origins and "used by an entire speech community" (Holmes 2000, p.6). As Shnukal (1988, p. 4) explains, Creoles "are no different from any other normal languages in terms of the complexity of their sound and grammatical systems and the richness of their vocabulary. They are true languages in that they are capable of expressing their speakers' need for self-expression and communication." Torres Strait Creole emerged in the latter half of the twentieth century and is a true language and not a pidgin (Tripcony 2000). Crowley and Rigsby (1979) documented the Cape York and Torres Strait Island area as "linguistically complex." Islander students arrive at boarding school with Torres Strait Creole (in both its formal and informal varieties) as their common language capital and with English – or with versions Tripcony (2000) called "englishes" – as a second, third or fourth language.

Superficially it may appear that Torres Strait Creole and English/es are similar in that they share a similar vocabulary. However, the sounds of Creole are very different and Torres Strait Creole bears very little cultural resemblance to English in that it does not carry meanings associated with western ways of thinking (Crowley and Rigsby 1979). Shnukal 1988 noted:

> Broken [Torres Strait Creole] has borrowed about 85% of its vocabulary from English although the borrowed words have changed in the process. On a deeper level, however, both the systems of meanings and the way the language is used resemble the traditional languages of the Torres Strait much more than English. It is far easier to translate from a traditional language into Broken and vice versa than into English. Speakers of any island language (including Broken) always remark on how uncomfortable they feel when using English, how 'frozen' they find it, even when they speak it extremely well. They find it difficult to express themselves fully. This is because, as a product and shaper of European culture, English is alien too much of Islander thinking. (p. 4)

Research conducted for the Queensland Indigenous Education Consultative Body (QIEC 2002) identified very few indigenous students from remote communities, including those from the Torres Strait who spoke English as a first language. These findings were confirmed in a socio-linguistic analysis of indigenous students from sixteen North Queensland boarding schools, including Djarragun College (Catholic Diocese of Townsville 2003). The Aboriginal and Torres Strait Islander students who boarded at each of the sixteen schools were grouped into four categories that describe the language capital they brought to boarding school: Group 1: A student's first language is a traditional language or dialect, the second language is Aboriginal English (AE) or Torres Strait Creole (TSC) and Standard Australian English (SAE) is, for all intents and purposes, a foreign language; Group 2: SAE (or a version) is a second or third language and the student's first language is either AE or TSC; Group 3: SAE (or a version) is a second dialect and AE or TSC is the first dialect; Group 4: SAE (or a version) is a first language. Few indigenous student boarders from remote Aboriginal communities on Cape York or from the Torres Strait Islands have English as their primary language capital. When they arrive at boarding school, these students are taught and assessed in Standard Australian English although they originally learned to construct concepts in Aboriginal and/or Torres Strait Islander languages.

Winford (2003) writes it is "problematic" to come to school with any kind of Creole as your thinking and learning language. There is a persistent "linguistic prejudice" against Creole languages in many parts of the world based on the fact they are new or recent languages and are the products of colonisation. The lower status of Creole languages is an ideological position and, "like other ideologies based on race, class or similar differences, language ideology helps to promote the interests of a dominant group or class at the expense of less powerful groups" (Winford 2003, p. 32). To be indigenous in this context is to both belong to home country that became the nation state of Australia and to also belong to a severely disadvantaged and marginalised group of peoples. Any state policy that advocated for officially teaching indigenous children in their first or second languages has been contested, though many primary schools practice forms of bilingual education in remote areas at the classroom level.

English is the language of power in this nation, and indigenous children and migrant children are expected to gain mastery of English in order to gain access to powerfully hegemonic ways of knowing. In Australian science curriculum documents, English is positioned as neutral, but it is hardly a neutral language for indigenous learners of science from rural and remote areas. Torres Strait Islander middle school students learning science must accommodate and negotiate differentiated traditional knowledge systems, a number of languages, school science taught in English, and their own emerging youth cultures and dialects. Indigenous home language and Creole thinking students learning a western science curriculum must be outstanding field negotiators in order to be positioned as successful learners within formal education systems. In reality, only a small percentage of students are so adept and indigenous students who do succeed in these fiendishly difficult and complex negotiations are rarely fully appreciated for how skilled they are.

We struggle with educational approaches that work from the assumption that Torres Strait Islander students come to the classroom with cultural deficiencies and lack necessary knowledge, social skills, abilities and cultural capital. Yosso (2005) challenges this traditional interpretation of cultural capital of indigenous groups by conceptualizing it from a place of community cultural wealth, which includes various forms of capital nurtured from the community such as aspirational, navigational, social, linguistic, familial and resistant capital. Osborne and Tait (2002) argue ignoring the socio-historico-political contexts of schooling is foolish if we, as teachers, take seriously our fundamental commitment to help all students. These forms of capital draw on knowledges indigenous students bring with them from their homes and communities into the classroom. This perspective shifts approaches to education from a deficit model to one of capacity building where arrays of cultural knowledge, skills, abilities and contacts possessed by socially marginalised groups are recognised and acknowledged. A capacity approach to science education acknowledges the multiple strengths historically marginalised students bring to school and serves the larger purpose of greater social and racial justice.

Thinking in Creole, Negotiating in English

> Research can be carried out by 'insiders' or 'outsiders'. Teachers, as inside participants in educational relationships, have the potential to 'see inside' these relationships; their 'in-sights' cannot be duplicated by those who gaze at these processes from the outside (e.g., typical university researchers). At the same time there are dimensions of issues and problems that are not apparent to those in the middle of a situation but potentially identifiable to those who are somewhat distanced from it. (Cummins 2000, p. 1)

Cummins (2000) argues that both "insider" and "outsider" researcher perspectives are necessary for better understanding organisational situations and relationships. One of the advantages of this research project was that Philemon, an outstanding field negotiator, was positioned "inside" the classroom collecting data with his students in his sensitive and unobtrusive way on how they were negotiating science learning. On the "outside" was Hilary, with whom Philemon talked throughout the research journey. Being a "whitey," Hilary had little initial idea of the complexities faced by students trying to learn school science in a second or third or fourth language (being practically monolingual herself). However, she did know about the applications of Bourdieu's sociology. Together, we turned to the writings and interpretations of Bourdieu to make sense of our findings, taking up Cummins (2000, p. 2) stance that, "it is theory that integrates observations and practices into coherent perspectives and, through dialogue, feeds these perspectives back into practice and from practice back into theory."

From the perspective of cultural sociology, science classrooms can be analysed as cultural fields, where all classroom activity is mediated by a complex history of social and cultural phenomena (Tobin 2005). Treating science as a culture implies doing science as cultural enactment and learning science as cultural (re)production

(Tobin et al., 2002). Language is a cultural resource upon which individuals (as agents) can draw on in a science classroom (as a field of practice). There are different dialects of Torres Strait Creole; however, all speakers can understand one another. Over 3 years, Philemon investigated how his grade 9 Torres Strait Islander students employed their home languages (Creole and indigenous languages) and formal science language (with required expression in English) when learning the concepts of energy and force. He was interested in how students participated and communicated in relevant science learning activities both with the teacher and with each other. He wanted to know how students were able to apply and reproduce concepts of energy and force as constituted in English. He observed what language resources they drew upon for developing understandings of energy and force. Philemon used both group and individual techniques to capture students' language use and concept knowledge. Islander students prefer to work together, so Philemon collected group brainstorming notes of everyday ways of knowing, group construction of Venn Diagrams to compare and contrast ways of knowing, group pre-inquiry and post-inquiry concept mapping in two learning units, one on energy and the other on force. He also collected individual student reflections where students were encouraged to draw bubble diagrams, pictures and cartoons to represent thoughts and feelings. Data collection took place during regular, scheduled science lessons and data collection was integrated into lesson planning. Philemon also made detailed observations of the languages students employed to discuss science concepts. In many instances, he observed students abandon English to use Torres Strait Creole to explain their understandings to one another. Philemon kept records on how keen students were to actively engage in classroom learning, including speaking, writing and physical actions.

Of the forty-four students in the study, the large majority, $n = 37$, or 84%, had some level of difficulty communicating in English, from limited but able to express concepts to severe difficulty expressing any concept in English. Only seven of Philemon's 44 students (16%) spoke and wrote English with facility. Almost all students were observed using Creole in the classroom in order to participate in group conceptual meaning-making. This is a logical strategy on students' part. Students may develop quite good understandings of science concepts as discussed with each other and expressed in Creole. However, unless these same adolescents are highly able to translate both language *and* concepts accurately into Standard(ised) Australian English, they are likely to be judged as attaining only "low" levels of academic achievement. In contrast to Islander adolescents, students from urban areas who speak and think English as a first language are distinctly advantaged by current standardized science assessment practices. All students from remote areas whose first language is not English face similar challenges in demonstrating what they do know about the world in the taken-for-granted culture of mass assessment.

Bourdieu's sociology favours classification as a means for understanding order through ordering. Classification is an arbitrary cultural act. Philemon, the persistent, Shona-thinking classroom researcher, eventually induced three categories of how the Torres Strait islander students employed formal science terminology and demonstrate knowledge of scientific concepts and processes. In Category A, were those students able to use scientific genre in speaking and writing to actively demonstrate an understanding of energy and force. They labelled diagrams correctly in English, used level appropriate scientific terminology and displayed evidence of phonic awareness and textual interaction (making meaning). Only nine of forty-four students (20%) fell in this category.

In Category B, students used limited scientific terminology but were able to demonstrate by direct actions (gestures, setting up equipment) their understandings of concepts of energy and force. This group could only marshal a limited set of terms with which to label diagrams in English. They showed evidence of phonic awareness in that they tried to pronounce scientific terms correctly but only demonstrated limited textual interaction (making-meaning) in terms of employing scientific words. They had difficulty writing science in English but could demonstrate conceptual understanding in the context of hands-on activities (designed to elicit such). These students know what is meant by a term, such as friction, can apply the concept in an activity-based classroom, but could not represent their understanding in written English very well. Fifteen students (35%) were so categorised.

In Category C were students who did not, or could not use scientific terminology to demonstrate their understandings in hands-on activities; showed limited evidence of phonic awareness and no evidence of textual interaction (making-meaning), were unable to label diagrams and found it difficult to describe or write concepts in English. They relied on their classmates to translate to Creole. This meant we, as teacher/researchers, could not appropriately assess their levels of formal scientific understanding as described in state curriculum. Twenty of the forty-four students (45%) were classified in this category (Table 1).

Almost half of Philemon's islander students had difficulty understanding the concepts as set out by the Queensland Studies Authority *Science: Years 1–10 Syllabus* (1999/2004) and by junior science textbooks. The problem was not a lack of conceptual ability but a lack of facility in/with the necessary language capital.

Table 1 Categories of TSI Students Employing Formal Science Terminology

Categories	Number of Students	Percentage of Study Group (%)	Main Structural Features of Competence in English
A	9	20	Used scientific genre in speaking and writing to actively demonstrate an understanding of energy and force
B	15	35	Used limited scientific terminology but were able to demonstrate by direct actions their understandings of concepts of energy and force
C	20	45	Could not use scientific terminology to demonstrate their understandings in hands-on eliciting activities

Students employed their home languages in the classroom. When studying the concept of force, Philemon noted students using terms such as *poke*, meaning to poke, prod or jab; *puse* and *pusem* meaning to push; *prese* meaning to press or switch on; *pule* (var. *puli*) meaning to pull; and *pulap* meaning pull up. These students are the most likely group to be designated as "poor" performers on achievement tests and constitute the "lower" end of "the gap" because they cannot formally express what they know in Standard Australian English even though they have the cultural resources of TSI Creole and other Islander languages to call upon when making meaning in the classroom.

This problem is compounded when we examine the nature of classroom interactions, the habitus of these indigenous classrooms, where all participants (including the teacher) are using a second, third or fourth language to learn the mandated science content and processes. Philemon wanted to investigate whether lack of facility in English is associated with an unwillingness to actively participate in classroom learning. Active, participatory learning is a highly desired pedagogy in middle school science curriculum in Queensland. Philemon set up many hands-on demonstrations and activities and made detailed observations of how his students acted and conversed in formal lessons.

Excerpt from Philemon's Research Diary October 2007

> I observed my [Torres Strait Islander] students were learning instruction words in science and using body action and Creole substitutes for these instructional words, though they could not be directly translated. I observed the key to understanding these words for my Torres Strait Islander students was to putting science instructional words to action, which is putting the science instruction words in body action combined with Creole language substitutes. There was evidence of students with facility in English translating and demonstrating what the instructional science word meant, example is when student B1 attempted to translate and demonstrate: "yupla (you me fellows) this kind", while demonstrating the actions of collating data.

Philemon's dilemma was this, as he explained to Hilary: "If I continue to encourage my students to use their Torres Strait Creole substitutes in their talking, writing and labelling of drawings, am I promoting a 'science language' that is not recognised by science educators, a 'science language' that would guarantee my students to 'underachieve' in the state, national and international assessments? If I discourage my students to use their Torres Strait Creole substitute words, am I not conveying to them that their language is inadequate or inappropriate? And, what about my own language? Denying my students use of their cultural capital is against everything I stand for, since the main purpose of this research is to consider how I can do better for my students and learn how to mobilise these students' cultural resources when learning science."

Philemon's second layer analysis attempted to capture students' comfortableness and confidence to engage actively in science learning. Were they able to hold productive learning conversations with him or with each other? Were they willing to take the lead and contribute to class discussions or did they hold back? Were they shy or reluctant or distractible? Only five students (11%) were observed and categorised as Category 1 active learners. These were independent students who

Table 2 Categories of TSI Students Participating in Learning Science

Categories	Number of Students	Percentage of Study Group (%)	Main Structural Features of Observed Participation in Learning Science
1	5	11	Independent students who attempted to establish their own narratives
2	19	43	Did not display confidence in their ability to learn independently
3	20	45	Were unable to adequately represent formal understandings of concepts of energy and force

attempted to establish their own narratives and compared their thinking with established scientific knowledge. They used scientific terminology accurately, and both understood and employed instructional words competently. Each of these five students, four boys and one girl was identified as a competent speaker of English and among the nine students in Category A. Philemon observed that four girls who were originally classified as Category A for employing formal science terminology, slipped into Category 2 because they did not consider themselves active generators of scientific knowledge. A total of nineteen students (43%) were categorised as Category 2. These were students who did not display confidence in their ability to learn independently and were careful to seek confirmation from Philemon. They were less willing to use formal science terminology unless explicitly encouraged to do so. Students in the third participatory category – Category 3 are the same 20 students (45% of the study group) from Category C who were shy about using scientific terminology – relied on fellow students to provide explanations in Creole and were unable to adequately represent formal understandings of concepts of energy and force (Table 2).

When we combine the first analysis (categories A, B and C) with the second analysis (categories 1, 2 and 3), the resulting four combination categories, A1, A2, B2 and C3 indicate a possible relationship between students' ability to use English fluently and their willingness to actively participate in science learning (Table 3).

This simple table of results suggests that if Torres Strait Islander students bring English language capital to the classroom, they are more willing and able to enact agency as independent learners. Our key concern is that only five students in this study (11% of total) possessed the cultural capital to participate in the classroom as competent and confident learners of science with ability to employ technical and abstract terms and mathematical symbols productively. The four boys and one girl in Category A were active constructors of scientific knowledge because they spoke and wrote English with facility. The Queensland Studies Authority calls scientific processes, "Ways of Working" and formal curriculum statements require that students are to identify problems and issues; plan investigations; research and analyse data; evaluate data, information and evidence; select and use scientific equipment

Table 3 Combined TSI Student Categories (n = 44)

Categories	Number of Students	Percentage of Study Group (%)	Main Structural Features of Competence in English and Observed Participation in Learning Science
A1	5	11	Competent in English, able to demonstrate understandings, active learners
A2	4	9	Competent in English, able to demonstrate some understandings, passive learners
B2	15	34	Limited competence in English, able to demonstrate some understandings, passive learners
C3	20	45	Not competent in English, demonstrated very limited understandings, minimal participation in any classroom activity

and technologies; conduct and apply safety audits; draw conclusions and explain patterns; communicate scientific ideas using scientific terminology in appropriate formats; and reflect on learning and reflect on different perspectives and *evaluate the influence of people's values and culture on the application of science* (QSA 2004, *italics ours*).

Constructivism (in all its many promulgations) holds that, given the appropriate mix of teaching strategies and pedagogical approaches, students learning science will construct their own understandings from what they already know of the world and from what they are invited to know in the classroom. Skamp (1998, p. 6) describes how many science educators view constructivism not only as a theory of learning but as a "way of knowing … a theory about what knowledge is and how it is generated." When students construct knowledge in non-western languages, it reproduces ontologically different ways of being in the world. This leads us to ask, can Australian formal education recognise this form of constructivism? We struggle to understand how constructivist approaches can work justly and equitably in indigenous classrooms. For forty-five percent of Philemon's students, a limited facility in English proved a barrier to active learning participation. This group relied on the language capital they brought to the classroom to negotiate learning. They used Torres Strait Creole to discuss physical science concepts in class and were either unable or unwilling to actively construct their understandings in written or spoken English. A teacher who must teach in Standard Australian English cannot judge the extent of formal science learning when adolescents call on non-English languages to construct their understandings. And yet to work only in English is, for Malcolm (1998, p. 131), indicative of "symbolic exclusion" in that:

> The school context may confront Aboriginal and Torres Strait Islander students not only with modes of expression and interaction which are unfamiliar to them, but also, at least by implication, with messages that deny their own identity. The standard English which is used without question … is not neutral to people to whom it has always been the language of the "outsider."… The exclusion of Aboriginal and Torres Strait Islander languages and Aboriginal English from classroom communication is a symbolic exclusion of the identity and perspectives of those who speak them.… It forces a choice upon Aboriginal and Torres Strait Islander students either to suspend or deny their identity, or to accept the status of "outsiders" to the education system.

This study was conducted in a wholly indigenous school where Aboriginal and Torres Strait Islander identities are explicitly celebrated. And half the students in the study struggled to engage with compulsory school science curriculum. As Philemon explained to Hilary: "I sometimes think in Shona while having to communicate in English. I have continually switched between different language and knowledge systems in my teaching career with indigenous students. I see my Torres Strait Islander students attempting to do similar, that is, think in Creole and then attempt to put in English." So, what does it mean for a grade 9 indigenous adolescent who knows how to identify problems, plan, research, analyse, evaluate and explain patterns but cannot communicate their scientific ideas in the required language? What if you thought in Creole but could not communicate the complexity of your thinking in a different language? How would you recognise yourself, or perform as an agentic learner in such a differentiated cultural field? How would a teacher implementing a constructivist approach capture the resources you bring to the classroom?

Malcolm (1998, p. 125) is very clear that, "when Torres Strait Islander students come to school with the ability to understand or speak an [indigenous] language, they possess a significant resource … of linguistic and cultural knowledge … that demonstrate they have a 'track record' as successful learners in experiential contexts." Malcolm (1998) argues that formal schooling needs to complement students' prior learning experiences. We see the problem is at systemic level where mandated curricula relentlessly treat the standard language of instruction and assessment as neutral, when clearly it is not. This study's data raise many questions for us. In the next sections of this chapter, we discuss our thoughts on how Torres Strait Creole could be used as a resource for learning western science concepts more productively in the classroom, and we express our current concerns about equity and assessment in year 9 science.

Making the Space for Creole in the Science Classroom

We are not linguists but science educators versed in the complexities of student understandings of physical science concepts. Given the findings that almost half of Philemon's students could not speak English well enough to confidently engage in science learning and represent their understanding of science concepts in his classrooms, we began a conversation about the possibility of teaching grades 8, 9 and 10 sciences in Creole, just to see where this would lead. We turned to published dictionaries to inquire how well physical science concepts are translatable between

Standard Australian English and Torres Strait Creole. We found there are no direct translations for the abstract concepts of energy and force. We looked! This finding in itself was not surprising. Indigenous Australian languages both new and old are subtle, dynamic and highly context specific languages. Energy and force as constituted in junior science curriculum are abstracted notions, both terms a shorthand for a constellation of practical applications in specific contexts. We could not find any Torres Strait Creole term for energy, in the sense that energy is defined as the capacity to perform work and is measured through its effects. There are words such as *inzin* meaning engine; *wok* = work; *nokop* = stop working; *aute* = switch off; *opene* and *prese* = switch on; *lektrik* = electricity. But the meta-category energy as constituted by science curriculum documents is untranslatable.

In terms of force, there are a number of transitive verbs in Torres Strait Creole to describe force actions, but these terms do not and, in all likelihood, cannot capture the meta-category meaning of the term force. Hilary searched through Shnukal's (1988) dictionary of Torres Strait Creole and found verbs relating to force acting in specific contexts including *mube* meaning to move; *asmape* meaning to hoist, lift, lift up; *kaumdaun* meaning to descend*;* *poldaun* meaning to fall off or fall over; *poldaun daun* meaning to fall down; *spidmape* meaning to accelerate, increase speed; *uke* (var. *uki*) meaning to hook and pull in a fish; *amare* meaning to hammer or knock; *apu* (var. *apo*, *apowe*) meaning to piggyback or carry; *bange* meaning strike or hit; *ploke* meaning to hit with a stick or other object; *paspas* meaning to get stuck (be unable to pass); *slu* meaning to turn; *slu raun* meaning to tack into the wind; and *pose* meaning to directly force something to move when it is stuck. Note that *pose* is a verb and cannot be substituted for the concept noun force in English. While Torres Strait Creole is linguistically derived from English, this remarkable language reproduces and reflects Islander ways of thinking and knowing. It doesn't reproduce western curriculum categories, but it does have a multitude of terms for force(s) in action.

Hilary wondered whether the action verbs for science inquiry skills could be reasonably translated to Torres Strait Creole. This is the limit of what we found: "observe" might approximate *luk*, *lukraun*; "compare with" might approximate *olsem*; "hypothesise" might approximate *kole*, which is translated by Shnukal (1988) as meaning "to claim"; decide might approximate *gad main*; evaluate might approximate *ting* and *ting baut*. We couldn't find Creole terms equivalent to design experiments, follow procedures, judge, conclude, generalise, theorise, classify, describe and report as outlined in the science curriculum. Yore (2008) points out theoretical notions of causality within western science do not sit neatly alongside indigenous ontological and epistemological perspectives, particularly in terms of relationships between observer and observed – the categories used to make claims about reality and explanations about cause. There are epistemological differences in how knowledge claims come to be known, the methods and procedures used to study phenomena, and the types of evidence used to justify and explain a knowledge claim or event. This being acknowledged doesn't mean translations for the scientific process skills taught in middle school are improbable. We have recently consulted with tropical language experts within the Cairns Institute to help us with this problem.

We will work with linguists at the Cairns Institute at James Cook during the coming years to further explore how to bring the conceptual resources of Torres Strait Creole into the junior science classroom to formulate bi-dialectical physical science learning opportunities.

In the meantime, Philemon, the classroom teacher, has been trying more culturally familiar ways to teach concepts of energy and force. Philemon has thought about the possibility of a “Creole science” for quite some time. Michie’s (2002) position is that attempts at translation can and do lead to rewrites of meaning. Translation is not a general solution to the overall problematic of field negotiations. However, Philemon has run a successful teaching career working in English and thinking in Shona. He became convinced that explicitly using language resources of students would assist conceptual learning in English. Differences between the western science and indigenous islander knowledge systems exist at several levels: on a conceptual content level, which is the focus of this study, and at the levels of epistemology (ways of knowing) and ontology (ways of being) that inform these knowledge systems (Nakata 2007). The epistemological and ontological questions are germane to an academic discussion of this study, and we discuss such further in the next section, but bear in mind Philemon’s research focus was always on improving classroom practices.

Our foray through Torres Strait Creole dictionaries (Ray 2001) revealed some effective translations are possible when considering learning concepts of energy and force through specific contexts. It is also an easy task to teach concepts using familiar terms. When learning about energy transfer, Philemon used the *kup mauri*, also known as a *kopa mauri*, a traditional sand oven used to cook food for feasting. Students used their commonly shared knowledge of how to properly build a *kup mauri* in which vegetables and meat are cooked together, to explore how heat energy is transferred from one object to another and to compare the properties and energy efficiencies of traditional oven materials and modern convection ovens using scientific terms. Here is an extract of dialogue between Philemon (P) and four students (B1, B2, B3 & G1) learning about energy transfer with the *kup mauri* in March 2008:

P: Why do you put pork at the bottom and vegetables at the top?
B1: Its more hot so you put pork, if you put vegetables it burns.
P: So we can learn about heat distribution in the Kup Mauri oven.
B1: Mister we can learn science when cooking Kup Mauri, that’s cool.
B3: No science is them big words, I hate them.
P: Yes we can learn science when cooking Kup Mauri, and today we will use two science words: conduction and convection to describe how heat follows.
G1: My aunt say if you are slake and not cover the Kup Mauri the food burns. (students laugh)
B2: I was told that, why so Mister?
P: What do you think?
G1: Aunt says wind make food burn.

P: What in the wind will make food burn?

B1: Aha! Oxygen mister, *Yupla* (you me fellows) that experiment, when you cover the fire stops and when you open you have fire.

P: How can we test this?

[Conversation interrupted by Dean of Students entering room to make a sports announcement]

Philemon introduced traditional drums to investigate kinetic (sound) energy and this too proved popular. Students were eager to try different beats on the drum and analyse waveforms on an attached oscilloscope and were fascinated with the relation between the amplitudes and frequencies of the waveforms to the loudness and pitch. One student commented: "I always knew there was something special about the skin on the traditional drums, the way my *man popa* (grandfather) makes them, I think we should investigate that next week, should I phone him" (from Research Diary, April 2008). Students investigated tightening and loosening (using the sun as a heat source) the skin of the drum, and investigated the air pressure at the end of drum using a barometer to investigate compression and rarefaction. Philemon is convinced normalising cultural diversity in science classrooms improves student participation and engagement. Employing learning strategies that recognise and celebrate Torres Strait Islander ways encourages students and generates enthusiasm, resulting in the all-important "shining eyes, smiling faces" outcome. We think it is a matter of educational justice to position indigenous students as knowledge creators capable of controlling their own learning. Osborne and Tait (2002) suggest it is time for teachers to test out, at the classroom level, a diversity of approaches that reflects social justice as well as curriculum justice. We add ecojustice to these considerations.

While climate change is not a focus of this research study, it is becoming increasingly difficult to think about the Torres Strait islands and the future of Torres Strait peoples without factoring in the cultural risks associated with sea level rise, depleting fish stocks and coral reef extinctions. Professor Ross Garnaut delivered the Eddie Koiko Mabo Lecture for 2009 at James Cook University and argued that climate change is in the process of transforming patterns of life in the Torres Strait Islands and on the adjacent shores of Australia, Papua New Guinea and Indonesia. Garnaut highlighted a number of issues facing Islander people, including a loss of cultural heritage due to eventual relocation. Following the lecture, a member of the audience, Kanat Wano, made the comment that Indigenous people of Australia were again facing cultural genocide in the face of climate change. He is quoted as saying, "for Indigenous Australians our land is our identity, it's our heritage and climate change threatens to destroy this land and to force us to move to other areas. This means a loss of identity and culture to our people," (JCU media release October 9, 2009). That which can be done to mobilise Islander language(s) and celebrate Islander ways of knowing and learning in the school science classroom is an act both of adaptation and resilience to undesirable change.

Recognising Islander Ways

Every student learning the language of science – regardless of their home language's alignment with the language of instruction – faces similar problems as a second language learner navigating and negotiating the border crossings between home, school, and science education discursive fields (Yore and Treagust 2006). The problem is compounded when one's home languages are accorded much lower status than the language of instruction (Malcolm 1998). In such a situation, small moves become significant. One means of redress is to mobilise existing cultural capital in the classroom. Educators can confer equal recognition to the cultural capital indigenous students bring with them to school. When indigenous students' cultural capital is ignored in science learning – as is unfortunately rather common – it becomes much more difficult for indigenous students to participate in class on an equal basis.

It seems reasonable to research the cognitive, social and cultural capital Torres Strait Creole represents and consider how teachers can draw upon this to promote and enhance science learning in the classroom. Functional substitutes for concepts and instructional science terms derived from home languages can be adapted to English language classrooms. Michie (2002) makes a strong case for multilingual learning and certainly in informal peer discussions and hands on learning activities. Philemon documented his students talking and explaining science to each other in Creole and has taught concepts using familiar objects and activities. While Torres Strait Creole is an unequally valued language when compared with Standard Australian English in the formal education context, we see no reason why its nuanced conceptual resources cannot be marshalled for the project of learning science. Indigenous students at school traverse intersecting knowledge and language systems on a daily basis (Nakata 2002). A science learning framework to accommodate students' experiences and everyday ways of speaking and knowing seems a reasonable approach that can also get around a problem explored by Yore (2008) that using or not using appropriate scientific language (in English) does not alone guarantee students have fully conceptualised scientific ideas. Words, symbols and terms are labels that may have no direct association with an underlying idea, or may have different meanings than the same label in another discourse community, discipline or social context. Correct spelling (or pronouncing) of the word does not ensure conceptual understanding of the signalled idea when the student is also negotiating language. Marshalling the nuanced richness of Creoles and other home languages may be of considerable value in developing authentic contextual scientific understandings with middle school indigenous students. Klenowski (2009) calls this "culturally responsive pedagogy." There is still much work to do on this idea. Additionally, whatever gains we make with respect to classroom practice, what remain are the problematic nature of knowledge reproduced through state-mandated curriculum and the problem of standardised assessment of achievement in science used to manufacture "the gap" in indigenous and non-indigenous student achievement.

Excluding Indigenous Ways

As we thought through the research findings and read more widely, a larger ontological consideration raised its questioning head. Science curriculum, as it is constituted at both state and national level, makes little real concession to indigenous ways of knowing. The Queensland Studies Authority website advises, "the QSA is currently developing a range of materials to support the inclusion of Australian Indigenous perspectives into the school curriculum. [Some] materials are available now, and more are in development" (QSA 2009c). On this website is http://www.qsa.qld.edu.au/ a beautiful Torres Strait Islander seasonal events calendar, a seasonal star calendar and a Zugubul star map. Such materials can be integrated into existing curriculum, but the ontological structure of the curriculum remains untroubled by this "inclusion." Mr. Ernie Grant (2002 p. 51–52), a Dijirabal/Djirrabal Elder from far north Queensland, sets out the problem this way:

> Indigenous communities have a holistic view of their world, which incorporates a vital link between Land, Language and Culture. This view is considerably different from what is considered the norm in western society. Many academics, over the years, have recognised and noted its success in passing on information accurately for centuries … there is a significant difference between western and indigenous approaches to the application and acquisition of knowledge. Western thinking generally adopts a more holistic approach to the wider issues, while its approach in more localised issues is compartmentalised. The end result is that most information in schools and institutions – whether it be oral or written – is organised and presented in a way that reflects this. On the other hand, largely because of the people's dependence on the spoken word and observation for sharing knowledge about their own world, the indigenous approach is quite the opposite. Aboriginal and Torres Strait Islander people look at the whole picture and identify relationships and links within it, whereas their western counterparts often focus on the detail of the individual parts without considering their possible interaction with others. This apparent conflict can be confusing and frustrating for all those involved in sharing the knowledge.

Grant advocates a holistic approach to knowing and teaching indigenous studies, to create "the total picture" encompassing consideration of Land, Language and Culture by contextualising Time, Place and Relationships. Grant (2002, p. 54) proposes that together, "these six components provide a flexible framework for organising and presenting information on a range of topics." The standardised science curriculum in the state of Queensland and the newly proposed national curriculum make no explicit reference to any of these elements. As it is constructed through formal curriculum discourses, scientific knowledge stands outside from Place and Time. Knowledge doesn't of course, but the way science is presented in state-sanctioned curriculum statements makes it very difficult to recognise the place of Place and the time of Time. No direct mention is made of Land – the central organising concept of Australian indigenous ways of knowing – nor is there formal mention of Culture. There is little, if any, recognition of the many and different cultures of indigenous Australians. And certainly, nothing is said concerning Language, the unquestioning default position being Standard Australian English in a continent with a multitude of unique and now disappearing indigenous tongues. More worryingly, the new national science curriculum in its current draft iteration proposes that, "science knowledge refers to facts, concepts, principles, laws, theories and models that have been established *by scientists* over time" (emphasis ours). So much for recognising old, established indigenous forms of knowledge, or newer emerging forms either. It seems that within what Nakata (2007, p. 215) calls the "very contested knowledge space" of the disciplines, the intense political tussle over what constitutes science curriculum in Australia has managed to exclude proper (or is that properly exclude?) consideration of the old sciences of wind and water, of people, ecology and place that made for the original habitation of Australia and its islands. It's not that Australian educators aren't hotly contesting the present constitution of national science curriculum, they are, and on many fronts, including from indigenous standpoints and from sustainability standpoints. But it is disappointing to see how little formal attention is actually paid to indigenous ways of knowing beyond the policy statements. As one of our university colleagues remarked, "what books haven't they [curriculum developers] been reading?"

A further problem is how culturally different styles of communicating and representing knowledge are, or are not, acknowledged. Literacy at school is usually defined as reading, writing, viewing, speaking and listening in Standard Australian English. From an indigenous perspective, literacy also includes storytelling, ceremony, songs, ritual and sharing a diversity of languages and dialects – what Martin (2008) describes as multiliteracies. Restricting science literacy to print-based forms of reading and writing denies the interacting socio-cultural and oral languages, gestural and spatial dimensions of both old and emerging indigenous cultures (Snively and Williams 2008). From our viewpoint, a middle school science learning framework that accommodates multiple language dimensions is conceivable and practical. Educators can respect and draw upon students' culture, lived experiences and home languages as foundations for them to advance their acquisition of science cultural capital. A science classroom can be a dynamic cultural field, but we continue to worry that existing systemic constraints continue to make classrooms sites for tribulation for a significant proportion of indigenous students when what they bring to the classroom – their languages, knowledge, skills and experiences – are not formally acknowledged in compulsory curriculum. Theobald has called being at school, "twelve years of institutionalised life that demands the most unforgiving brand of conformity" (1997, p. 132). Schooling is presently endowed with an instrumentality "that has become even more refined and pronounced," where schools are now seen as "the mechanism designed to give the corporate liberal state what it needs: workers capable of doing their jobs well and a certain group of elite maths–science performers who will carry the torch forward toward [national] domination in the global economic market" (Theobald 1997, p. 133). Our purpose in conducting this research was to look beyond the rhetoric of "the gap" and investigate science learning in a real classroom situation. We argue learning science for Australian indigenous students consists of staged and complex negotiations as modelled below (Table 4).

Science educators and researchers can do more to develop appropriate ways to smooth negotiations for the many indigenous students who constantly move between different language and knowledge systems. Klenowski (2009) argues such

Table 4 Language Negotiation Model for Indigenous Students Learning School Science (Chigeza 2008)

An indigenous student's everyday ways of talking and knowing		Scientific ways of talking and knowing
An indigenous student from a community where the vernacular is the commonly used language, and English is used only in schools.⟶	An indigenous student from a community where English or dialects of Indigenous people's English is the community and school language⟶	An indigenous student becoming competent in school science ways of talking, thinking and doing
Legend⟶ Language negotiation		

work is necessary on equity grounds alone given the systemic obsession with standardised assessment of a narrow science curriculum in Australia. National benchmarking assessment is done using written text. Yet, the many and varied indigenous cultures present on the Australian continent are predominantly oral and visual cultures. Historically, the Torres Strait Islander ways of knowing did not include codifying concepts in writing. Knowledge was and is passed from one person to another in oral form. Indigenous students are asked to demonstrate scientific understandings in a language not their own, conveyed in a non-traditional form (in writing), and they must negotiate knowledges that are inimical to long-established ways of being in the world. A socio-cultural view of knowing acknowledges cultural differences in the nature of learning, what is valued as knowledge and the ways in which indigenous students in secondary school draw on their cultural legacies to learn as best they can the disciplines of western knowledge systems that inhabit Australian school curriculum (see Murphy and Hall 2008). Returning to Bourdieu (see Snook 1990), we need to acknowledge language serves essentially practical ends for institutions as well as for groups and individuals. We are not certain what purpose is served by positioning Australian indigenous students as generally deficient in science achievement when measured against/by standardised state, national and international testing regimes. One-fifth of Australian indigenous students did not meet the lowest international TIMSS benchmark in science (Thomson et al., 2008). Our research suggests what is being assessed on benchmarking achievement tests in Australia is a student's facility to represent concepts in Standardised Australian English. Nearly half of Philemon's Torres Strait Islander students did not have the cultural resources to formally express physical science concepts in the language of assessment. Klenowski (2009) argues equity in relation to assessment is a socio-cultural matter rather than a technical matter. In our view, any claim that remote indigenous students possess "low" levels of scientific literacy is unreasonable and unjust, for how can this claim be truly justified? What we have learned is that the historically persistent, deficit positioning of indigenous learners in Australian science education is a dismal fiction that doesn't stand up to classroom analysis. What does seem just is the creative deployment of multi-cultural resources in the classroom towards the project of learning middle school science. And we continue to work together to further research such possibilities.

Please note. Many researchers capitalise the term indigenous as a mark of respect to indigenous peoples. We have not capitalised the word because we followed the example of Mr Ernie Grant who uses a lower case i. If we have made a mistake we apologise.

References

Bourdieu, P. (1984). *Distinction: A social critique of the judgement of taste*. London: Routledge (original 1979).

Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Ed.), *Handbook of theory and research for the sociology of education*. New York: Greenwood Press.

Catholic Education Office. (2003). *Right talk right place: A resource book for teachers of Aboriginal & Torres Strait Islander students in North Queensland*. Townsville, QLD: Catholic Diocese of Townsville.

Chigeza, P. (2008). Language negotiations Indigenous students navigate when learning science. *Australian Journal of Indigenous Education, 37*, 91–97.

Crowley, T., & Rigsby, B. (1979). Cape York Creole. In T. Shopen (Ed.), *Languages and their status*. Cambridge: Winthrop Publishers.

Cummins, J. (2000). *Language, power and pedagogy: Bilingual children in the crossfire*. Clevedon: Multilingual Matters.

Dodson, P. (1996) Reconciliation misunderstood [Letter to the editor] *The Australian.* September 13, 1996.

Giddens, A. (1979). *Central problems in social theory*. London: Macmillan.

Grant, E. (2002). My Land, My Tracks: A framework for the holistic approach to indigenous studies. In *Aboriginal and Torres Strait Islander Studies handbook for the senior syllabus 2001* (pp. 50–67). Brisbane, QLD: Queensland Board of Senior Secondary School Studies.

Holme, J. (2000). *An introduction to pidgins and creoles*. Cambridge: Cambridge University Press.

James Cook University. (2009). Garnaut challenged in Q & A. *Media release*. October 9, 2009, from http://cms.jcu.edu.au/news/archive/JCUPRD_052634

Jenkins, R. (2002). *Pierre Bourdieu* (Revisedth ed.). New York: Routledge.

Klenowski, V. (2009). Australian Indigenous students: Addressing equity issues in assessment. *Teaching Education, 20*, 77–93.

Mahar, C., Harker, R., & Wilkes, C. (1990). The basic theoretical position. In R. Harker, C. Mahar, & C. Wilkes (Eds.), *An introduction to the work of Pierre Bourdieu: The practice of theory*. London: Macmillan.

Malcolm, I. (1998). "You gotta talk the proper way" language and education. In G. Partington (Ed.), *Perspectives on Aboriginal and Torres Strait Islander education* (pp. 117–146). Katoomba: Social Science Press.

Martin, K. (2008). The intersection of Aboriginal knowledge, Aboriginal literacies and new learning pedagogy for Aboriginal students. In A. Healey (Ed.), *Multi-literacies and diversity in education* (pp. 59–81). Melbourne: Oxford University Press.

Masters, G. N. (2009). *A shared challenge: Improving literacy, numeracy and science learning in Queensland primary schools*. Melbourne: Australian Council for Educational Research.

Michie, M. (2002). Why Indigenous Science should be included in the school science curriculum. *Australian Science Teachers' Journal, 48*, 36–40.

Murphy, P., & Hall, K. (2008). *Learning and practice: Agency and identities*. London: Sage.

Nakata, M. (2002). Indigenous knowledge and the cultural interface: understanding issues at the intersection of knowledge and information systems. *IFLA Journal, 28*, 281.

Nakata, M. (2007). *Disciplining the savages: Savaging the disciplines*. Canberra: Aboriginal Studies Press.

OECD Program for International Students Assessment (PISA). (2006). Paris: OECD.
Osborne, B., & Tait, S. (2002). Listen. Learn. Understand. Teach. Social Justice and teaching Torres Strait Islander and Aboriginal students. In G. Partington (Ed.), *Perspectives on Aboriginal and Torres Strait Islander education*. Katoomba: Social Science Press.
Queensland Indigenous Education Consultative Body. (2002). *Standard Australian English and languages for Queensland Aboriginal and Torres Strait Islander students*. Brisbane: QIECB.
Queensland Studies Authority. (2004). *Science syllabus years 1 to 10 (1999/2004)*. Brisbane: QSA.
Ray, S. (2001). *H*. Dictionary of the Torres Strait languages, Cairns: Rams Skull Press.
Sharp, N. (1993). *Stars of Tagai: The Torres Strait Islanders*. Canberra: Aboriginal Studies Press.
Shnukal, A. (1996). *Broken: An introduction to the Creole language of Torres Strait*. Canberra: Pacific Linguistics.
Skamp, K. (1998). *Teaching primary science constructively*. Sydney: Harcourt.
Snively, G. J., & William, L. B. (2008). "Coming to know": Weaving Aboriginal and western science knowledge, language and literacy into science classroom. *L1 – Educational Studies in Language and Literature, 8*, 109–133.
Snook, I. (1990). Language, truth and power: Bourdieu's mini-sterium. In R. Harker, C. Mahar, & C. Wilkes (Eds.), *An introduction to the work of Pierre Bourdieu: The practice of theory*. London: Macmillan.
Theobald, P. (1997). *Teaching the commons: Place, pride and sense of community*. Boulder: Westview Press.
Thomson, S., Wernert, N., Underwood, C., & Nicholas, M. (2008) Highlights from TIMSS 2007 from Australia's perspective: Highlights from the full report, Taking a closer look at mathematics and science in Australia. *TIMSS 2007*, from http://research.acer.edu.au/timss_2007/1
Tobin, K. (2005). Urban science as a culturally and socially adaptive practice. In K. Tobin, R. Elmesky, & G. Seiler (Eds.), *Improving urban science education: New roles for teachers, students and researchers*. New York: Rowman & Littlefield.
Tobin, K., Elmesky, R., & Carombo, C. (2002). Learning environments in urban classrooms: Contradictions, conflicts and reproduction of social inequality. In S. Chiew Goh & M. Swe Khine (Eds.), *Studies in educational learning environments: An international perspective*. Singapore: World Scientific.
Tripcony, P. (2000). English literacies: Indigenous Australian context. *Indigenous perspectives support materials*. Brisbane: Queensland Studies Authority. Retrieved August 1, 2009, from http://www.qsa.qld.edu.au/learning/3035.html
Winford, D. (2003). Ideologies of language and socially realistic linguistics. In S. Makoni, G. Smitherman, A. Ball, & A. Spears (Eds.), *Black linguistics: Language, society, and politics in Africa and the Americas* (pp. 21–39). New York: Routledge.
Yore, L. D. (2008). Science literacy for all students: Language, culture and knowledge about nature and naturally occurring events. *L1 – Educational Studies in Language and Literature, 8*, 5–21.
Yore, L. D., & Treagust, D. (2006). Current realities and future possibilities: Language and science literacy – empowering research and informing instruction. *International Journal of Science Education, 28*, 291–314.
Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education, 8*, 69–91.

Chapter 36
Are We Creating the Achievement Gap? Examining How Deficit Mentalities Influence Indigenous Science Curriculum Choices

Jennifer Lance Atkinson

Chigeza and Whitehouse highlight a significant negotiation indigenous Australian children face each day at school. The bridge between different languages presents a challenge for the students to score well on standardized science assessments. Rather than truly assessing students' knowledge of science concepts, Chigeza and Whitehouse provide a wealth of evidence, which supports that students may be tested on the mastery of standard Australian English rather than science concepts due to their home language being different than English. Chigeza and Whitehouse recommend that science educators and researchers should develop more appropriate classroom instruction to help students successfully navigate between languages when learning science. Language is highly contextual and as Chigeza and Whitehouse discuss, students are characterized by their language use. Despite their science knowledge, indigenous Australian students are deemed deficient based upon standardized testing scores because of their language.

While I agree that negotiating language differences between academic and home environments is extremely important in preparing students for different discourses, I see a more troubling problem associated with Chizega's and Whitehouse's study, which reflects assumptions found in western society. My own experience as a science teacher enables me to understand that students' discourses between home and school are rarely congruent in the science classroom. The vocabulary, style, rules of argumentation, and structure of "science talk" is substantially different. Helping students not only learn the language and concepts of science, but also having them incorporate the ideals of science into classroom discourse is a constant negotiation. I use an example of bridging different discourses from my classroom to illustrate that successful teaching and learning can still produce an "achievement gap" when standards are taught and the language negotiation is successful.

Consider the following lesson I taught concerning ecological succession to secondary students. Believing that learning should have a rich and complex context, the students and I hiked outside, drew pictures of the landscape, described

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*, Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_36,

differences in trees and plants, and discussed the causes for the differences we noted in the landscapes of temperate deciduous forests around our school. Students accurately concluded the causes of succession, the stages as evidenced by plants, and discussed the implications of human-made disturbances. To my surprise and delight, students began to discuss the merits and consequences of the logging industry (a significant employer in our area) on ecological succession, stream ecology, and wildlife. When I assessed them both informally in conversation and on more formal assessments in the classroom, my students discussed science concepts using vocabulary and correct terminology, and they also integrated science discourse into their home conversations. Many students returned the following week and recounted stories of dinner conversations and car rides where they had discussed ecological succession. When the standardized state assessment was administered, I was confident that my students would excel in questions concerning ecological succession. After the test was sent to the state for evaluation, some of my students came to me days later with a puzzled look. To my surprise, they asked me how ecological succession happened in the tundra biome. After some discussion, I asked them about their sudden interest in the tundra. They replied that the questions on their standardized assessment concerning ecological succession were about a tundra biome. Their confusion added to my confusion. We live in the southern United States, and to my knowledge, my students have rarely seen snow, much less traveled to the tundra in Alaska. Why would a standardized assessment in Georgia measuring student understanding concerning ecological succession discuss the tundra in a state, which has never seen glaciers? My students successfully used science language, concepts, and research skills, yet the context of the standardized test question positioned them as deficient. Was the deficit a reflection of my teaching and their learning?

I use my teaching experience to extend Chigeza and Whitehouse's argument that standardized assessment positions students as deficient. While they recommend changes in classroom practice, I argue that the "achievement gap" assumed in their work cannot be solved with classroom pedagogy or assessment. The "achievement gap" occurs because standardized assessment robs the teachers and students of autonomy and creates a false impression of deficit-model thinking in science. Therefore, I argue that the idea of an achievement gap is based upon a set of ideologies that categorizes students based on intrinsic factors rather than a lack of knowledge. Standards-based curriculum and standardized testing create an illusion that public schools are preparing students for global citizenry. Can students be prepared for participation in global citizenry when the implicit narratives embedded in the standards movement are based upon a deficit model of thinking about diverse groups of students? Is it possible to have a global citizen identity promoted by standardized tests or should we focus on diversity?

Standardized testing is the principal accounting method behind many standards movements in Australia and the United States. Embedded in this form of testing is the real question for students, educators, and politicians: "Who has control of the curriculum?" One scholar, Pinar (2004) calls the notion of "high-stakes testing" a "conversion from intellectual inquiry" to a question of who has power (p. 20). When standardized testing is administered in Georgia, it is not simply a measurement of mastering standards and addressing areas of weakness or strength for reteaching or enrichment rather, the standardized test is tied to the student's grade, credit attainment, and graduation test score in order to obtain a diploma. In order to bring equity to secondary science classrooms and public schools, the standards movement should not use criterion referenced tests (CRTs) to evaluate the implementation of the science standards. A different philosophy will be argued in this paper.

Criterion referenced tests (or CRTs) promote the alternative conception that children are deficient in science when very little analysis has occurred concerning the environment of the child, the course of science study, and the quality of science experiences. With the student's future and the perception of a community's school being determined by the CRTs, more analysis about the philosophy and psychology of learning and impact of standards-based curricula should occur. I address some alternative conceptions that standards are equitable and the deficit models influencing the implementation of No Child Left Behind Act of 2001(Public Law 107–110) create a false assumption concerning achievement among diverse groups of students.

Standards and Equity

Standards-based instruction is a concept deeply rooted in the educational reforms of the early twentieth century (DeBoer 1991). Sleeter (2005) discusses standards as an organization of curriculum based upon the efficiency movement where learning objectives are derived from social and economic needs. Teachers deliver the curriculum and measure student progress against achieved objectives. Current science standards can be traced to the document, *A Nation at Risk*, which expresses concerns against failing educational progress in the United States and cites the needs of the economy as a driving force to produce more scientifically literate students.

Standards seem to promote equity on the surface because of the general assumption that all students are homogenous vessels who can learn a set of objectives outlined by "experts" in science teaching and the science disciplines. Many national science standards documents, such as the *Benchmarks for Scientific Literacy* (AAAS 1993) and the *National Science Education Standards* (National Research Council [NRC] 1996) are generally accepted as a consensus between some "experts" in science teaching and professional scientists, but in reality, many of the objectives in these documents are filled with controversy, especially those concerning the social context of science and multiculturalism (Sleeter 2005). Standards deemphasize the differences in classrooms with respect to culture and language by defining the behaviors associated with meeting standards. In effect, if students do not exhibit correct language, accept content knowledge without question, and reason using accepted multiple-choice answers to the corresponding standardized test question, they are, in effect, not meeting standards and assumed to be deficient in their understanding of science. Because diverse populations tend to demonstrate the lowest test scores, then it is assumed that schools and teachers are at fault. The solution is to change the teaching strategies used to engage students through remedial courses which emphasize passing standardized tests.

Since the standards movement is deeply tied with business and economic interests, the need for cultural assimilation is implicit in curriculum with standards-based education. Strong economies need skilled workers, so the standards documents upon which the teachers build their science curricula are centered on producing a new generation of science workers. Because the need for a strong national economy outweighs the needs of what the local community may desire, the standards and criterion-referenced tests become the tools to reinforce the power infrastructure of capitalism and economy. However, other problems are present such as individual and community health issues, the resources within the school, the availability of funds based on property values, and the sustainability of the economy. Standards do not produce equity in science achievement; rather, they reinforce the current stratification of the existing class systems around capitalism.

Deficit Models in Science Education

If the current standards movement in the United States grew out of the government document *A Nation at Risk*, then the spirit behind the standards is one which promotes the notion that students are "falling behind" their international counterparts in the sciences. Much of No Child Left Behind and its subsequent effects on forcing states to adopt accountability measures assume that some children are deficit while other children are not. Because the standards movement assumes a homogenized mixture of children with no regards to differences based on culture or ethnicity, we must ask the question: what does this standards-based child look like? Leonardo (2007) has criticized No Child Left Behind and the standardization of knowledge as an "educational construction of whiteness" (p. 261). Students are now being classified based on adequate yearly progress (AYP), which divides students based on ethnicity, gender, and socioeconomic factors (see http://www.doe.k12.ga.us/ayp2009.aspx, e.g.). The ability to claim that standards are "colorblind" and the equity that surrounds the standards movement is an issue reinforces the societal notion that race, ethnicity, and culture do not matter in education.

It is highly plausible that students who do not have to confront issues of race or ethnicity in the classroom have a privilege of whiteness (but may not necessarily be "white"). Leonardo (2007) defines "whiteness," or "color blindness" as a conscious effort to downplay and avoid issues of race while reinforcing the individualness of success or failure (p. 267). If a school fails, then the fault rests with the students and teachers and their failures rather than infrastructural inequalities. Conversely, if a school passes, then merit is based upon the success of individuals rather than structures, which insure success. The ideology behind a standards movement assumes that people who are unable to claim or unwilling to claim the privilege of whiteness are deficit and ultimately labeled as failing the national educational system. It is not a coincidence that schools, which have higher achievement rates tend to have a relatively homogenous population of seemingly white, middle class advantaged students. The "achievement gap," or differences in scores between groups of people, exists to reinforce the notion that "white students" are outperforming "students of color" in the sciences. The success of "white" students is portrayed as one where these students are individuals who work toward life success.

Racial isolation continues to deepen in the United States, and we face one of the most segregated eras since the 1950s (Kozol 2005). Because of inequity in funding, a school with diverse populations and high poverty faces inequities with deteriorating environments, which threaten the health of students and perpetuates the assumption that its students are "at-risk" and failing to meet standards. Rather than embracing the variety of cultural values and individual talents students from diverse backgrounds bring to the classroom, districts with high diversity seek to "teacher-proof" the curriculum and deliver knowledge to students as if they were vessels to be filled with standardized knowledge (Kozol 2005). Students are targeted with "best practices" teaching strategies designed to facilitate higher test scores and assimilate students into thinking that certain answers and knowledge is assumed superior (Kozol 2005). Implications of deficit model thinking have serious consequences for the science classroom. Moreover, the scholarly science community questions the lack of diversity in the disciplines, and yet standards-based science curricula state the need for more students to become scientifically literate (one literacy for all). When the construction of standards curricula is based upon the notion that a deficit exists and students and schools need to be "fixed," economics, not equity, will most often drive the science standards movement. As a result, economics will never be challenged and we will continue to problematize the "achievement gap."

Tracking and the Standards

Perhaps, the most striking manifestation of inequity occurs in the tracking of students in secondary science. Tracking is defined as the separation of students based upon achievement and in regards to future career plans such as college or the workforce (Lynch 2000). Tracking affects a broad spectrum of curricular activities. The amount of resources, for example, spent in the science classroom is a product of tracking. Another example is how advanced science classes often consume more lab equipment while less advanced classrooms use "paper labs," which seldom require science lab equipment. The influence of grouping students has been well documented and affects how students perform. Even when individual differences are accounted for, students in different science tracks perform differently as a group. If a standardized test is *the* measure of performance, then a gap between different tracks is impossible to close (Lynch 2000). While strong arguments have been waged for tracking, especially in the realm of gifted and talented education, even those higher tracks with gifted students are disproportionately white and upper middle class advantaged (Lynch 2000). While few, if any, teachers will advocate holding a high-achieving student back simply to keep group dynamics diverse, these arguments regarding how students are chosen for advanced tracks need more examination because of a disproportionate representation of advantaged students in advanced classes.

When students are placed in science classrooms where they are not expected to engage in higher level thinking or complex experimentation because they will "never be college-bound," the expectations for these students are manifest many times in the types of activities planned for them. As a result, these students lack an understanding or appreciation for the application of science in their own lives, and educators puzzle as to why they do not perform as well as their counterparts in advanced classes. Tracking is not a phenomenon limited to secondary science. Students are tracked as early as elementary school. Students who do not perform well in reading and mathematics are pulled from science and social studies classes to be remediated in order to pass statewide standardized assessments. Again, the emphasis is on the economy rather than equity as schools struggle to keep funding through test scores. Because of decreasing exposure to science, these students through elementary and middle school have different science experiences (Lynch 2000). As a result, when students are tracked in secondary science, they continue to have a lack of quality science teaching. The perception of students' limited performances is not a statement of individual merit; instead, deficiencies in the science curriculum and the limits imposed by a lifetime of tracking is deemphasized or ignored.

Implications for the Future of Science Curricula

In order to prepare students as scientifically literate citizens, we should examine several policies concerning the current ideals of science curricula. Consistency in science teaching is needed. Science teaching in the early grades cannot continue to be for a select group of students or limited exclusively to extra time leftover after math and language arts instruction. Qualified teachers with strong science backgrounds and understandings of the strategies, which help diverse students participate as science learners, should be present throughout all grades. These things dissolve the gap mentality.

Policies concerning tracking and curricula should be examined with regards to race, gender, and socioeconomic status. Curricula decisions, which reinforce the economic ideals of the United States will not create equity because the current economic system depends on a stratified system of people to support different classes of workers. Implicit in the class system are racial inequities, socioeconomic class inequities, and gender inequities. These inequities are also evident in pay salaries, job demographics, the worth of the "stay-at-home mom," and the value of indigenous knowledge. One national set of students is the most important goal of education based upon standardized knowledge supported by science CRTs.

When the science curricula is not measured by CRTs and linked to graduation, discussions concerning the standards can center on the application of diverse types of knowledge and their integration with science standards. One might argue that different forms of assessment are now needed so that students are not compared across the state, but my response is that any evaluation model only evaluates the central ideologies upon which the curricula is derived. Regardless of how standards are measured in a capitalist society, they are still ideals based upon deficit model thinking. Therefore, any measurement of them will rarely reveal the hidden deficit ideologies embedded within them or the vulnerabilities for the loss of culture inherent within testing. The comparison of students is already flawed due to structural inequities. Current assessment measures only continue to reveal the embedded deficit ideology within the standards. The social context of the standards should be examined in order to determine how different cultural knowledge wealth can expand the participation of students as scientists. Programs where students are exposed to different types of science research through mentoring, citizen science, environmental education, international travel, and other enrichment activities ought to be funded for diverse students throughout the elementary, middle, and secondary grades.

The current assumptions around science standards and CRTs undermine potential equity in public science classrooms of Georgia (United States). It is highly reasonable to assume these issues impact children outside of Georgia, too. If we accept the challenge of not relying on an "achievement gap" to do our work, what drives us to examine issues of diversity and culture? Moreover, an examination of teaching practices, the structure of educational reforms, and consistent implementation of science embracing and valuing diverse student strengths is needed for teaching today.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York: Oxford University Press.

DeBoer, G. E. (1991). *A history of ideas in science education: Implications for practice*. New York: Teachers College Press.

Kozol, J. (2005). *The shame of the nation*. New York: Three Rivers Press.

Leonardo, Z. (2007). The war on schools: NCLB, nation creation, and the educational construction of whiteness. *Race Ethnicity and Education, 10*, 261–278.

Lynch, S. J. (2000). *Equity and science education reform*. Mahwah: Lawrence Erlbaum.

National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

Pinar, W. F. (2004). *What is curriculum theory?* Mahwah: Lawrence Erlbaum.

Sleeter, C. (2005). *Un-standardizing curriculum*. New York: Teachers College Press.

Chapter 37
Indigenous Stories: Knowledge Is Sometimes Where You Least Expect to Find It

Lauren Waukau-Villagomez and Curry S. Malott

The famous American baseball player Yogi Berra, who played for and coached the New York Yankees once said, "this is like déjà vu all over again." As we read the chapter *Australian Torres Strait Islander Students Negotiate Learning Secondary School Science in Standard Australian English: A Tentative Case for also Teaching and Assessing in Creole*, Berra's famous comments rang true for us as a Native person who has worked in Native American schools for nearly three decades and as a white man who has worked in critical pedagogy as a teacher/researcher for many years. However, we are not trying to be glib. The similarities between Native Americans from North America and the Aboriginal and Torres Strait communities from Australia are just far too obvious. It is sad for us to see the same oppression and failed decontextualized pedagogy being implemented for the education of Aboriginal children as have been implemented in the United States for Native children. In our response, we reflect on the ways in which our educational experiences on the Menominee Reservation in Northern Wisconsin mirror issues similar to those experienced by Chigeza and Whitehouse in Australia's Torres Islands.

In *Teaching Native America Across the Curriculum: A Critical Inquiry* (Malott et al., 2009) we discuss how Menominee children tend to do well in elementary science education because it is contextualized within the seasons, which approximates the ways in which they are traditionally socialized into the world of nature and science by their grandparents. Within this process, children are taught a cosmology of interconnectedness, which views nonhuman life forms as having inherent rights to exist and be respected as opposed to just serving the shorter-term self-centered needs of people. In other words, for example, through ceremony, children learn to respect the trees, learn to act responsibly, and conserve the whole forest. Children are taught the importance of maintaining balance and taking what they need without becoming a destructive force to the environment. However, science achievement scores among Menominee youth (and Native youth more generally) tend to drop significantly by middle school, and especially high school, which we attribute to not only poverty and the association of school

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_37,

with the dominant white colonizing society, but with secondary science education tending to be more abstract, decontextualized, and irresponsible (we return to this point and Menominee milieu under "Using Indigenous Knowledge Systems in the Content Areas").

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We commend Chigeza and Whitehouse for promoting ecojustice and the use of Indigenous knowledge systems in the teaching of science with Aboriginal children in order to close a perceived gap in educational opportunity and academic achievement. Like Chigeza and Whitehouse, we believe the Earth cannot be controlled – She (a term used in the most honoring way here) can only be respected or disrespected, and if disrespected, there will be *hell to pay*, as it were. This lesson is a hard lesson to accept. It requires humility and a sense of respect and responsibility that, for the most part, science has arrogantly ignored. From an indigenous perspective, this is the great challenge of our time, of humanity.

Dissolving the Language Puzzle for Native American and Aboriginal Children

Over the years, there has been high quality and interesting research published on how to educate Native American children. Much of this research reinforces and supports the ideas and approaches Chigeza and Whitehouse use in their science curriculum, in order to address the mismatch between home and school language. The lack of fit between home and school language has been an issue on the Menominee Reservation. Several Native women, high school teachers on the Menominee Reservation, have had long telephone conversations on cold winter nights, discussing the role of language and instruction and trying to find solutions to "problems" of Native schools. The Menominee Indian Reservation is located on land that has been inhabited by tribal ancestors for the last 5,000 years. The reservation is primarily forest land and the term Menominee means, "wild rice eaters." One of these women, a social studies teacher, used to say sometimes that she thought her Menominee students spoke a foreign language. She had the sense that her students didn't understand anything she was asking them to write about. There were two anthropologists, Susan Philips and William Leap, who helped these teachers begin to make sense of what they were observing.

- In 1972, Philips, with an interest in linguistics and language, lived on the Warm Springs Indian Reservation in central Oregon. At that time, the reservation was 564, 209 acres with a population of 1,500 descendants, where the children were primarily monolingual speakers of English (Phillips 1972). Nevertheless, the children did not speak Standard English like their teachers, but a dialect of English distinctive to the local community with some influences from the Indian language spoken on the reservation. The tribal leaders and elders were concerned about the disparity between the academic performances of Indian students when compared to non-Indian students in the same school district

(Phillips 1972). Warm Springs Reservation children, as a rule, did not verbally participate in their classes; and the teachers wondered why the children did not feel comfortable talking in their classes. There was no simple answer to that question or the problems of academic failure. Phillips (1972) found that Warm Springs children were taught differently in their homes. That is, they interacted with adults differently, and they were given many more responsibilities at a young age in comparison to white middle class children. Because of these differences between the home and school, children would not verbally participate in classroom interactions.

- Teachers cannot assume that because Native American children have assimilated all the sociolinguistic rules underlying interactions in the classroom, they are fluent and comfortable in non-Indian social situations where English is spoken. Native children, especially those born and raised on reservations, are from a different cultural background than that which is implicit in the American classroom. In other words, just because children are speaking English doesn't mean they understand what their teacher says to them in Standard English.
- Leap (1993) studied languages on American Indian reservations in the western United States. In his research, he emphasized the idea that many Native Americans do not speak Standard English; rather, they speak a combination of their native language and English. Leap called this combination American Indian English (AIE). He defined AIE as an aggregate of varieties, which differ, as a group, from Standard English and from varieties of English spoken by non-Indians in American society.
- Leap (1993) believes that there are at least 200 different varieties of Indian English in the United States today. Consequently, in today's world, more than two-thirds of Native American young people speak AIE, and it is the only Indian-related language they know. Furthermore, Leap (1993) postulates that they learn their rules of grammar and speech from their ancestral language traditions.
- Leap's (1993) study has implications for the teacher of Native American children today and probably Aboriginal children as well. Leap's work suggests that educators should not view Indian English as an example of language deficiency. Rather, children should be allowed to be proficient in all language domains. They should not be forced to forsake Indian English-related proficiency before they can develop Standard English.

As we make a final point about the language differences of Native American and Aboriginal children, we must emphasize our belief that there is power in language and in the spoken word. The oral traditions of many cultures should be valued and respected, and education should not rely solely on print-based mediums that dominate eurowestern societies. For the most part, western-based societies have been dominated by Eurocentric conceptions of literacy (Malott et al., 2009). Likewise, James Paul Gee (2008) notes that Eurocentric learning standards and their corresponding goals, pedagogy, and curricula can marginalize and blur different knowledge and discourse styles within Native American and Aboriginal communities.

Using Indigenous Knowledge Systems in the Content Areas

Chigeza and Whitehouse write about Aboriginal students navigating between their culture and that of nonindigenous Australians and the measurement of achievement through culturally monochromatic lenses. In a similar vein, Gregory Cajete (1999) wrote about the need to provide a way to bridge the differences between the worldview of traditional Native American students and western science. According to Cajete, for many years, Native children were treated as if they suffered from cultural deprivation. In more recent years, with the emphasis on Indian self-determination, this perspective has slowly changed. In the 1970s, Native American tribes were given more control over their government and education. Further, cultural traditions received more attention. Native American language and culture became a part of the school curriculum in many reservation or Indian-controlled schools. When the Menominee Indian School District was founded in the late 1970s, culture was included in the mission statement. Menominee language and history became required classes in the grade school and high school. Special programs were developed to train Menominee people to become certified teachers.

Cajete (1999) promotes the idea of what he calls a bicultural science education. This differs greatly from what he calls modern European American education, where students are prepared for tasks important in an industrial and technological society. Bicultural education, according to Cajete, emphasizes understanding reality for a particular cultural group, which involves establishing communication about nature that is meaningful to the group. This understanding of reality and nature is meant to help Native students develop more positive attitudes toward science and strengthen their tribal identity concomitantly, which is significant in assisting youth to become more successful in school and society.

Cajete (1999) also emphasizes the importance of understanding the core values and beliefs of Native Americans, noting that these values differ from some values in North American education. He believes that Native cultures may conceptualize ideas in terms of cultural mysticism and longer-term tribal narratives. He uses the example of Keresan Pueblo Indian philosophy as his case in point and in particular, the mythical being of "Thinking Woman." There are several elements to the narrative of Thinking Woman. The first element points to the importance of an individual's perception of their environment and the value of their individual experiences. The second element highlights learning through modeling and the value of that sort of learning. Cajete notes that the narrative of Thinking Woman represents the core values of harmony and balance. These core values and beliefs, according to Cajete, are representative of Native American philosophies in the southwestern United States.

More recently, Sara Unsworth, a doctoral student from Northwestern University, completed a study in 2008 on the Menominee Indian Reservation. She received special permission from the tribal elders to study the scientific knowledge of Menominee children. In fact, the tribal chairperson sat on her dissertation committee and the Menominee Tribe owns the copyright to her research. As Unsworth conducted her study, a number of things became apparent that are related to Chigeza and Whitehouse's study in terms of Native American and Aboriginal children's familiarity with their environment. Unsworth found that children on the Menominee

Reservation are allowed to learn their lessons in life by exploring and experiencing their environment; this contrasts starkly with the educational experience of non-reservation youth. Many children living on the reservation spend a great deal of time outdoors in activities such as swimming or hunting. Many families eat venison and other wildlife game as a regular part of their diet. Parents regularly take their children camping to gather berries and roots or to cut fire wood for the winter. Children might also help their families pick ginseng to sell to supplement the family income. In the process, children might learn that when picking ginseng, it is important not to pull the root out of the ground so that it will come back in the spring.

Unsworth (2008, p. 3) was concerned about cultural variation in cognitive and developmental psychology. She also wanted to know how changes in culturally based education practices could increase opportunities for children to use their "own valuable cultural knowledge and frameworks to connect to new material" (p 3). She noted that earlier research had shown that Menominee individuals were more likely to think of humans as a part of nature and to think about ecological relations in nature. For example, she learned that "rural Menominee Native Americans have more psychologically close orientations toward nature" (p. 4). She concluded that both verbal and nonverbal discourse practices (hand gestures) play an important role in the learning of psychologically close orientations toward nature. She noted implications of the research for the "development of culturally based science education programs in relation to language, culture, and cognition" (p 4).

Unsworth (2008) pointed out that, according to statistics from standardized testing, Menominee children were successful in science at grade 4 and sometimes superior on their test scores in relation to non-Native students. However, by grade 8, Menominee students were scoring below the national average. Unsworth attributes this underachievement to changes in the formal educational setting and not in the students themselves. She surmised that the teachers in the lower grades on the reservation were more attuned to the ways of the reservation and nature and used this knowledge in their teaching, or that the science curriculum changes in ways that have more of an influence on older Native children.

Her assertions are reflected in what occurs at Menominee Tribal School (MTS). The students at MTS, which is the more traditional school on the reservation, practice Menominee traditions and culture in many ways. For example, eighth grade students gather wild rice from the lakes during the fall. They travel in canoes and go through the whole process of harvesting and winnowing the rice. The activity is incorporated into their science, social studies, language arts, and computer classes. Another example of how both teachers and students are attuned to nature on the reservation is maple sugar camp. All the students and grade levels participate in the maple sugar camp. Maple sugar was a staple in the Menominee diet years ago and the Tribe does not want the tradition lost. Older children are allowed to participate in the entire process while younger children participate in only parts of the process. This activity is also a part of the science, language arts, and social studies curriculum.

Unsworth (2008) also discussed the ways in which Menominee people tell stories about nature and animals. The Menominee clan system is based on animals and the clans all have stories and mythology connected to them. Unsworth observed that Menominee elders tell stories designed to teach listeners tribal values and a respect for nature. Menominee people have lived in harmony with nature for hundreds of years, as evidenced by the pristine northern Wisconsin forests and lakes.

Both Leslie Teller and Lisa Waukau are Menominee teachers who use storytelling in their classrooms. Leslie uses traditional storytelling and Lisa uses informal storytelling. The students love to hear their stories. One semester, Leslie taught a distance learning class on mythology for Menominee and non-Menominee students. She believes that the native Menominee students had an easier time relating to the stories she told in the class than the non-native students, since the sharing of oral narratives is a part of the Menominee students' traditional ways of coming to know the world.

The multifaceted nature of native storytelling is also evident in another example from Leslie Teller's teaching practice. Many years ago, Leslie heard a story when she was taking a class in Arizona. Today, she uses this story to teach onomatopoeia to her students. She teaches the word for owl in the Menominee language, which is "koo-koo-a-oo." The students usually laugh and they don't believe her since the word sounds like an owl hooting. Then she relates a story about prairie dogs and the Dust Bowl in mid-America of the 1930s:

> The Apache word for prairie dog is ee-ee, which is the sound that prairie dogs actually make. When the white man moved to the Great Plains, he saw the prairie dog as a nuisance. They did everything they could to rub them out. The prairie dog towns were complex and vast – one was reported to be as big as the state of Indiana. Indians said that the prairie dogs were necessary to aerate the land. When most of the prairie dogs were gone and the rains came, the water couldn't soak into the land. It was an ecological disaster. People did not know the stories and they suffered.

Lisa uses storytelling to introduce important events or ideas in history. Sometime the stories are funny and come from the news or current events. Other times, the stories are family stories about war or they are events in Menominee history. The following is an example of a true story from Menominee history that she uses to demonstrate the conflict between Native tribes and European colonists:

> It was a beautiful October and the year was 1811 when the word spread that the great Tucumthe was planning to visit the Menominee and it was a time the young people of the Tribe would remember. You may know him as Tecumseh. Imagine this man, the greatest warrior of his time, was coming to visit the Menominee. The young men could barely contain their excitement and the young women could not understand why. He was after all, just a man not even from our tribe. So what that he was coming from so far away. One girl was heard to comment, "He isn't exactly the sun in my cornfield." And a young man retorted, "Well, when Tucumthe speaks, his enemies tremble. How many people do you know that can do that?"
>
> But, the big question was why is this hero of the battles in the Ohio Valley coming to visit the Menominee? It must be important for him to come all this way. Menominee bands from all over were coming to meet Tecumthe in a Grand Council and soon the main band was hosting people from all over at the little village at the mouth of the Menominee River called Minikani. They wanted a chance to see, to hear, and to touch the great Tecumseh.
>
> Finally, he arrived in his flotilla of canoes and excitement was in the air as he disembarked. There he was: tall, muscular and handsome and not very old, and he looked every bit the son of a great chief. Our Chief Tomow greeted the visitor along with all the other band chiefs and they escorted our visitors to the Council Lodge where they smoked

> kinnikik, exchanged gifts, and prayed that the creator god would look kindly on their gathering and hear their good words.
>
> Finally, Tucumthe rose to speak to our council of chiefs: "Brothers, I wish you to listen to me well so that you understand why I have come all the way from where the sun comes up to speak to this grand council. Brothers, the Americans have made treaty after treaty with the red man and have broken every one. He kills our women and children and takes our lands and then hides behind his army. He gets our old chiefs drunk with his strong whiskey and convinces them to sell land that does not even belong to them. Those who sell the land must be punished and they shall suffer for their conduct.
>
> But, my Chiefs, as I stand before your wise council, I humbly ask that you and your warriors join the Shawnee in our fight, not against those old chiefs who sell the land, but against those Americans who swindle those old men with their strong drink and cheap presents. Brothers, I say that if you choose not to join us now, who will come to your aid when the American want to cut down your mighty forests to fence their land and when their broad roads pass over the graves of fathers. Soon, brothers, you too will be driven from your Native lands as leaves before the winter storms. Stand with me brothers in our Great War confederacy. Fight with me to reclaim all the lands the creator gave his red children. Many of us may die in this noble cause. And we must all die sometime and isn't it better to die defending your families than to live like paupers. If it is your time to die, be not like those cowards whose hearts are filled with fear of death, but sing your death songs, my chiefs, and die like a hero going home. Confederacy or extermination is your only choice, my brothers. Which do you choose?"
>
> When he sat down, it was so quiet you could almost hear a leaf falling in the forest, and then the council exploded with clapping and whoops and tomahawks were flying in the air. Even the wise old chiefs could not hold back the young warriors. And so the Menominee made ready for war.

The use of storytelling in the Menominee classroom is an illustration of the infusion of culture and tradition in the classroom, which is, very much similar to what Chigeza and Whitehouse are trying to do in their science curriculum. Menominee children enjoy and relate to the stories because these narratives are grounded in their everyday way of living and being in the world.

The Connection between Native Americans and Aboriginals

In reflecting on our own work, the following question arises: How does research in the Menominee context connect to the indigenous knowledge systems important for the work of Chigeza and Whitehouse? This sort of research can lead to a more interdisciplinary acceptance of diverse indigenous customs and traditions that could be incorporated in schooling and society. The language, culture, and knowledge of indigenous peoples should be recognized, respected, and accepted by schools and teachers of indigenous children if these children are going to be successful.

There is much to be learned from the history of Native Americans for the teachers of Aboriginal children. Traditionally, government policy and practice in the United States has been one of cultural acculturation and assimilation. This has been in actuality a detriment to Native people by breaking down the culture and social fabric of indigenous knowledge systems. The message to the people became one of:

there is something wrong with you and you are culturally deprived. In many cases, the very psyche of individuals or communities was affected with devastating results. Tell a person this deficiency narrative long enough and s/he'll start believing it. Let's stand together with Chigeza and Whitehouse in their call for indigenous approaches to science for ecojustice, cultural rejuvenation, and celebration.

References

Cajete, G. A. (1999). The Native American learner and bicultural science education. In K. G. Swisher & J. W. Tippeconnic (Eds.), *In next steps: Research and practice to advance Indian education* (pp. 135–160). Charleston: Clearinghouse on Rural Education and Small School.

Leap, W. (1993). *American Indian English*. Salt Lake City: University of Utah Press.

Malott, C., Waukau, L., & Villagomez-Waukau, L. (2009). *Teaching Native America across the curriculum: A critical inquiry*. New York: Peter Lang.

Phillips, S. (1972). Participant structures and communicative competence: Warm Springs children in community and classroom. In C. Cazden, V. John, & D. Hymes (Eds.), *Functions of language in the classroom* (pp. 696–735). New York: Teachers College Press.

St. Clair, R., & Phipps, A. (2008). Ludic literacies at the intersections of cultures: An interview with James Paul Gee. *Language and Intercultural Communication, 8*, 91–100.

Unsworth, S. J. (2008) *The influence of culturally varying discourse practices on cognitive orientations toward nature*. Unpublished doctoral dissertation. Northwestern University, Evanston.

Chapter 38
Ways to a Waterhole

Jennifer D. Adams

80.1/7055 Waterholes along the Tingari track
Courtesy of the Division of Anthropology, American Museum of Natural History.

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*, 455
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_38,

I first saw this actual artifact during a teacher education workshop in a museum. “This is a map,” explained the collections manager at the Museum of Natural History. “It tells you how to get from one watering hole to the next and how to *think about* getting from one watering hole to the next.” “It is a depiction, drawn by an Aborigine artist, of a cave painting.” When it was exhibited, the copy read:

> All Aboriginal art, including body painting, shares a visual language. A combination of elements usually portrays the journey of a Dreamtime ancestor and describes the landscape transformed by these travels. Concentric circles may represent a waterhole, a campsite or other landmark. Lines depict the paths of the ancestors, while tracks show locations where animals or humans traveled during the Dreaming. For the initiated, specific designs identify particular locations that follow specific “site paths” and serve as maps.

I was struck by the notion that this map would not only point out geographical landmarks but also depict a way of *thinking* about traveling between these features.

Every so often, I revisit this artifact when I think about indigenous ways of being and what these complex understandings of the universe could offer science and science education. In mathematical terms, concentric circles are nested objects that share the same center. This map could serve as a metaphor for the relationships between indigenous or local knowledges. In this case, the waterholes represent embedded knowledges in a given area with place being the center of focus. The entire map is a collective global network of reciprocal knowledges. Each circle(s) represents a particular worldview that focuses on a center but is yet interconnected with other worldviews, suggesting a global interplay between knowledges and cultures. This image seems reflective of the “glocalization” that Lutiel and Taylor introduce in their chapter. They present this idea as an alternative to globalization, which implies a univeralist position of western knowledge over indigenous and regional ones. These authors also discuss the influence of a colonial history on education. Western and Eurocentered ways of knowing are often positioned as foundational, relative to local or indigenous knowledge. Other authors key in on this hegemony largely at play with Eurocentric and local knowledge. One might argue, however, that every knowledge is derived from some ancient disposition, and even when eurowestern scholars do not acknowledge it, there are always deeply embedded roots for this knowledge somewhere in the region. Glocalization, the dialectic between local(s) and more global practices, creates a space for a more inclusive, pluralistic math and science education. In their response, Sutherland and Henning highlight their lived experiences with foundationalism – as a scholar and First Nations researcher – and how they believe that students ought to be grounded in their local systems – language, traditions, and ways-of-knowing – before they critically interface with science. In other words, one must know their waterhole before being able to think of it in relation to the others.

Troubling Waters and Troubling Borders

In rethinking the notion of borders, Carter and Walker remind science educators that Eurocentric notions of borders are indeed hybrid, flexible, and more complex than the ways in which they have been conceived. Cultural studies and indigenous thinking about borders were used to make the case that borders are more culturally complex, and historically layered, than typically written about in science education literature. In this sense, borders are interfaces or zones where one always finds complicated processes of negotiation and transculturation (Hall 2001). The spaces Carter and Walker describe are places where diverse and at times contradictory knowledge may be "tolerated or held in tension" in a way that opens up spaces for understanding how knowledge has come to be and how multiple knowledges have been shaped by global, cultural, and historical processes. The point is that all knowledge – indigenous and Eurocenteric – exists in relation to the other; however, subaltern knowledge is always at risk of being deemphasized or lost. How do we protect these knowledges from being appropriated or eclipsed by hegemonic structures? It is important to keep these knowledges at the center of discourse about science and science education as equal recognition of the parts (of global understandings of the natural world) gives us a greater understanding of the whole.

Two other scholars, Chigeza and Whitehouse, created a hybridized space for recognizing the importance of integrating the language and culture of their Torres Strait Islander students into the standards-based classroom. They acknowledged the inequity created in education when the language of instruction and assessment (Standard Australian English) is not the same Creole language that students use in their lifeworlds. Drawing on Bordieu's notion of capital, they cite a lack of SAE linquistic capital as one of the reasons that Torres Strait Islander and Aborigine students consistently underperform in the national assessments when compared to their dominant-language counterparts. Building on Yasso's notion of community cultural wealth, Chigeza and Whitehouse note that their students became more successfully engaged in learning science when their linguistic and cultural wealth was leveraged to learn science concepts of force and energy. Not only did they learn these science concepts, but they used words and artifacts derived from their culture to demonstrate science concepts. They also added another dimension of understanding to their cultural practices, that of modern science concepts and how it relates to their indigenous cultural practices and skills. Cultures and languages that are often held in tension in this Northern Australian schooling context, played reciprocally, create a shared understanding of science concepts and certain aspects of Torres Strait Islander culture for both the students and their teacher. Students were valued and placed at the center of the science classroom along with textbook knowledge. Think about the powerful scientists these students have the potential of becoming when they see themselves as part of the scientific enterprise. Think about the kinds of research questions they will ask and the methods they will use to answer their questions when they have opportunities to bring together their combined knowledge and science conceptualizations to bear on understanding the natural world.

Jennifer Lance Atkinson reminds us that incongruence between home and school cultures is not unique to indigenous people. She discusses how standards-based educational efforts have seemed to do more to abate the successes of marginalized students in science education than create equitable learning opportunities. She problematizes the notion of "achievement gap" by discussing the deficit ideology it implies and the way it relates to normative concepts of "whiteness" vis-à-vis students of ethnic, racial, economic, and linguistically marginalized groups. Concordantly, Waukau-Villagomez and Malott call for an educational approach of incorporating indigenous core values and beliefs learned at the heart of their contexts into teaching and learning. Such an education would make it meaningful to the local students while preparing them to be successful in the world beyond their concentric circle. This idea resonates with Buxton and Provenzo, who recognize that while centering teaching and learning on localized knowledge is important, ultimately, there is science content that students must know and understand to be able to interact in the global context. And, as critical scholars, we need to be extremely careful about placing our views or reimporting colonization in the place of others. We need to think about how indigenous knowledge challenges "critical thinking."

Concentric Places

One theme that resonates through all of the chapters in this section is the embeddedness of indigenous knowledge. Like the concentric circles on the map, the embeddedness tells of its entity. It has ancestral history. And, at the same time, concentric places are connected by paths, tracks, and by their positions, which are relative to one another. As Carter and Walker suggest, "indigenous understandings of space are far more intuitively inclusive of the hybridity and interconnectedness," which is evident in the map. The map not only depicts the physical features of a place, but also historical and ancestral relationships to the place and relations to the physical features of that place. The more we know about a particular culture, the less we seem to know. It becomes difficult to write about it in the way that academic writing dictates! Let us not forget that for native cultures, oral narratives, visual arts, song, and dance are often used to communicate histories and cosmologies.

Places are always layered with historical, spiritual, and cultural systems. For Stonebanks, in Malawi, Mount Kasungu seems as if it is a dominant physical feature on the landscape, but he learns it is also a layered and very complex place for the local people representing spiritual, historical, and economic significance for them. Buxton and Provenzo point out that we ought to always get to know these places with as much detail as possible, but that can take many years, and so we must often do the best we can with what we know. Stonebanks uses a critical theory lens to guide his work. He discusses how the colonial history of the mountain rendered it practically useless (due to natural resource depletion) to local people. Despite that, Stonebanks calls for teacher education to unpack how education serves to maintain the status quo. He reminds us that critical pedagogy can serve to bring an awareness of how these historical power structures influence goals of schooling in ways where we could be more positioned to teach in equitable ways. To elaborate, Buxton and Provenzo further remind us that place-based education and critical media literacy can provide powerful sources of engaging preservice teachers in reflecting on what they take for granted as part of the local landscape. These field experiences and the intellectual tools teachers know can be critically analyzed with their experiences, as a way around traditional "multicultural" education.

Coda

In reviewing the chapters in this section, I think about waterholes and the concentric circles that represent circles on the map and the journey implicit between waterholes. I think about how indigenous, local, or regional cultural, or biodiversity knowledge and traditional skills ought to be conceived also as a journey. When these things become a journey through concentric circles, they become multiple ways of knowing that are centered on place. The authors in this section leave us with different stories from their research, to continue the conversation, to work diligently as teacher educators, and autobiographers of locations that enable us to learn the different ways that indigenous knowledge should be leveraged in science education. In other words, they present us with ways of *thinking-acts* about how to get to a waterhole where science is inclusive of different ways of educating and understanding. They give us a glimpse of their world for more discussion.

Reference

Hall, S. (2001). Negotiating Caribbean identities. In B. Meeks & F. Lindahl (Eds.), *New Caribbean thought: A reader* (pp. 24–39). Jamaica: University of the West Indies Press.

Chapter 39
Ecodemocracy and School Science: How Projects of Confluence Guide the Development of the Ecosociocultural

Michael P. Mueller and Deborah J. Tippins

Eco-Mentalism Paradox

When integrated holistically, a passion and love for cultural studies and environmentalism is a serious mental disorder inflicting scholars, teachers, preachers, politicians, activists, and children. For the purposes of this chapter, let us call this disorder the "ecological mentalism[1] paradox"! It is more dangerous than malaria, the common cold, and the flu. These diseases combined are very treacherous for humans and yet the impacts of disease are far outweighed by the results of many people's shattering disorders, attitudes, and behaviors toward other human and nonhuman lives. Diseases and cultural disorders are analogous in that they are both highly resilient, adaptive, and will continue to evolve within different conditions, during different periods of time, and in light of the "antibiotics" applied by researchers and academics who endorse them over human history.

Lasting a long time now is an "antibiotic," democracy – one of the most highly prescribed and pervasive conventions for living in relation to others. But what is democracy? Further, what is the emerging trend of "Earth democracy" or "ecological democracy" described veraciously by Vandana Shiva (2005) – why do scholars such as John Dewey (1916/1966) say that we move toward it like a "truth!?" The purpose of this final chapter, in a book on the confluence of justice, place-based (science) narratives, and indigenous existence, is to demonstrate how *confluence* brings into being a larger wisdom of ecological knowing and helps to expand the sociocultural realm in order to further develop ethics that are inseparable from ecological well-being. While we do not fully develop it in this chapter, the term ecosociocultural is one way of nurturing these "ecorelations." Hence, we hope this book might serve as an impetus for the further development of ecosociocultural theory and associated practice.

The reason for starting with plain metaphors of disease associated with humans – really horrible disorders in some cases – is to show how absurd and irrational it is to infer that disease (if it is a part of ecologies) should participate more fully in

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D.J. Tippins et al. (eds.), *Cultural Studies and Environmentalism*,
Cultural Studies of Science Education, Vol. 3, DOI 10.1007/978-90-481-3929-3_39,

some democratic decisions before us. Essentially, should we really be looking out for the "viability of being a disease?" Should we grant a sort of special status of "democratic voice" to a disorder so that it will not disappear? Does "ecological democracy" mistakenly convey that every living thing should have a "say," vote, or choice in cultural studies and environmentalism? When do ecological organisms need advocacy? When should human advocates be appointed to serve as a proxy for these things, similar to how river advocates represent the appropriateness and significance of a clean river? What say would the Earth's rock have, if it could utter something about our use of its minerals? These questions are important if we wish to understand the steps to fruitful departures from here, be taken seriously, and engage in larger conversations about justice, place, and regional wisdom.

The veracity of ecological democracy (*ecodemocracy* for short) depends much on where our ideas begin to go from here in schooling, rather than being perpetuated as contributing to the degradation of thinking and action in school. This goal also depends on downplaying high-stakes preparedness for economic superiority within the admin policies of Clinton, Bush, and Obama, which endorse doctrines of shock, competitiveness, and authority. Will we reclaim ecojustice, geography, and tribal wisdoms which have been described in this book? Without justice, will we listen to others and situate them in the best possible light? Without geography, will we attempt to "walk in the shoes" of others and garner respect for what they know and do? Without endemic knowledge, will we grant empathy and generosity or extend some human rights for the Earth? The point of this final chapter is to ponder some possible critiques for ecodemocracy and discuss its fruitfulness in science education and the larger educational domain within and outside of schools. Our purpose is to prepare scholars and educators who align with ideas in this book for scrutiny.

First, we demonstrate how absurd it is to deploy "ecodemocracy" within eco-mentalism. Yet, logic is not the exclusive force for which we make our arguments for ecological well-being. We do not need to rely on the superiority of the "rationale paradigm" in science and education as noted by Pagan and others. There is an interesting paradox with eco-mentalism which both inspires and puts us at more risk. We make ourselves more vulnerable to critiques and dismissal because of coined "ecological" prefixes. These days, everything has teleported itself into the eco-mentalism paradox for exploitation. While eco-this and eco-that serves to show how we embrace and value the "greening" of things, it also creates severe vulnerabilities for youth and adults who spend a lot of money. Without even recognizing it, we have become more at risk as culturalists and environmentalists. We have become threatened and may even lose more through the trajectory of the mass media. Concomitantly, we are actively charting the waters of creativity, imaginative, and genuine appeal. Repositioning ourselves within the very exclusive science and schooling domains cannot be avoided. But how? Especially in light of what gets to be tested? Why and where should we democratize science and schooling in an ecological vogue? We anticipate that this chapter will open the optimistic doors to cultural studies and environmentalism in a way that must be taken seriously with others in this book, and further endorse *our* change efforts. We do this change with and alongside of Nature, not for Nature but for the betterment of all kinds. We conclude with some nurturing ethical and moral imperatives for cultural studies and environmentalism.

Absurdity and Irrationality in Cultural Studies and Environmentalism

> The absurd is the essential concept and the first truth. (Albert Camus 1913–1960)

Why do we need heterogeneity for human survival and reproduction? We now have gene manipulation sciences which can be used to select the very best characteristics for our children. Why not? Who wants a child with serious birth defects – speech, sight, touch, taste, or intellect? It is absurd to think that for the sake of "cultural diversity" we should protect and conserve people with limited abilities, learning disabilities, and DNA for schizophrenia and despicable crimes. When these things can be selected out of the equation for parents, will not those who care for their children most prefer those characteristics of offspring that make sense in terms of human viability and reproductive potential? In terms of the taken-for-granted ethical imperative for human survival – yes! How could one argue that they would conserve those things above? With rapidly increasing technologies, it is easier to sort humans into capabilities and potentialities, similar to the ways in which they have been sorted throughout history. Already there exists "genetic counseling" and other meditations for parents who want to take advantage of "knowing" ahead of time what advantages and disadvantages could be predicted for their children in US society.

Why Grow Old?

Genetic human engineering holds the promise of curing dodgy diseases and holds the possibility of changing phenotypes for whatever is popular, trendy, or stylish, within our society. These things used to grasp an appeal for those interested in science fiction books and 1950s films. But today, these things retain more widespread appeal, yet in different forms, which are taken for granted. For example, why grow old? There is a widespread spotlight on expanding the life span, which is a highly lucrative market in the USA and Europe (e.g., $50 billion in the USA!). Antiaging products involve nutrition, exercise programs, hormones, skin care, supplements and herbs, and ancient remedies, cosmetic procedures, and more recently, reducing harmful diseases. Since the average life span within different world human populations is lowered by destructive diseases and nutritional problems – causing infant and child mortality – there is currently a significant focus on eliminating cancers and cardiovascular diseases and other limiting variables. Theoretically, if we could replace damaged bodies by rejuvenating deteriorated cells and tissues, why shouldn't we? It is absurd that people should have to die early from destructive aging issues. From a cultural diversity standpoint, we discriminate against the elderly when we do not ensure their participation more fully in the democratic-decision processes of the community and environment, in a way where they are afforded equal opportunity so they would take part in full mind and body (what sort of person would deny their grandparents or elders the medical treatments or technological advantages needed?)

Democracy for the Dead (or Unborn)

Would it not be cool to live forever! The dead are dead! Or do the dead partake in some forms of ecodemocracy through spirits, ghosts, apparitions, or advocates of extrasensory perception (ESP)? If they do, "the dead" should be included more fully through ecodemocracy, because they are part of the broad spectrums that blur a boundary between life and death within the larger ecologies of the supernatural world (albeit it is seldom considered "normal" to embrace and value a "sixth sense" in the environmental sciences). Diversity scholars, multiculturalists, and educational pluralists limit diversity when not considering the dead (and the unborn) significant enough to address as cultural identities. Indeed, there are many cultural traditions for the dead and nonliving spirits (e.g., El Día de los Muertos). What are the ways that the dead could be more fully included in science education? What ways could the dead become alive again through gene reinvigoration? Cloning cells and tissues appear to be a viable option or freezing entire bodies for those who are seeking limitless lives forever solidified at negative 130°C in aluminum containers. Could these peoples' spirits or actual lives be raised from death? Is "death" a democratic matter? If people could decide, it is likely that some individuals would select to die based on the most democratic option – when they would like to die. Perhaps, certain people would not want to die. For example, if an ecologically sophisticated sort of human were developed by science, why die? It is also true that some decide when to die by way of a gun, knife, or rope, and it makes sense that these choices are democratic (suicide decisions are the third leading cause of teenage death). Some older individuals elect to die through euthanasia when they are terminally ill, and others decide when and where to terminate a pregnancy (e.g., rape, Down's syndrome, or Spina bifida). The point is that death *is* democratic. However, the justifications for why to postpone death are vulnerable and threatened. Nevertheless, societal laws do not tolerate for all types of euthanasia, suicide, or infanticide. Withstanding the freedoms we have in choice of death, democracy seems to perpetuate a sort of ecological violence or Earth pressure. On the other hand, if democracy is extended for nonhuman animal species, then it seems logical to include it as a movement with education for the ecodemocracy of all organisms.

Unbiased Diseases

Who would you want to bring back from the dead? Would it be a dog, cat, fish, or other family pet? Would it be your favorite aunt, grandparent, neighbor, teacher, or even a child who never had the chance to live the life they deserved to live?

Consider youth who die from cancer. Children are not supposed to leave this Earth before their parents. Meet 6-year-old *Elena* (http://www.notesleftbehind.com/) who left behind hundreds of notes for her younger sister and parents who love her dearly, and for whom, she will forever inspire. She tucked notes away in bookcases, briefcase pockets, dresser drawers, and the china cabinet. She wrote notes that read: "I love you Mom and Dad," and "Grace [her little sister] I love.… Grace Go Go!" Her father writes these things in a book on Elena's life and that her last days showed a community how to love and live. Elena died of brain cancer. Genetic manipulation could have been used to save her. But what is the "ecological violence" and double standard of privileging cancerous humans over the Earth? Although Elena's story tugs at the heart, it is worth exploring these issues within ecodemocracy.

What Would the Eco- (or Environ) Mentalist Do?

Hard-core environmentalists often decry the 6.8 billion people who now live on our planet, along with how and why we should limit the number of children that people are allowed to birth. Ideas such as mandated birth – similar to what is enacted in countries such as China – follow these rationales. Moreover, environmentalists who wage claims about the ecological violence of population pressures, call for policies restricting the genetic modification of plants, animals, and humans. We probably know one of these environmentalists, or we ARE one of these environmentalists, but a specific example is E.O. Wilson who claims in *The Future of Life* (2002) that we should limit birthrates. Wilson is not alone. Further, we might reduce the human population by shielding against disease, famine, and other grounds for death such as environmental disasters that reduce human survival and reproductive probability. But how many environmentalists want these things applied to their own children or their lives? It would be interesting to find out! Very few studies have been done to determine the ways in which environmentalists contradict their own opinions, explanations, and appeals to the Earth. It is absurd to think that individuals living today will want to shorten their own life for others' (when that resolution logically begins to decrease the human population). But for the sake of pondering the ideas mentioned, let us consider some of the following remedies for environ mentalism:

1. *Reduce research in the area of heart disease and prevention – a leading cause of death*
2. *Reduce the hospitals dedicated to cancer research and the "pink" and "red" promotion of products*
3. *Ban super-sized automobiles that provide vehicle safety for petite, fuel-efficient vehicles*

According to the Center for Disease Control and Prevention, heart disease, cancer, and vehicle accidents lead to more than one million deaths yearly (http://www.cdc.gov/nchs/fastats/lcod.htm) and these deaths are a small measure of the ways in which human deaths impact global populace. Withstanding few exceptions, how did ecoenviron mentalism get this absurd, without much thought?

A Short History of How Environ Mentalism Came into Being

Now, we will provide a brief history of environmental sciences to further support the claim that today's environmentalism and thinking of the Earth in scientific ways contributes to eco-mentalism. These examples are taken from Peter Bowler (1992), a professor in the history and philosophy of science at Queen's University Belfast. He writes extensively on the history of the environmental sciences (e.g., biology, ecology, geology, and meteorology). Bowler explains that when the environmental sciences first emerged in the eighteenth and nineteenth centuries, they were considered less responsive to the rigors applied in the labs of the physicist and chemist. He notes that "one of the most important developments within the cultural framework of modern science is the emergence of this awareness that Nature has a history that determines its present structure" (p. 6, capitalization in original).

The beginnings of environmental sciences can be traced to *natural theology*, the view that the natural world was divinely created by God. The natural theologists viewed God as an intimate part of nature and they took for granted that the Earth remained perfect or stable after humankind's fall into sin (Bowler 1992). Initially, the natural theologists did not want to see that the Earth has an "imperfect" or uncertain history. As natural theologists wrestled with trying to find certainty and stability in the natural world, they encountered a constantly changing and irreducibly complex Earth.

The early naturalists were caught in the flux between their desire for certainty and what they actually observed and experienced. The naturalists' efforts to reduce the natural world into certain categories resulted in the compartmentalization of the disciplines. Naturalists would now favor science as *the* way of knowing the Earth. Robert Hooke (1635–1703; *Discourse of Earthquakes*, 1705 as cited in Bowler 1992) was an early scholar to propose that the Earth had an uncertain, complex past – lacking stability and divinity. Hooke pointed out that the fossils in the rocks were once living organisms, uplifted by earthquakes, and revealed by erosion. He was irritated by the naturalists' spiritual views of God's divinity in the natural environments. Hooke thoroughly challenged the religious sentiments, arguing that some of the fossils in the rocks were once living and now extinct. This scientific narrative went against the spiritual grain of the naturalists who were trying to make sense of a perfectly created Earth that could not have extinct species.

Another scholar, James Hutton (1726–1797; *Theory of the Earth with Proofs and Illustrations*, 1795 as cited in Bowler 1992) proposed that volcanism was the primary mechanism of change for the Earth's landscape. But unlike Hooke, Hutton wrestled mightily with certainty: he was unable to accept an idea of a decaying Earth that did not have the hope of balanced renewal, the "perfect workmanship of God" (Bowler 1992, p. 133). Hutton postulated a new theory of the Earth: the idea of perpetual balance between constant erosion and mountain building or uplift. While the naturalists were starting to come to terms with the Earth's changes and complexity, they still needed to resolve their ideas with certainty in mind, which stirred more conflicts. The beginning of thinking with uncertainty was there, but it was still out of reach for those who desired to think of Earth in certainty.

The scientific mentalism that "order in nature" was imposed by God, lingered on in the minds of naturalists. This historical period is often referred to as the beginnings of the Age of Enlightenment, which also inspired Romanticism with thinkers such as Jean-Jacques Rousseau (1712–1778). Romanticism was characterized by a heightened interest in the natural world and it began to dissolve the certainty thinking with imagination and emotion. However, thinking with certainty in mind was still privileged as scientists tried "to reimpose divine order upon a world that had degenerated into chaos" (Bowler 1992, p. 111). (Bowler can be criticized for not emphasizing that "chaos" also is a human constructed metanarrative for the uncertainty of Earth's changes and irreducible complexity.) Gradually, the early naturalists began to accept the biodiversity and the changing and complex Earth as beautiful. (It should be noted here that today, many environ/mentalists inadvertently perpetuate Romanticism in environmental education, place-based projects, ecojustice.)

Bowler (1992) notes: "[P]aradoxical that an age that was becoming increasingly conscious of the earth as a source of minerals to be exploited for industrial development should develop an enhanced awareness of natural beauty" (p. 111). The earlier ideology of separating spirituality, philosophy, and the arts from science made it easier for industrial thinkers to exploit the natural systems and for scientists to exact physical laws. In other words, while artists were off painting beautiful mountains and landscapes, industrial leaders were exploiting nature and scientists were imposing order on it. One example is the Swedish naturalist Linnaeus (1707–1778) who envisioned a *natural economy* "in which each species depended on others for its food, and in turn was depended upon by its own natural predators" (p. 144). Linnaeus was strongly influenced by the religious views of a stable Earth, and yet was able to position the Earth as the property of humans to be categorized. Religion and science did not have to be "at war" if they could be logically separated to accomplish different goals. The science metanarrative would remain at the foreground when needed. Science (mentalism) concurrently developed around certainty in Earth.

Earth's natural history became one of the most contested areas of the sciences in the eighteenth century. Bowler (1992) explains that the "challenge faced by eighteenth-century naturalists was that of balancing the human passion for imposing order upon the world against growing evidence that the world was so complex that its true order would forever remain unknowable" (p. 159). The notion of a stable Earth continued to break down when Thomas Malthus published a book in 1797 called *Essay on the Principle of Population* (Bowler 1992). In this book, Malthus "proclaimed that the human race's capacity to breed ensured that the population would constantly tend to outstrip the food supply" (p. 172). This book challenged the very foundations of natural theology, and it became more difficult for naturalists to reconcile their static views of nature with the anticipation of a rapidly growing population, changing standards of living, and environmental changes.

The Enlightenment and Industrial Revolution ushered in Darwin's theory of natural evolution, more geologic evidence for natural history in the fossil record, and new conflicts (Bowler 1992). Despite increasing specialization in what is now known as the natural sciences, the role of certainty for the "scientist" became recognized in 1840:

> Governments were forced, some of them reluctantly, to support scientific research and education. The scientists argued that, in an increasingly industrialized world, they alone held the key to progress and hence to national development. In order to make this case, however, they had to stress the practical value of scientific knowledge rather than its theoretical content, often concealing their own real interests from their paymasters. (p. 195)

The ideological conflicts between scientific mentalism and other cultural ways of knowing might be seen as the consequence of how society thought it should be governed. Theory was de-emphasized and many scientists “abandoned” theoretical work (Bowler 1992). Scientists who persisted with theoretical projects received very little funding. Theory would be seen as “secretly” informing scientifically based environ (mentalist) and other important societal decisions. The generalized certainty of science was exciting for euro-westerners, which led to accepting it prima facie as the highest form of knowing; it was believed to provide the rigor and reason needed for making government decisions. Science would help expand the frontiers of industrialization. But, a limitation of using Bowler’s 1992 description is that he does not name specific scientists who de-emphasized or ignored theory work. Yet, Bowler’s description is highly plausible, and the cultural residue of de-emphasizing or ignoring the Earth’s high uncertainty as science/environ mentalism continues to linger in the scientific reports produced by groups of environmental scientists worldwide (International Panel on Climate Change [IPCC] 2001).

In the early twentieth century, with the acceptance of natural history, the need for an interdisciplinary know-how led to the field of ecology. The term “ecology” was actually coined in 1866 by Ernst Haeckel to describe the relationships and interactions of organisms within the natural world (Bowler 1992). Ecology emerged quickly for scientists from diverse fields because they could access research funding for many different kinds of projects. For most scientists, ecology became a way to better inform the management and sustainability or the exploitation of natural resources (garnering as much research funding from private institutions as governments).

Environ (mentalism) developed concurrently with the *emergence of ecology* (mentalism). Bowler (1992) defines *environmentalism* as the emergence of a “green” movement “with its emphasis on the use of science to pinpoint the problems of the modern world ... a two-edged sword ... to support either an exploitative or conservationist view of the environment” (pp. 4–5). The “Green movement has appropriated the term ‘ecology’ for its own purposes by pretending that anyone aware of the complexity of the interactions between species must be concerned to preserve the natural balance” (p. 362). In more recent years, the environmental movement has gained considerably more attention. Now let us shift the focus to problems with eco/environ mentalism.

Eco/Environ Mentalism and the “Ecological Crisis”

Environmentalism has been growing in the USA and abroad; research institutes, citizen-based organizations, corporations, spiritual groups, and nonprofit foundations – all have had a hand in its growth. Despite the prevailing cultural view, environmentalism does not adhere to certain virtues. For example, in Germany the environmental movement was adopted by the rise of the Nazi party to warrant genocide (Bowler 1992). Eco/environ mentalism fit "into the Nazi's ideology because they encouraged a suspicion of urban values and saw a renewed peasantry as the foundation of their social order" (Bowler 1992, p. 513). The Nazi party "established nature reserves – on land cleared of Jews and Poles sent to the death camps" (p. 513). Not surprisingly, the American public developed a disdain for environmentalism in the postwar years, and yet it caught on as an important endeavor linked with the preservation of the natural world with early scholars such as John Wesley Powell (1834–1902), famous explorer of the Colorado River, who "warned that it would be impossible to irrigate large areas of the arid lands of the west and protested against the destruction of forests" (p. 203). Another scholar, William James (1901) wrote about the destructive clear-cutting practices of the colonial settlers in the Smoky Mountains of North Carolina. In turn, Aldo Leopold (1949/1968) and Rachel Carson (1962/1994) began writing about conservationism and land ethics. A theme of "respect for nature" emerged during the 1960s and in 1972, the Club of Rome report on the status of the environment improved cultural attitudes toward environmentalists. And finally, in the late 1970s and early 1980s there was a reemergence of holistic theory with scholars such as James Lovelock (1979/1987). For scientists, Lovelock's Gaia Hypothesis sounded too much like cultural mysticism (i.e., eco/environ mentalism) to take seriously.

Cultural mysticism and science/environ mentalism is now recognized as intimately woven into the social threads of scientific and popular cultures. Science may be used to legitimize particular modes of reality construed by humans, conceptualizations which reflect and endorse beliefs and values, as well as the expectations and interests of the constructors. Bowler (1992) warns:

> Whether you support the free-enterprise system, or see industry as a curse that must be removed, you should do so because that is how you feel about the situation in which you live, not because you think science offers unequivocal support for your position. (p. 548)

Science does not "speak for itself" and cannot be used to support an exclusive-objective or reality position – not even for the ecological crisis (Mueller 2009). Rather, the significance of multiple cultural perspectives, including agendas on both sides of an issue ought to be upheld. When faced with high uncertainty, there is always more than one right or certain way of knowing, which may conflict with the *Status Quo*. The importance of bringing together cultural studies with environmentalism, with justice, place, and endemic wisdoms, cannot be understated.

A study of the history of the environmental sciences and eco/environmentalism helps us to witness the emergence of the ecological crisis, whether anticipated *or* real. The metanarrative came to be, as humans started to learn from, and apply knowledge to, the changing and complex Earth. These explorations have been traced to the ancient Greeks and through the emergence of the environmental sciences. Humans have been creating metanarratives to think of Earth in certainty since the beginnings. These metanarratives share common grounds when the taken-for-granted assumption is that humans have been granted the essential anthropocentric rights to survive and reproduce on Earth (we return to this point). The notion of "where people put their faith" is what makes the presumption of ecological crisis so dangerous, particularly, when thinking with science/eco/environ mentalism is privileged. While the environmental sciences are now less concerned with thinking of the Earth in certainty, and more concerned with how to reduce uncertainty, the shift to uncertainty thinking is subject to criticism when the methods and criterion used to evaluate possible ecological outcomes inadvertently reify eco/environ mentalism; for example, the constructed hierarchies that scientific thinking implicitly privilege, such as mathematical modeling. Mathematical proof is often taken more seriously than local knowledge, beliefs and values, expectations, and place-based testimonies. It might be argued, that reducing Earth's uncertainty through whatever means possible provides a more viable way for making qualified ecological decisions about human survival and reproduction. To that, we cannot argue.

Eco/Environ Mentalism and Anthropocentric Tendencies

Now let us explore the inherent assumption privileging human survival and reproduction. The philosopher Reg Morrison (1999), author of *The Spirit in the Gene: Humanities Proud Illusion and the Laws of Nature*, notes that the origins of rationality can be traced from *Homo habilis* (i.e., "handy man") to the emergence of agriculture-based settlements, when the need to be more certain emerged as a way to ensure human survival and reproduction. Keeping cattle and farming food helped humans to become the most populated species of mammals on the Earth – only second to the cattle now kept for food. Morrison reasons that humans have now entered "plague status" or severe overpopulation and are headed toward anticipated population collapse. He explains that humans have, up to this point, followed all the characteristics of species that are on the verge of collapse and that our science and technology can do little to bail us out of this predicament. His central thesis is that we use cultural mysticism (or mentalism) to disguise the Earth's evolutionary process and as a way to ensure our genetic survival. In other words, Morrison claims that we rationalize the Earth to protect genetic imperatives to reproduce.

Morrison (1999) builds his case by pointing out how humans and chimps are 99.6% similar, and yet minor differences such as the Broca's and Wernicke's areas in our brains have allowed for specialized language development. Recent environmental declines can be attributed to our DNA or genetic wiring differences: the ability to spread out, to develop culture and language, and to rationalize the Earth. A significant problem is that humans tax the natural systems much more than other species do, on a per capita basis, and we view consumerism as acceptable and admirable. We devastate biodiversity and, consequently, strengthen the numbers of pathogenic species that prey upon other species and us. We rationalize humankind's devastating impacts: land degradation, exhausted soils, intensive erosion, dryland salinization, overzealous land clearing, overfertilization, transgenically altered crops, declining fisheries harvests, destruction of freshwater and oceanic habitats by aquaculture, freshwater shortages, highly toxic pollutants, ozone destruction, and acidic rain. We legitimize this destruction with the cultural mysticism of "growth" and "progress" and, consequently, the worst may be yet to come from the rapidly thawing tundra, which releases methane, a potent greenhouse gas having the potential to dramatically increase the Earth's temperature in just a few decades.

With increasing rates of population growth and a lack of sufficient food, the abundance of methane in the atmosphere may reach levels that would inevitably result in abrupt population collapse. There may be very little that humans can do to counter Earth's natural stabilization process, evidenced by five mass extinctions in the last 600 million years. Even seemingly "environmentally friendly" practices such as biotechnology and aquaculture have implicit impacts. More than a billion people are without sufficient food to eat because of the protein-rich diets of euro-westerners: "[W]e currently feed between a quarter and a half of our annual grain harvest to livestock, even though it would be far more energy-efficient to eat the vegetable biomass ourselves" (Morrison 1999, p. 44). Likewise, two-thirds of the world's freshwater supply is already being depleted for agriculture. By the year 2025, 70% of the Earth's freshwater will be required by the increasing human population. Morrison reasons that "even when humans are reduced to eating nothing but white rice, mere subsistence costs about 2 t (almost 530 US gallons) of water a day per adult" (p. 46). His key point is that there is no scientific or technological solution to our ecological disorders; every illusionary "environmentalist" solution exacts a commensurate eco/environmental fee (or influence). Morrison writes that the impact of humans on the natural systems is based on three criteria: "the size of the population, its per capita level of activity, and the level of technology it employs" (p. 52). He warns that any amount of population growth with unchanged levels of activity and technology will result in devastating consequences.

Morrison (1999) argues, "the remedy for such imbalance is as simple and effective as it is inevitable: the [human] plague brings about its own collapse, the biota rebuilds itself, and life goes on" (p. 129). Although his thesis may shock the senses, the scientific evidence he uses to justify his claim is coherent. The distinguished biologist Lynn Margulis notes in the foreword of Morrison's book that his scholarship may be met with some initial resistance and yet his work "cannot even be deeply criticized without well-developed counterevidence" (p. viii). Margulis' (Margulis and Sagan 1995) symbiosis work strengthens Morrison's arguments, and he follows James Lovelock's (1979/1987) Gaia Theory closely, which helps him to claim that humans are not exempt from the Earth's natural evolutionary process that dictates self-destruction for other plague-prone mammals (e.g., lemmings, mice, rats, and prairie dogs).

While Morrison (1999) emphasizes genetics, he should not be misinterpreted as suggesting that genes work independently of cultural feedback. He explains the interplay: "[O]ur final decisions still represent the inevitable reactions of our particular genetic makeup to the peculiar patterns of perceived information investing us at the time" (p. 173). He further notes that every scrap of pollution we generate and add to the Earth's biosphere is the by-product of our pursuit to send forth our genes – all species produce wastes. Humans, however, have the ability to "habitually attach some degree of mystical significance to anything that has a bearing on the survival of our genes, now or in the future, and this extends to the very edge of our perceptions and the limits of rationality" (p. 184). A million years ago, too much culture would have been detrimental for humans who needed to rely on their instincts (i.e., genetically informed) to survive Earth's many uncertainties. Today, cultural mysticism succeeds because it allows humans to bend the rules of the evolutionary process – however, "all species must fail eventually, especially the very successful ones, or the whole system would grind to a halt" (p. 191). It is an eco-science mentalism that humans now attach to everything, which serves as the X-factor for Morrison to conclude that "Gaia is running like a Swiss watch," in other words, extraordinarily well.

The notion that we will continue to populate the Earth at existing levels and make it unscathed requires a great deal of spiritual faith, environmentalism, or schizophrenia. Unfortunately, our species is not exempt from the Gaia mechanism that has effectively dealt with many species' plagues during the course of Earth's 4 billion year natural history. It takes a great deal of faith in the human spirit, science, and technology to think it any differently. Morrison (1999) notes:

> [T]echnology merely lures us deeper into the environmental trap. Meanwhile our myth-based technoculture keeps us thoroughly bedazzled, entertained, and unable to comprehend the magnitude of our blunder until all the exits are blocked and the consequences are unavoidable. The denouement of our 2-million-year play will not dawn on us until very late, however. We will have to wait until climatic disorder, rising sea level, rampant famine, social disintegration, and a growing list of pandemics finally bring the human plague to a halt for the full gravity of our predicament to sink in. Nevertheless the truth is creeping up on us even now in a million microscopic forms. (p. 250)

Beyond the fact that humans are now spreading diseases more efficiently around the world (e.g., jetliners, cars, rail), we are now contributing to the Earth's climate change. The massive reserves of methane that will be released if the Earth continues to warm may not be taken seriously – due to our debilitating disease. The mentalist ability to think of the Earth in certainty is what may eventually lead to the anticipated human population collapse. Certainty goes against the evolutionary process of incremental change, irreducible complexity, and high uncertainty.

Jared Diamond's (2005) work further supports Morrison's thesis and provides examples of why ancient civilizations collapsed. Civilizations collapsed because they privileged particular ways of knowing, the mentalist disorder that led to their ultimate demise. The scientific evidence that supports Morrison's work makes for a scary situation in which the "right" thing to do might be to continue with what we are doing for the Earth. While it might be argued that Morrison defends genetic determinism, he contends that the devastating overload on the world's ecosystems was triggered concurrently with the development of cultural narratives, which diverged into diverse cultural memories, which impose rationality and certainty on the Earth. These memories all have something in common: the capacity (and perhaps NEED!) to consume and pollute, some in more effective ways than others, and yet they are essentially the same for almost all cultures.

For the sake of argument, if humans did not privilege survival and reproduction, there would be no need for cultural studies and environmentalism the way it is supposed. It might be argued that Morrison's (1999) argument is essentially ethnocentric and anthropocentric, and yet cultural mysticism is used to justify human progress and growth, which legitimize some narratives over others. The cultural narrative of renewing and revitalizing the commons, which is based on the certainty of "ecological crisis" (another mental disorder) is aligned with the cultural imperative to protect the survival and reproduction of the species. It does not matter how the story is told (i.e., genetic or cultural), the ending is plausible, and yet it remains highly uncertain.

It is counterintuitive that ecodemocracy would support cultural thinking patterns and behaviors that accelerate ecological declines. A difficult yet necessary focus should be on the mentalism that legitimizes human rights to survive and reproduce at the expense of others in the Earth's ecosystems. The ecological crisis is the eco/environ mentalism that drives accelerated ecoinjustices for Gaia because it legitimizes anthropocentric tendencies for survival and reproduction. Chet Bowers (2001) fails to recognize the schizophrenia implicit within these disorders of the metanarratives in his own work, which tends to also support the idea that cultural myths disguise anthropocentrism (i.e., human survival and reproduction). Interesting that he warns against *scientism*, yet the same caution is now stern for *environmentalism*. For Bowers, the destructive metanarratives that perpetuate accelerated ecological impacts developed concurrently with the Enlightenment and Industrial Revolution, but the roots of these metanarratives also have been traced to the ancient Greeks (Abram 1996). The ancient Greek metanarrative that led to the decaying relationship between humans and the natural world has been firmly established by philosophers. However, it may be too easy to blame the ancient Greek dichotomy between humans and nature for the cultural roots of today's "ecological crisis." The ancient Greeks did not make the connection that humans could negatively impact their natural surroundings. They could not know that the Earth's resources were finite when so few people lived on the Earth and their standards of living were insignificant compared with today's.

Nevertheless, the desire to think with certainty for the ancient Greeks led to the creation of a cultural metanarrative that later developed into the sciences. In particular, Aristotle privileged rationalizing a world "out there"; he privileged the construction of cultural metanarratives that inadvertently disguised the Earth's uncertain natural history (Barnes 1982). These things were thought to make the Earth more predictable, precise, and certain. Adversely, the process of rationalizing the Earth's history is the very contemplation trap that is inclined to be absolutely certain in the face of the ecological unknown. Perhaps this contemplation trap is the imperative to protect anthropocentric tendencies. The cultural residue of the ancient Greek metanarrative of thinking the Earth in certainty still permeates today's environ/mental sciences.

Be Green! Like Everyone Else Eco/Environmentalism

The amplification of the environmentalist movement in society has led to other major problems. What color is eco/environmentalism? The antibiotic for ecoenvironmental disease is environdemocracy. But, how do we democratize ecoenvironmentalism when it is seldom assumed to be anything bad? Green is good! Corporations know it! Capitalism feeds on the manipulation of us; let us explain.

People take green products and services as inherently good if not taught to question them. There is a precedence of false advertising for corporations interested in manipulating what the general public implicitly takes for granted as good, right, just, beautiful, or strong within schools. As a green environ/mentalism has rapidly emerged within the past decade, youth are now more vulnerable than ever to manipulation by those who wish to take advantage of the color scheme. In the same ways that "pink" is being exploited with breast cancer and "red" is being exploited with the HIV/AIDS campaign and increasingly manipulated through false advertising, "green" is the new target scheme on the backs of children, walking about their school campuses. "Green is good," is a mentality inadvertently passed on during environmental education, recycling projects, stream restoration, place-based learning, and other environ/mentalist pursuits. The green environ/mentalist campaign has implicit messages embedded in recent films, such as the hit movie about vampires, *Twilight*, where a science teacher states the words, "green is good!" These implicit messages, which guide how children and adults frame their world around them, are not likely to be caught by the vast majority of film-goers deeply embedded within a green ecoenviron/mentalism.

Consider the ways in which people have surrendered to false advertisements more recently. Airborne, Powerade, Target, Nike, Proctor & Gamble, Dell, Johnson & Johnson, and Microsoft are the latest perpetrators according to Mike Schuster of the web site Minyanville (http://www.minyanville.com/slideshow/index.htm?preview=1&a=134). For example, consider how Target misappropriated the term "organic" with an advertisement to promote the soy milk brand Silk, which quietly removed organic for the "natural" category, which is open to pesticide and other toxic chemicals. Or Nike, which turned a "blind eye" on foreign sweatshop operations in inadequately regulated factories. Or notice a large billboard in Times Square, New York, spring 2009, where a green transparent and curvy image of a beautiful woman is camouflaged with a lush green forest, advertising Vodka as "green!"

Consider several more examples from the New York Times. One newspaper insert advertises the "go green" brand-wagon and vulnerability for youth. Two models wearing outerwear coats are pictured, standing in front of a snow-covered field, with some deciduous trees in a grayish background. The trees are straight and narrowly aligned, as if they are a wind break for a farmer's field. The "eco-brand" name is "Rainforest" outerwear (www.rainforest.com) and yet there is no rainforest pictured, and this company does nothing to contribute to the ecological well-being of rainforests. So why use a label? A brief overview of the web site shows very little information on the company. There is a description about Rainforest®: "since 1986

Rainforest has been a leader in outerwear offering innovative technology including expertise in down, *eco-conscious* insulation, and the highest standard of quality" (n.p., emphasis added). Further review of the web site does not demonstrate anywhere on the site why Rainforest brand should be considered "eco-conscious." There are very few justifications, and in fact, a stronger case could be made that Rainforest implicitly uses eco-mentalism or the idea that people will buy the product and buy into "ecological consciousness," without much ecological thought at all. Rainforest products do not contribute to the restoration of the rainforest (or rainforest well-being) and we doubt individuals would need rainforest outerwear clothing to visit Costa Rica, Belize, Brazil, or other places where tropical rainforests are geographically emphasized. No doubt, there are cool seasons in these rainforests (and other types of rainforests). Yet so often the case is that students learn about rainforests as something similar to a textbook image where they remain out-of-view, and this assumption is now being exploited to filter affluent consumers; especially those who do not question the eco-mentality they learned in schools or society.

Next, we have a "Rodney Strong" 2006 Reserve Cabernet Sauvignon from Sonoma Valley, Sonoma County, where one can find some of the largest US vineyards. The heading on this advertisement reads, "Place Matters." It is a photo of a wine bottle in the foreground and Alexander Valley (Sonoma County), California, vineyards in the background. The ecomentality is that if "place matters" to a company, then people can buy it reassured that the geographical or physical environment is being taken care of. In other words, we can feel good about our purchase of wine. Again, false advertising lures consumers into the snarls of eco-mentalism. Considering North American pollinator declines (National Research Council 2007), this "place matters" mentality is particularly problematic. Consequently, entomologists have documented the conversion of oak woodland to vineyard, which is especially problematic for bees, because bees do not pollinate grapes (see for example, Gretchen LeBuhn, http://online.sfsu.edu/~lebuhn/). Bees are losing their nesting habitats and food resources. Non-vineyard areas are now landscaped heavily because Napa Valley is prime real estate for wealthy Californians. These landscapes are inhospitable to bees for habitat and food resources. Although Rodney Strong Vineyards (www.rodneystrong.com) is making progress toward more conscious ways of farming, and reducing their carbon footprint or impact, they say very little about the impact of vineyards on the degradation of bee pollinators. In other words, while Rodney Strong is taking measures to be carbon-neutral, produce energy through solar options, reduce their impact on local fish populations, and endorse a more "sustainable" method of farming, they conveniently de-emphasize pollinator declines. Taking strides to become more ecologically sensitive is a move in the right direction, but should not be used as an advertising gimmick as there are other negative impacts of wine (e.g., irrigation and fungicide practices, to name a few).

Other advertisers banking on taking consumers for an "eco/environ/mentalist ride" include companies who contribute a very small portion of their profits to fight HIV/AIDS, tuberculosis, malaria, pediatric cancer, and support pediatric hospitals, fair-trade, artisans in economically marginalized nations, or other selected charities, all under the auspices of eco-mentalism. R.J. Reynolds Tobacco Company uses the well-known "Camel" to sell its cigarette brand. Many companies deploy this sensational appeal to obtain funding – even the World Wildlife Fund! (Click http://www.worldwildlifefund.org/ogc/ to adopt a charismatic "Coca-Cola Polar Bear"). While it might be argued that animals serve an important artistic function in plays or Broadway performances, or anthropomorphized dances, which are products in one sense and expressions of human imagination in another sense, they are not intended as a way to manipulate buyers per se. During breast cancer month (October), many advertisers use the color pink to manipulate sensitive consumers when very little, if any, of their profits will be given to fight breast cancer. For example, many companies throw a pink ribbon on their advertisements to show support but also to attract valuable attention to their products, which do not always generate cancer research. Starbucks uses the RED label (AIDS research) to "go green with red" giving a small fraction of their profits to support the Global Fund (http://www.theglobalfund.org/en/) while downplaying the historical consequences of coffee production on the world's rainforests and vast biodiversity. The list goes on and on. Another example is cotton, which is advertised as the "fabric of our lives" and usually marketed in a way that emphasizes environmentalism. Check your "Do You Know Green" knowledge at TheFabricOfOurLives.com web by taking a fun ecomentality quiz (http://www.mysteryfabric.com/MysteryFabric/?section=gre). Question three is particularly interesting in that it claims organic cotton is not the only eco/environmentally friendly cotton, using the logic that "all cotton comes from a plant – so it is renewable and natural, organic or not." Perhaps eco/environmentalism ought to be indigo, cobalt, navy, or sapphire blue? A color dejected!

Cultural Studies, Eco/Environmentalism, and Academic Careers

Before we move on to discuss environmentalism as an ethical and moral imperative for activism, we want to point out more of the critiques that are plausible to surface for eco/environmentalists. Scholars in academic careers are particularly vulnerable in that to obtain tenure and promotion at a university or college there are certain expectations that will be considered compromising ideas. For example, the notion "publish or perish" has deeply seated ramifications for culturalists and environmentalists, because academic articles are typically printed in higher-priced journals and books, which are not accessible for people who cannot afford them, or who have limited access. One example is a scholar the first author has worked with from Ghana. This scholar notes the difficulty of keeping up with euro-western academics, because of her limited access to journals. "Open Access" programs typically cost more than US$3,000 to publish articles on-line. Very few professors (let alone new or assistant professors) can afford to make articles accessible, unless they publish their work in on-line "free" journals, or run the risk of copyright infringement. The problem with "free" journals is that they are not generally valued or embraced in terms of what it takes to obtain university promotion and tenure. There is a significant trade-off when considering whether one should publish articles on-line or the lowly compromising of our "soul." Then there is Chet Bowers who courageously publishes his work for free on his web site without the refereed practice of publishing companies (Mueller 2008). Some scholars will argue that this process is not legitimate and avoids the rigor of academic scholarship. Bowers considers his work to be part of a digital commons which provides more access for academics and others, similar to the commons which was described in George Glasson's ecojustice chapter on Malawi. Glasson advocates his efforts on an accessible web site (http://www.mmp.soe.vt.edu/index.html), similar to so many of us who use the Internet to disseminate ideas. But to what avail these ideas? Publishing articles and books on-line for free and publishing a web site take many hours and yet they may not be rewarded in the ways in which higher-status publications are rewarded. Have academics only perpetuated the problem with higher-status works?

Additionally, there are conferences which cost upward of US$1,000 or more to attend, unless they are regional or local state conferences (which again hold a lower prestige for tenure). When there could be Internet options for telecommuting or for digital presentations, there aren't. However, when these options are available, they privilege individuals or communities with Internet access. Likewise, professional conferences are often held at grandiose hotels with no expenses barred, plastic dinner plates and utensils, and menus which offer foods that have been through many hands. As the meats and seafood do not come with labels to tell if they have been treated in a humane way, or whether they have been factory-farmed, ocean-farmed, or shipped hundreds of miles, we have to assume they are foods obtained at the lowest cost to the hotel for the most profit in sales. We have rarely, if ever, heard anyone who designs the infrastructure of the conference complain. But lest you think we are picking on conferences, this scenario, with few exceptions, unfolds when we eat at most restaurants, fast food establishments, or even at our university cafeterias. These practices beg the following set of questions: Why are environmentalists traveling to these expensive conferences? Why haven't the impacts of these conferences been questioned? What do justice advocates endorse when their names continue to appear in conference brochures? What practices do hotels engage in that are forms of environmentalism? Why do environmentalists rarely say anything about the influences of and impacts of food items? Often these environmental issues are too difficult for cultural studies and environmental scholars to reconcile with, and so they get de-emphasized or ignored at conferences such as the North American Association for Environmental Education (NAAEE, with minor exceptions), the American Educational Studies Association (AESA), the National Science Teachers Association (NSTA, largest association for science teachers in the USA) and more notoriously at the American Educational Research Association (AERA) and the National Association of Research in Science Teaching (NARST), to name a few of the incessant and uninterrupted architects of eco-mentalism.

Is Eco/Environ/Mentalism So Bad?

On the other hand, if we can learn to live with absurdity, irrationality, irony, and contradiction, there may be more to be gained than lost. If we learn to live with critique and scrutiny, what then? First, can we acknowledge that we are indeed absurd, irrational and contradictory idealists! The meaningful purpose of being a "cultural studies scholar" or "environmentalist" is to coffer the invisible into being, that is, create a presence for something invisible – make it more able to be seen. If we see something that others cannot see – this is what makes us ecosocioculturally here. "Absurd," they might say, but we listen and acknowledge their view, and then discuss purposeful *visibility*. We may say things they do not want to know. We plant seeds of change when opportunity avails. We plant seeds together. There may be nihilists, and more doubt than we care to adhere to. But we push rocks uphill daily. We cannot quit, because quitting is for those who cannot fathom cultural and environ/mentalism. By becoming more aware of its presence and recognizing more fully a few green vulnerabilities, what contrasts our positions, will either strengthen or reaffirm, or change us in a democratic way. We might challenge ourselves to think about ethics and ecomoralist poetics for cultural studies and environmentalism, and organize ourselves around the ethics and morals that drive our thoughts, theory, and practice.

Hope, Peace, Love, and Passion

New directions for educational research are embraced and valued by the ontological categories of hope, peace, love, and passion throughout this book. When we fail to recognize an absurdity in cultural studies and environmentalism, we open ourselves to the vulnerabilities of the notion. We further marginalize our efforts. We succumb to the pressures of those who want to fail us. We do not achieve hope, peace, love, and passion in science education and other fields this way.

By acknowledging that we are absurd and irrational, we relegate the "dictatorship logic" from having its way with cultural studies and eco/environ/mentalism. Rather we emphasize the ethics and moral obligations of people who hope for ecological peace and a future for different species. We invoke love and passion in acknowledging the publishers who will give us a fighting chance, who have the abilities to enable our movement for hope and peace for every species and habitat. We travel long distances to embrace the face-to-face interactions we value with colleagues from other institutions. In the process we are enriched as they share their own experiences with ethics and morals embedded in cultural studies and environmentalism: hope, peace, love, and passion. One might argue that this book represents a contradiction of sorts for cultural studies and the eco/environ/mentalism described by educators throughout this book. This argument begins with logic and ends with ethics, however. Passionate publishers and academics will come together despite the odds, with a confluence involving ecojustice, place-based efforts, and native knowledge systems, and the hope and peace, in conversing, about things that are greater than any one of us as individuals. This condition for hope, peace, love, and passion, is the "spark" for ecodemocracy and schooling.

Charity, Empathy, Generosity, and Humility

The absurdity implicit in cultural studies and environmentalism intensifies the need for charity, empathy, generosity, and humility in the search for pluralistic truths within ecojustice. When we can set aside our pursuits and listen to the narratives of others, grant them our respect, and say something with them, we begin to know what charity is about. Throughout this book, we have encouraged the educators responding to each other to respond in a way that will help and not hurt, to amend and extend ideas, in a way that is fruitful for science education and elsewhere. The purpose is to stir up a passion for the principle of charity as part of what it means to engage in cultural studies and environmentalism. That is, recognizing that we have common grounds in which to ponder our common interests that requires relationships around mentorship and charity. Being generous is a worthwhile pursuit for those who believe in the confluence of ecojustice, place-based (science) education, and indigenous knowledge systems. We can feed off each other. In confluence, we are more evocative than by ourselves. Together, we are much more passionate. Of course, humility is grace we provide each other as we lift up our common pursuit in the truth (the antonym of democracy is autocracy or one's pursuit of truth in justice, place, and wisdom). Ecodemocracy ought not be autocratic. Humility is a condition of democracy when we share pursuits, conversation, and limit freedoms in a way such that we do not severely limit others'/species'. Freedom gained is freedom lost somewhere. Humility is at the heart of our efforts to move forward with conversation around ecojustice, places, and truths in place. Rather than sympathy, let us move ahead with empathy for each other and for other Earth species (and in this manner, we benefit ourselves and those who we care for us, past, present, and future).

Coda

Phew! What a project of confluence! Let us move forward with conversations of how to further analyze what is fair and just for the needs of protecting diverse cultural systems and natural geography. Analyzing cultural assumptions and the ways in which worldviews play a role in how we frame the world will cultivate perpetual notions about how we treat other humans and the Earth. This is a first step toward enriching science education. Concordantly, we might examine how schooling plays a big role in what is endorsed. To do this, we need to highlight how experiences or place activities have associated impacts for people, animals, plants and geography. Schooling is a very small part of the larger educational realm of neighborhoods, communities, and rural/urban/suburban landscapes. Once recognized, the larger educational domain will have its way. Finally, let us aim for more sustainable ethical theories that drive aspirations to engage in cultural studies and environmentalism, and develop a love for lifelong learning and commitment to the planet.

Notes

For this chapter, *mentalism* is defined as the theoretical doctrine where sources of knowledge cannot be explained by physical laws, and/or do not have existence outside of the human mind.

References

Abram, D. (1996). *The spell of the sensuous: Perception and language in a more-than-human world*. New York: Vintage Books.

Barnes, J. (1982). *Aristotle*. Oxford/New York: Oxford University Press.

Bowers, C. A. (2001). *Educating for eco-justice and community*. Athens: University of Georgia Press.

Bowler, P. J. (1992). *The Norton history of the environmental sciences*. New York/London: W.W. Norton.

Carson, R. (1962/1994). *Silent spring.* Boston/New York: Houghton Mifflin.

Dewey, J. (1916/1966). *Democracy and education*. New York: Macmillan.

Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. New York: Penguin Books.

International Panel on Climate Change (IPCC). (2001). *Climate change 2001: The scientific basis. Contribution of working group I to the third assessment report of the International Panel on Climate Change*. UK/New York: Cambridge University Press.

James, W. (1901). *Talks to teachers on psychology and to student's on some of life's ideals*. New York: Henry Holt.

Leopold, A. (1949/1968). *A sand county almanac.* London/Oxford/New York: Oxford University Press.

Lovelock, J. E. (1979/1987). *Gaia: A new look at life on Earth.* Oxford/New York: Oxford University Press.

Margulis, L., & Sagan, D. (1995). *What is life?* London: Weidenfeld & Nicolson.

Morrison, R. (1999). *The spirit in the gene: Humanity's proud illusion and the laws of nature*. Ithaca/London: Cornell University Press.

Mueller, M. P. (2008). Ecojustice as ecological literacy is much more than being "green!". *Educational Studies, 44*, 155–166.

Mueller, M. P. (2009). Educational reflections on the "ecological crisis": Ecojustice, environmentalism, and sustainability. *Science & Education, 18*, 1031–1056.

National Research Council. (2007). *Status of pollinators in North America*. Washington, DC: National Academy Press.

Shiva, V. (2005). *Earth democracy: Justice, sustainability, and peace*. Cambridge: South End Press.

Wilson, E. O. (2002). *The future of life*. New York: Vintage Books.

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