Chapter 4
Provoking EcoJustice—Taking Citizen Science and Youth Activism Beyond the School Curriculum

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In this three-part chapter, the authors draw on their own educational experiences to exemplify how ecojustice, citizen science, and youth activism come together to be enacted in three different (but interconnected) settings: a youth expedition to the Arctic (Part I), a class of elementary student teachers working on a media project in collaboration with a local aboriginal community (Part II), and a lesson on the social aspects of "genetic disorders" with a class of high school biology student teachers (Part III). Adopting a broader definition of education (in opposition to schooling) across all sections, we seek to illustrate ways in which teachers, students, and community members can collaboratively expand the implications of science education for promoting a society that is more socio-environmentally sound.

Amongst the many interrelated components of ecojustice philosophy, there is the recognition that its pedagogy is centered on understanding relationships within society at large and within the natural environment (Bowers 2002). In other words, our connections with other-than-human systems and also with one another are essentially the same: one does not exist without the other—this is the "web of life" (Capra 1996). That is, our very survival as a species depends not only on the health of the natural environment around us, but also on the strength of our society while diverse and democratic. Ultimately, the "destructive relationships and practices" that afflict our communities are a threat to our existence as much as any other

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ecological problems of our time. More so: it can be said that the contemporary ecological crisis is both socially constructed and culturally sustained. For example, from a social inclusion theory standpoint, the (social) prejudice and discrimination that are directed toward individuals whose mental or physical capabilities are unlike those of most of us can be very destructive to one's health (Ontario Prevention Clearinghouse 2006)—just as any other current environmental issue, like climate change for instance. However exaggerated this assertion might look at first, it merely suggests that our society has been the major source of its own maladies. Climate change is known to have been displacing people around the globe to the point where now we have permanently incorporated the term climate refugee to our everyday lexicon (Bettini 2013; Scheffran et al. 2012). At the same time, climate-induced migration is a survival strategy, meaning that many do not endure long enough to make the journey or succumb to the attempt of it. Likewise, prejudice and discrimination (unfortunately already also part of our lexicon) are notoriously linked to some of humanity's darkest moments. This is the case with respect to the profound effect that eugenics exercised in the international medical and social spheres—for example, Europe, North America and Africa—drove the development of reforms in the area of mental health as well as education and social development in the last century (Ure 2009). Similarly, on a smaller scale, there is the public physical violence suffered by African-Americans and homosexuals in certain cities in Brazil. Ultimately, these examples—and there are many others—speak to the fatality of our inadequacy to care for individuals of our own species. Whether it is climate change or prejudice and discrimination, the fact is that these ecological tribulations weaken us socially and wound us psychologically. Subsequently, they pose a danger to our presence on this planet and require actions aimed to minimize their effects—and (public) education (as opposed to schooling) seems to be one of the right places to implement these changes.

Part I: Building Youth 'Change Agents' on an Expedition in the Arctic: Rethinking Science, Environmental, and Civics Education (Lisa Glithero)

How can we collectively develop in today's youth the knowledge, skills, and capacities needed to be ecologically and socially responsible community builders? What kinds of learning experiences (might) build student capabilities for deep public participation contributing to environmental and social change? These questions serve as my philosophical and pedagogical guide for developing educational programs aimed at youth environmental action. This section of the chapter looks at the learning framework, experience, and impact of the Students on Ice (SOI) program through my lens as the former education director (2004–2008), as well as from the perspective of five student alumni. Since 1999, SOI has taken over 2,500 high school and university-aged students from around the world on learning expeditions to the Polar Regions. This section seeks to examine the following two questions:

(a) How does the co-participatory and intergenerational sharing approach used in SOI's learning framework evoke a type of citizen science that contributes to youth actively engaging in public environmental action on a local and global scale? And, (b) How does this type of expeditionary and place-based learning promote a mode of ecojustice pedagogy through participants' direct experiences with the "knowledges of different cultures and cultural relationships to place" (McKenzie 2008, p. 366)? To begin with however, I offer a brief discussion on recent trends in the environmental education (hereafter EE) literature, as well as a general overview of an ecopedagogy philosophy, in the hopes of giving some theoretical context to the possibilities and limitations of the SOI experience and similar programs.

EE has traditionally been situated within a unit of the science curriculum. In turn, the environment has often been subjugated in science-based learning. Furthermore, EE practice has long focused predominantly on individual change, particularly attitudinal and behavioral change specific to environmental issues (Kool 2012). By building knowledge and pro-environmental attitudes, educators committed to environmental learning have looked to environmental literacy and positive nature-based experiences for developing ecologically responsible citizens and stewards (Hungerford 2010; Marcinkowski 2010). However more recently, environmental educators and researchers advocate a need to move beyond a central focus on individual attitudinal and behavioral changes towards collectively building a better understanding of environmental learning processes aimed at socio-ecological change (Orr 2004). To achieve deep community transformation, one emerging trend is the development of 'environmental action' or 'action competence' in youth as a critical objective of environmental learning (Schusler and Krasny 2010). As more EE research explores the learning process of developing capabilities in youth to participate in environmental action in the public sphere (Almers 2013; Arnold et al. 2009), so too are related discussions on the growing relationship between environmental, science, and civics education. These exciting discussions speak directly to the emerging trend of environmental and scientific-based learning aimed at active democratic citizenship (Gough and Scott 2007; Wals and Jickling 2009). Central to these discussions is ecojustice.

Rooted in relationships, ecojustice philosophy serves as an important theoretical bridge to environmental and science education. In perceiving these two fields as mutually symbiotic, the environment no longer becomes subjugated. Each field is dependent and informs the other.

A pioneer of the social justice-education movement was renowned Brazilian educator Paulo Freire. At the time of his death in 1997, Freire was working towards developing an 'ecopedagogy'; a now well developed ecologically-oriented practice taken up internationally by scholars including Gadotti (2004), Kahn (2008), and supporters of the Earth Charter Initiative (see, www.earthcharterinaction.org). Ecopedagogy embodies a relationship-oriented, ecologically conceptual framework that advocates for a broader planetary worldview. It adds an ecological lens to Freire's critical pedagogy's focus on social justice (considered, anthropocentric). In other words, it extends values of justice to include the environment and 'environmental racism' (Bowers 2002). Ecopedagogy, situated within broader

ecojustice theory, offers a valuable pedagogical lens that helps to ground epistemological elements of ecological thinking in meaningful praxis. For Bowers (2009), the deconstruction of a perceived knowledge hierarchy that places "scientific/technological/ industrial" theories of knowing above diverse cultural knowledge and multiple ways of relating to the natural world represents one of ecojustice philosophy's main objectives (p. 199). Through ecojustice education, he asserts that students must be exposed to ecologically sustainable practices of diverse cultures and prioritizes their participation in "non-commodified aspects of community life" (2002, p. 21). Further strategies for implementing ecojustice pedagogy include: "learning principles of ecological design;" regenerating "non-commoditized skills, knowledge, and relationships [of self-reliance];" and "democratizing technology and science" (Bowers 2002, pp. 30–32). Ecojustice education also calls for time spent in "out-of-classroom spaces and places; experiencing the knowledges of different cultures and cultural relationships to place; gaining a diversity of natural history knowledge; and developing community relationships and actions" (McKenzie 2008, p. 366). It is this latter point that most resonates with the Students on Ice (SOI) program and student experience.

Students on Ice as an Experiential Learning Framework

The mandate of the SOI program is to provide participants—students, educators, and scientists—with inspiring educational opportunities at the Earth's Polar Regions. In doing so, the aim is four-fold: (a) to connect participants to the natural world; (b) to foster new understanding and respect for the planet; (c) to explore solutions to our most pressing challenges; and finally, (d) to inspire each other to take positive action. This educational approach draws on elements of experiential, expeditionary, inquiry-based, and place-based learning. In some of the most awe-inspiring ecosystems in the world, students, along side a team of international educators, polar scientists, and social change-oriented leaders, examine the natural sciences of both the local and global ecosystems, including the cultural and natural aspects of these places. Topics such as glaciology, oceanography, climate change, and Inuit history are explored through various learning formats including: lectures, workshops, and hands-on activities that are field, zodiac, or ship-based settings. Immersed in these places and experiences, students are able to situate what they learn in a very personal way. As a result, science and environmental learning—that is often abstract and/or highly complex when taught in a classroom and from a textbook—becomes much more accessible, palpable, and critically relevant to students. They are able to take this 'personal knowledge' and transfer and apply it to their everyday lives in their respective home communities, despite the geographical, sociocultural, and socioeconomic diversity.

As the 2-week expedition progresses, the ideas of uncertainty and difference emerge with a 'floating family', where friendships and connections bridge generations and diverse cultural and socioeconomic backgrounds. Curiosity and

excitement guide learning and paths of inquiry. Hikes across Arctic landscapes, visits to Inuit communities, and intimate moments shared with wildlife all serve to add authentic context to two central programming foci—citizen science and youth activism. Through both 'pod teams' (small collaborative learning groups) and the learning community as a whole, many socioecological issues facing the Arctic, as well as the participants' home communities and the global community at large, are explored. One aspect of this process involves students working as co-participants with mentoring scientists in conducting evidence-based field research. For example, students conduct plankton tows focusing on marine diversity; examine new arctic plant specimens due to changing ecosystems; take ice core samples to measure various pollutants levels; conduct bird surveys; or take whale biopsies to be catalogued for migratory studies. Through these intimate opportunities to learn methods of scientific inquiry, develop preliminary research practices, and enhance scientific literacy skills, students become empowered in the process to consider pursuing science-based careers and/or to engage more readily in types of citizen science or environmental action initiatives in the public sphere post-expedition.

Another aspect of the learning experience involves students exploring ideas around how to create change, the process of community change, and what kind of changes matter most to them as youth and in their respective bioregions. Various action agendas, youth forums, and initiatives emerge by the end of an SOI expedition including: youth statements presented at international conferences; establishment of youth-activism based organizations; and conceptual frameworks for documentaries or social media-related campaigns and project initiatives. In having gained a deeper understanding of the interconnectedness and complexity of current environmental and sociocultural challenges, many students following an SOI expedition go on to demonstrate the range of youth activism possibilities aimed at societal change. Examples of youth activism initiatives carried out by a small sample of SOI participants are listed in Table 4.1 at the end of this section. These examples, generated by five self-selected program alumni, speak to the impact of the SOI program in contributing to young people's capabilities to participate in community and societal transformation.

Although supportive of the importance and pervasiveness of science in our everyday lives, the program faculty of SOI have learned firsthand over the past decade that building scientific knowledge, skills, and literacy is not enough in the pursuit of creating a more sustainable and just society. There is now the need and opportunity to foster in students the motivation and capacity to utilize their scientific and broader understandings to enact deep systemic change. For example, teaching global climate change in the context of the SOI program is not simply about building student knowledge on the science around increased atmospheric levels of greenhouse gases or related issues, such as the acidification of today's oceans. Rather, it is about knowing, doing, and looking beyond the traditional disciplinary science content to examine with students the root causes of any given environmental issue and to explore on an individual and collective level how we are connected to the issue—thus, making it personal, shared, local, and critically relevant. Furthermore, provoked by an experience that *personalizes* knowledge gained, students are, as stated by one, "more inspired to act."

Table 4.1 Example of youth who are leading the way in recent environmental action

Name (Nationality, Year of Expedition)	Citizen science	Youth activism
Cassandra Elphinstone (Canada, 2010)	Locally, Cassandra works on a salmon habitat enhancement project. Internationally, she served as a member of the SOI Youth Rio+20 Earth Summit in 2012 and introduced the idea of a modified Environmental Currency Transaction Tax (ECTT) as a reward mechanism to aid states that act as environmental stewards.	Cassandra founded GAIAactivism, a network of student leaders from Europe, Asia, North America, and most recently Africa. GAIAactivism coordinated an environmental Global Day of Gathering in 2012.
Andrew Wong (Canada, 2010)	Andrew has a Geography and Biology double major from the University of Waterloo and believes in non-profit organizations. He is an Editorial Intern with *Alternatives Journal*, which communicates environmental issues to the Canadian public. Andrew also worked at Earth Day Canada on corporate conservation practices. He volunteers as Environment Chair of the Waterloo Students Planning Advisory, examining local environmental planning issues.	Andrew founded and led a delegation team of 14 SOI alumni youth to Rio de Janeiro, Brazil for the Rio+20 Earth Summit in June 2012. Summit themes included examining an institutional framework for sustainable development and operationalizing a 'green economy.' The delegation was the only youth-based organization present advocating for polar sustainability.
Jenna Gal (Canada, 2009)	Jenna is currently studying Environmental Science at UBC Okanagan where she is working on a research project aimed at understanding the impacts of land use changes on the Similkameen River watershed. She volunteers for other local watershed conservation groups and interns for the Yukon Climate Change Secretariat in public education outreach initiatives.	Jenna volunteers with school groups on environmental education, a priority she feels in empowering today's youth. She currently serves as Chair of the Environment and Sustainability Society at UBC Okanagan, Chair of the Central Okanagan Foundation for Youth, and works as a youth volunteer with the BC Sustainable Energy Association.
Sun Ye (China, 2007)	While on expedition, Sun Ye discussed wanting to write a book for Chinese youth on climate change upon returning to Shanghai. Fourteen months later, a beautiful professionally published 84-page book arrived in the mail to the SOI office.	The book is being distributed to thousands of youth across China and Sun Ye continues to write, study, and advocate for climate change action.

(continued)

Table 4.1 (continued)

Name (Nationality, Year of Expedition)	Citizen science	Youth activism
Irene Shivaei (Iran, 2007)	After returning to Tehran, Irene began writing weekly columns about climate change in the national newspaper, JameJam Daily, and writes an environmental page monthly in an Iranian student magazine aimed at pre-teen readers. She also started a radio program about science and environmental issues while studying physics at the University of Tehran.	Irene played a leading role in developing the StarPeace Program launched in 2009. It is an official International Astronomy Year project aimed at bringing together people from nations with shared borders—often conflict-torn—to the actual border lines of their respective countries for public events to observe and learn about the stars, with hopes of fostering peace.

Through critical reflection on the 12-year practice of SOI, we recognized the need to broaden the scope of the program beyond science and environmental education. The foci of the education program has grown over time to include, for example, culture, politics, art and music, history, and socioeconomic fields of study. Naturally, these subjects are interconnected and we have woven them together using an inter—and trans—disciplinary approach. This broadening of programming foci, in turn, strengthens the students' science and environmental understandings, as well as serving to better inform their subsequent actions. More importantly, this 'beyond science and environment' approach has also served to engage youth participants who might not have a pure science or environmental interest or who might perceive these fields and related modes of learning as intimidating. The Inuit and First Nation youth participants, in general, are a great example. Analyses of the SOI student experience over the years has shown that for Inuit and First Nation youth, it has been the art, music, storytelling, and traditional knowledge learning circles, that provokes their connection to, and engagement in, the science and environmental issues being explored on expedition. I would suggest this is largely because 'the science' (western scientific knowledge) has/does not take into account indigenous ways of knowing about the natural world that are indeed scientific. An ecojustice pedagogy, one that bridges western scientific knowledge with traditional ecological knowledge (TEK) through critical and relational discourse, coupled with an interdisciplinary approach to learning, helps us move beyond the binary and disconnect. In turn, student engagement and student 'success' are positively impacted for *all* students.

In providing students with unique educational experiences where polar landscapes and Arctic communities become the classroom, different knowledge perspectives and cultural relationships to the polar and global ecosystems are explored. In turn, this learning experience and approach directly challenges the ways in which students perceive the world. Central to this approach are five key themes to the SOI philosophy, emergent over the past decade, that are worthy of highlighting: (a) sustainability is an imperative that should inform our decisions. By making sustainable choices and taking action, we can arrive at the best possible outcomes for the planet,

humans and other living things, now and in the future; (b) change is happening rapidly in the polar regions, places of special importance to the planet. While global climate has changed over millennia, it is the rate of modern climate change that is alarming. Global climate change is happening in the context of complex cultural, governance, economic, and ecological changes. Peoples' capacity to choose, mitigate, and adapt to particular changes will inform our future collective well being; (c) creativity and innovation means thinking about new ideas and doing things differently. They are important across all sectors of society including the arts, sciences and the transition to new 'green' economies; (d) indigenous ways of knowing remain profound and relevant. Despite modern influences and conveniences, indigenous peoples in the Arctic (and elsewhere) have retained their languages, core knowledge, and beliefs. Indigenous knowledge contributes to the advancement of a sustainable Arctic and a sustainable planet; and finally, (e) youth have a key role to play in shaping the world of today and of tomorrow. Energy, idealism and innovation are the currency of youth. We need young people actively engaged as participants in different community leadership and decision-making roles where their fresh conceptions and energy can help drive positive change—what we might then call the youth effect.

If we were to look at the above five themes—i.e. sustainability; change; creativity and innovation; indigenous ways of knowing; and the youth effect—to help inform pedagogical praxis around education framed by ecojustice philosophy, how might we as educators around the world begin to engage youth in the building of a more sustainable and just society? These themes, it seems, bring together EE and science education in a way that does not subjugate one or the other, but rather works to inextricably connect what both disciplines embrace more fully (see also the forum carried in the following three papers: van Eijck and Roth 2007; Mueller and Tippins 2010; Reis and Ng-A-Fook 2010). Might this renewed interpretation—one that advocates for and supports citizen science and youth activism—serve to expand the implications and reach of science and environmental education for promoting a society aimed at socioecological well-being?

Part II: Developing Collaborative Social Action Curriculum Projects: Media Studies, Science Education and Ecojustice Activism [Nicholas Ng-A-Fook]

This section of the chapter looks at how teacher education students can utilize media studies as an approach to integrate ecojustice activism within their curriculum designs of the Ontario science curriculum. It reports on a case study where pre-service teachers from the University of Ottawa work with a First Nations community to create public service announcements that take up ecojustice issues that are important to elders, teachers, and local students. Moreover, this section addresses the following two questions: (a) How can media studies help future teachers and students to become critical consumers and producers of the scientific literacies; and (b) How might non-Indigenous researchers and teacher candidates collaborate with

First Nation teachers and students to promote a type of ecojustice activism that challenges the current colonial frontier logics embedded explicitly and/or implicitly within the Ontario science curriculum. Consequently in this section of the chapter, I discuss how global cohort students were afforded opportunities to work collaboratively with the Kitigan Zibi (an Algonquin First Nation community) to develop cross-cultural social action curriculum projects within the contexts of science education. To do so, I share some student narratives that illustrate the possibilities and limitations of their lived experiences while enacting their different social action curriculum projects (SACP) in relation to media studies, science education, and ecojustice activism.

In 2008, our Faculty of Education created its first global education cohort as part of our larger Developing A Global Perspective for Educators (DGPE) program (www.developingaglobalperspective.ca). The primary goal of this unique program is to establish collaborative partnerships with local schools, community leaders, and NGOs in order to re-imagine and re-articulate familiar curriculum concepts across different subject areas such as—but not limited to—science education. Moreover, the DGPE program seeks to develop critically reflective teaching professionals who personify an ethic of caring, knowledge of, and commitment to, their eco-civic responsibilities through public education (Ng-A-Fook 2010). In turn, students are invited to understand, among other things, how they can imagine curriculum development in relation to international cooperative development, social justice, peace education, and environmental sustainability. To do so, teacher candidates learn to design and implement different SACP over the course of the academic year.

Although not a novel concept, SACP are reermerging as a conceptual framework for conducting action research in subject areas like science education. The *Project Method* itself, is more than 100 years old. During the turn of the last century, progressive educational researchers like John Dewey and William Heard Kilpatrick designed and implemented some of the first action research projects within the broader field of education at the Chicago Lab School and within Teachers College at Columbia University (Kilpatrick 1918). Today a SACP still affords educational researchers, teacher candidates, teachers, students and their communities opportunities to identify relevant and pressing issues, work through possible solutions, and engage in contingent action planning to address social inequities (Schultz and Baricovich 2010). Much like the tenets of participatory action research, it requires that each participant put the practices, ideas, and assumptions about institutions to the test, while questioning and making critical analysis of their own experiences as a political process (Macdonald 2012, p. 39). SACP enables researchers, teachers and students with educational opportunities not only to learn more about the possibilities and limitations of their praxis, but also practice social justice-orientated modes of democratic citizenship (Westheimer 2005). And yet, what might these modes of citizenship mean for science education programs and/or for developing science curriculum with teacher candidates and First Nation communities? In response to this question, I share two short stories about how teacher candidates enrolled in our DGPE cohort work with Kitigan Zibi teachers and students on different SACP within the contexts of science education.

Over the course of the last 3 years, students enrolled in our program have volunteered to participate in a community service-learning placement—a key component of the overall DGPE initiative—that enabled them to travel and work with First Nation teachers at the school Kikinamadinan (which means "place of learning" in Algonquin). The school is located on the Kitigan Zibi reserve, which is 90 min north of the University of Ottawa in the province of Quebec. Although the school is funded by federal grants, the Band Council is responsible for administering the funding as well as developing the various programs for the school. On the other hand, the Kitigan Zibi community receives two-thirds of the funding children off reserve get through taxation to support their livelihoods as learners within public education. Consequently, they must work to develop innovative pedagogical and curricular strategies to provide the same services their students would receive at any other publically funded schools across Canada.

In 2010, a primary/junior cohort of students in our teacher education program made three field trips to work collaboratively with elders to develop lesson plans that sought to address different Algonquin traditional ecological knowledge and values across the Ontario curriculum as an approach for teaching ecojustice activism (Kulnieks et al. 2012; Martusewicz et al. 2011). In that context, one group of teacher candidates decided to examine what they (and Kitigan Zibi students) could learned from animal scat as a form of science literacy and as a language for rereading eco-literacies of place (Brody 2000). During that specific lesson plan, students were asked to examine fake animal scat in terms of size, shape, and contents to determine which animal it would have come from. They reproduced animal scat using oatmeal, water, and cocoa powder for their peers to identify based on an animal scat identification poster. They had opportunities to develop their traditional ecological knowledge as well as science literacy, Algonquin language, and understanding of the differences between herbivores, omnivores, and carnivores (including their diets and the flow of energy between them), aspects of digestion, and how human impact on the environment can affect an animal's eating habits. The teacher candidates learned how to live within the relational spaces of cross-cultural collaborations on a social action curriculum project to arrive at the final version of the lesson plan put forth.

During our first trip to the reserve, the Director of Education (Anita Tenasco) provided an orientation to the educational infrastructure of the community and some cultural background information about the students who attend both their elementary and secondary schools. The principal (Shirley Whiteduck) also spoke to the global cohort about the various school programs in place as well as the socioeconomic, cultural, and psychological dynamics of their students. During our second trip, elders advised student teachers about how they might further incorporate an Algonquin conceptual framework in terms of the cultural and narrative dynamics of their proposed teaching and learning activities. The collaborative work with elders also provided a unique learning opportunity about the historical narratives that remain at present absent from school textbooks. Together, elders and teacher candidates made the content of their lesson plans more culturally relevant for their student body (Kanu 2011). Moreover, we were asked to create lesson plans that

integrate emergent technologies like Smart Boards, writing and art activities, games and quizzes, and promote traditional ecological knowledge as science literacy.

As part of their SACP, I asked students to develop, what Aikenhead (2006) calls cross-cultural science curriculum while still addressing the overall expectations of the government curriculum policy documents. In other words, teacher candidates are invited to reconsider how they might teach scientific concepts taken up within the curriculum policy documents in relation to working with First Nation elders, teachers and students to develop science curriculum that they can teach at Kikinamadinan School. The underlying principles of locality and contextuality applied in the process can be also implemented in the development of teaching pedagogies at any other school across the province. In response to such curricular and pedagogical invitations, students in one group established the following question to frame their lesson plan for Grade 4 students: What is scat and what can it tell us? As a result, their lesson addresses the following two overall expectations from the Ontario science curriculum: (a) analyze the effects of human activities on habitats and communities; and, (b) demonstrate an understanding of habitats and communities and the relationships among the plants and animals that live in them (Ontario Ministry of Education 2007).

As their professor, I supplemented what they are learning from Kitigan Zibi elders, teachers, and students with various readings that examine the possibilities and challenges for non-indigenous teacher candidates to teach subject areas like science within First Nation, Métis, and/or Inuit communities across Canada. We studied the historical colonial politics of residential schooling as a conceptual framework to discuss the historical narratives put forth and/or absent within the Ontario curriculum (Battiste 1998; Kirkness 1998). Likewise, we examined the possibilities and limitations of nonindigenous teachers working with indigenous communities (Taylor 1995). At the end of the term, I then invited each teacher candidate to write a newsletter article about their lived experiences during the SACP. One student writes the following:

> This experience allowed me the chance to reflect, re-examine and question some of the existing pedagogical issues that I among other teachers will face in the classroom. I begin to question the traditional model of teaching, which assumes students are sitting receptacles of information rather than inquisitive explorers of their learning (Freire 1970/1990) … As I reflect on the stories told by the Elders during my visit to Kitigan Zibi, I contemplate if there is room for different types of knowledge within our curriculum. One that does not adhere to the banking model of education… I felt a sense of shift from my linear Eurocentric lesson delivery. I experienced an epiphany that would change the way I viewed myself as a teacher.

Overall, teacher candidates learned from First Nation teachers and students how to develop placed-based science curriculum that addresses the local contexts of their communities (Chambers 2006). More importantly, learning to teach within such cross-cultural hyphenated relational spaces provoked some teacher candidates to reconsider their subjectivities as future teachers and to decolonize their pedagogical approaches for teaching science curriculum. Such contextual reconsiderations enabled future teachers with opportunities to re-imagine how they can combine traditional and conventional modes of teaching science education as a form of critical ontology.

"An important dimension of critical ontology," as Kincheloe (2006) reminds us, "involves freeing ourselves from the machine metaphors of Cartesians" (p. 182). In order to expand the multiplicity of knowledges (multiple literacies) put forth in science education, we were able to incorporate some key concepts from Hampton's (1995/1999) conceptual framework for working with Aboriginal students into their curriculum designs: spirituality, service, diversity, culture, tradition, respect, history, relentlessness, vitality, conflict, place, and transformation (see also MacIvor 1995/1999). The broadening of what constitutes science literacy in Ontario classrooms, I would argue, is part of an ecojustice activism conceptual framework for teaching science education in twenty-first century.

In the second story, I would like to focus on a media studies social action curriculum project that we develop with elders and Grade 5 and 6 students. This time our teacher candidates had to develop two different SACPs: Hula-Hoop (Llyod 2012) and Public Service Announcements. Much like the year before, during the first trip teacher candidates were introduced to the community and tour the school. Then, teacher candidates and elders watched "The Invisible Nation" (Loumède et al. 2007), a documentary film that examines the historical and ongoing displacement of Algonquin communities due to European colonization. Prior to returning to the community for our second fieldtrip, teacher candidates organized themselves into small groups and tentatively developed an action plan that facilitated a 1-day program for Kitigan Zibi elementary students and elders to create and film student-driven public service announcements (PSAs). Teacher candidates provided support for students to write up the storyboards as well as with the filming and editing of the final products. Prior to beginning the second visit, an elder conducted the opening prayer and smudge ceremony in order to welcome us and bless our work. Once again, elders advised teacher candidates how they might further incorporate an Algonquin conceptual framework in terms of the cultural and narrative dynamics of their proposed PSAs.

Upon our return to the University of Ottawa, teacher candidates edited the filming to create 90 s PSAs, which we share with elders, teachers, parents, and students during our final fieldtrip. One of these PSAs was titled, Water is Life. It stressed the importance of understanding the impacts of the types of relationships that we as humans choose to foster with the different environments that we inhabit. In the final version of the PSA, an elder shared the following wisdom tradition story about water:

> I'm proud of it [my indigenous relation to this place]. When I was young, maybe 8 or 9 years old, my sister had two children. They were small and she was sick. She could not wash anything. She was too sick and she was running out of diapers. She asked me, "Would you go and wash the diapers? Rinse them, wash them." I said, "o.k." And I thought to myself, "I am going to do it the easy way." I took the diapers and took a pot, and went down the hill by the river. And, I started washing diapers and rinsing them off in the river. It was the easy way. Then I heard somebody on the hill, "What are you doing?" It was my mom. She said, "Oh no, you don't do that!" I realized this is the way…you have to keep the water clean. Life is water.

Throughout the PSA activity students shared some of the extrapolated lessons they learn from the elder's story in order to rethink our existing relationships with the environment—for example, current practices around production, consumption,

and waste management and the polluting affects they have on the water systems that give life to different ecosystems either here in Canada or abroad. The PSA ended by stating, "worldwide one billion people lack access to safe drinking water," followed by a Grade 5 student who points to the camera with his finger and says, "don't abuse water, or else I will come for you." The teacher candidates, elders and students created three other PSAs titled, Protecting Animals (Animal Rights), What will you Choose (Drug Prevention), and Dear Fellow Canadians (First Nation Youth Advocacy for Access to Equitable Education on Reserves). Although this SACP was quite different from the first year, teacher candidates still experienced several epiphanies. After the project was completed a teacher candidate shared the following testimonial:

> My colleagues and I had the opportunity to work with grades 5 and 6 First Nations students from students to create public service announcements (PSAs) that enabled Algonquin youth to voice their concerns about an issue that was important to them, exchange ideas with education students, and learn techniques to create effective PSAs. In turn, we would have an opportunity to get to know interests and concerns of First Nations youth, develop our teaching practices, run small group activities, integrate technology, and develop a connection with the community…The experience of this project allowed me to reaffirm my commitment to addressing issues of diversity and equity. However, it also developed my awareness of the importance of building bridges–partnerships that allow for better understanding within and between our communities, as well as building capacity for creating positive social change.

The PSAs provide an exemplary way to think about how teacher candidates can collaborate with elders to reconceptualize curriculum development that takes at its heart all the educational vision and mission of the Kitigan Zibi community—namely, the development of individual talents and abilities, provision of opportunities to develop the skills of effective communication, creation of relational spaces for different cultures, reaffirmation of diversity and equity, and understanding of their responsibilities and privileges as members of local families and global and communities (Kitigan Zibi 2012). Finally, creating PSAs provides a pedagogical space for students to express and enact their multiple literacies (cultural, media, digital, ecological, etc.) within the science classroom as a form of ecojustice activism.

Part III: Advancing Citizen Science and Youth Activism Through Ecojustice—The Story of Marianna [Giuliano Reis]

This section of the chapter focuses on science education as a point of entry for ecojustice in teacher education programs and high school curricula. Specifically, it draws on a lesson about the sociocultural aspects of Trisomy 21 (i.e., Down Syndrome [or DS]) with a class of high school biology student teachers. The activity originated from an uncomfortable classroom situation and as such it was designed to challenge inaccurate (simplistic) representations of the terms 'normal' and 'natural'. It aims to promote a more comprehensive and action-oriented conception of genetic disorders by situating them at the intersection of natural and sociocultural

systems. It also exemplifies how youth activism can be originated in schools to produce citizen scientists in our communities who are committed to disseminate and denounce the un-scientific basis of prejudice and discrimination. (That's right: citizenship science is not only about collecting and analyzing hard data about bird migratory routes or new plant species.) This framework for citizen science in science education is important for everyone (researchers, teachers, students, community leaders and parents) as it contributes to the realization that the overall physical and mental health of individuals in our society is the responsibility of all. This is but one ecojustice principle by which we would measure achievement [and sustainability by extension] more properly (Mueller and Tippins 2012).

The natural (biological) aspects of genetic disorders commonly make up small sections in high school biology textbooks. Consequently, their sociocultural implications—for example, prejudice and discrimination, social inclusion in school and the workforce, economic impact on health care system, effect on family structure, and so forth—are expected to consume little time of classroom instruction (and what a miss this is!) Alternatively, science education for ecojustice confronts teachers and students with the responsibility and opportunity to promote critical conversations to plan appropriate actions regarding the importance of respecting and caring for those of us carrying a genetic build that varies from what has been arbitrarily defined as 'normal.' As humans, our sense of 'normality' is always evolving. Concomitantly, we need to appreciate how language contributes to create and sustain a taken-for-granted description of reality that favours specific attitudes toward particular cultural norms of acceptance (Bowers 2001; Cox 2010; Wilson 2012).

> An eco-justice pedagogy places on understanding that language is not a conduit for communicating objective knowledge. Rather, language carries forward culturally specific ways of thinking—and the student is connected, often in unconscious ways, to this symbolic ecology (Bowers 2001, p. 414).

Otherwise, the politics of knowledge that shape and validate certain privileged narratives in school science will continue to ignore the voices of the already marginalized by ignorance, discrimination and prejudice. In exemplifying a strategy to minimize the costs of our actions to our social (and natural) surroundings, I seek to find out "whether or not science leads to reducing human (and nonhuman) suffering" (Stonebanks 2010, p. 374). I equally anticipate rekindling the discussion around the possible ways that science teachers can ethically approach the conflicts emerging from learning of the existing differences amongst living beings, especially humans. This is akin to the theoretical underpinnings of human ecology (Bates and Tucker 2010).

Brushing Up on Biology

A cell can be defined as the basic structural and functional unit of living things. In other words, all known living organisms, though markedly diverse when viewed from the outside, are essentially similar inside as all their cells share the same machinery for their most basic functions (Alberts et al. 2008). The latest count

suggests that there are about 8.7 million species on the planet (we are definitely not alone!) (Mora et al. 2011), and yet they reproduce themselves faithfully—or as faithfully as possible—according to information handed down by parent organisms that specify, in amazing detail, the characteristics that the progeny will inherent. As a result, individuals belonging to the same species see—more commonly than not—their numbers increase exponentially. Whether or not this is the work of "selfish genes" (Dawkins 1976), the fact remains that the phenomenon of heredity is central to the definition of life itself.

In the case of humans, our hereditary material (genome) is passed onto newer generations when two opposite-sex individuals bear children who will then carry a mix of their parents' information—that is, one half from the male fuses with another half from the female. In addition, these halves are transported in highly specialized cells called gametes, which are produced in a cell division known as meiosis. In some cases, the sorting of information that takes place during meiosis can go unplanned—what many deem a 'mistake' or 'error'. This section of the chapter challenges the reader to understand the school practice of ecojustice from the perspective of one of these peculiarities. Her name is Marianna Reis.

When Past and Present Meet Up

Circa 1866 Dr. Langdon H. Down had his attention directed to the possibility of making a classification of "congenital mental lesions" (Down 1866, p. 259). His classification system was an attempt to assist medical doctors of his time with the diagnostic and prognostic of a particular "defect which may have come under their observation" (p. 259). The subjects in his study were generally referred to as "feeble-minded," "idiots," and "imbeciles." In addition, and perhaps inadvertently, he created another meaning to the term 'mongoloid': "A very large number of congenital idiots are typical Mongols" (p. 260). Although Dr. Langdon's description of the syndrome was not the first one (Genes 2005), his name is now forever linked to it. Today, Down syndrome is a very common genetic condition and occurs in about 14 in 10,000 live births in the US alone (Dierssen 2012). In Canada, the numbers indicate an estimated 40,000 individuals with DS (Public Health Agency of Canada 2003).

Back to the present, it is now the winter of 2010. I am in my science methods class for high school biology pre-service teachers at the University of Ottawa. One of my course requirements is for groups of students to demonstrate how to effectively teach a lab activity. As part of their usual presentation ritual, students often provide some theoretical groundwork before proceeding to the hands-on aspect of their demonstration. I watch the performance of one group on the topic of cell division when one of the members mentions DS as an example of when meiosis "goes wrong." That last sentence provokes me to end my evaluation writing mode momentarily and throws me back to all those times when people asked me what had happened to my sister and whether or not 'what she had' was contagious. Although my

brother and I were children back then, the typical ignorance of people about her condition is something that I have never forgotten. Her physical appearance is telling of the differences she carries—or maybe telling of the ones that we carry by contrast—and that might have made people feel uneasy. Curiously, I sensed—although not with absolute certainty—that most students in my class feel troubled by the comment made by the young yet-to-be teacher. This teacher's perspective may be changed after all, I optimistically thought to myself.

The following week, I mention the incident in class in order to make my students astutely aware of it. I question (without scolding) the inappropriateness of that type of language—unscientific, to say the least. At the same time, I recognize that this bias is not (entirely) their fault. Existing biology textbooks are filled with the same depreciating semantic imagery used to describe DS. For several examples: "errors and exceptions in chromosomal inheritance" (Campbell et al. 1999, p. 271), "nondisjunction disorder" (Miller and Levine 1991, p. 235) and "abnormal meiosis" (Ritter et al. 1993, p. 556). Likewise, the words 'syndrome' or 'mutation' themselves are synonyms with 'anomaly.' Although all these words are (probably) meant to indicate that the cell division does not generate a faithful progeny, I sincerely doubt that anyone enjoys being called any of them. This language consciously signifies undesirable adjectives.

Aside from the negativity assumed in those descriptors, the Ontario high school biology curriculum document mandates that "whatever the specific ways in which the [high school science curriculum] requirements outlined in the expectations are implemented in the classroom, they must, wherever possible, be inclusive and reflect the diversity of the student population and the population of the province" (Ontario Ministry of Education 2008, p. 16). Correspondingly, when aiming at the provincial curriculum goals, teachers can choose how to best meet them as long as they do not lose sight of their students' existing cultural and cognitive multiplicity. This inclusion is not an easy task when it comes to DS. (I deliberately omitted a discussion on the "wherever possible" part since I have difficulty conceiving a situation or place where the policy would not apply.) Oddly, the curriculum has 12 instances where the word "meiosis" appears, two where the word "trisomy" is used (keep in mind that Down syndrome is but one type of trisomy) and none for DS. Despite this, DS remains part of the fifth most common "developmental disabilities or disorders" between children aged 5–14 in Canada (StatCan 2001), which is one of the signing countries (Foreign Affairs and International Trade Canada 2010) to the UN's Convention on the Rights of Persons with Disabilities (2006).

In class, we also do the "mitosis square dance" as one example of how to hook or make introducing cell division fun for students (YouTube has numerous videos on this activity). Next, I invite Marianna (my sister) and our mother (Carmen Reis) to talk with my beginning teachers. Together, we are people whose biographies intersect with both DS and schooling. Marianna, although rejected by many schools, was able to finish her secondary education. (Mom feels that she was rejected too, every time schools said "no" to Marianna. However, when she looks back she feels it was worthwhile—her parental persistence has certainly paid off.) Marianna is not

capable of explaining the inheritance laws of Mendelian genetics, but she understands well that she is different—or that we are different from her. She is not afraid to tell other people that she has Down syndrome and that she is special. Although her first language is Brazilian Portuguese (which she speaks fluently), she greets my students in English. (This is something we had to rehearse the night before the class, because of her insistent requests to learn some English.)

Marianna was only 6 weeks old (!) when she started what my brother (Felipe Reis) and I know as 'the treatment.' Although we were younger, we remember the treatment involved a lot of exercising but no drugs (we had a monkey bar inside the garage at some point!) Perhaps because we grew up with Marianna around us, we never perceived her as anything else but our sister—and we never teased her more than any other brothers would their own sisters. Maybe because Marianna is our family, we always felt strongly that prejudice and discrimination were both undeserving and unjust. (Curiously, my brother is now a physical education teacher with a number of qualifications in special education). As for Marianna herself, she went on to be a Special Olympics medalist in 1991 (2 gold, 2 silver, and 2 bronze in gymnastics!) and has been employed full time ever since she finished high school. She is not a "genetic disorder," let alone an "error." She is also more than an illustration in a biology textbook in the Down Syndrome section. She is a daughter, a sister, friend, girlfriend, employee, and a human being. She is what books cannot embrace in their pages: she is a member of our society, who deserves the same mental and physical happiness that anyone else longs for. More so: she deserves the right to live—isn't social/ecojustice also about mental and physical wellbeing? In class, Marianna is excited that my students have questions for her—she likes that she's getting the most attention in the room. My wife (Juliana Reis) and children (Ana-Julia Reis and Maria-Luiza Reis) are also present. What was supposed to be a lesson has now become a family event. Now cell division has a new face for my students—Marianna. There are many others like her in schools everywhere the world over. I wrap up the presentation by challenging my students to get to know these other 'special people.' Moreover, I suggest they invite their own high school students to do the same—maybe make it a classroom project on the sociobiological aspects of discrimination? This is at the core of the cut-deep-and-travel-far and the reach-outside-biology principles for effective biology teaching put forward so eloquently by E.O. Wilson (2007). Other stories emerge: cousins, brothers-in-law, neighbours, friends, etc. My students seem to get the message. We all pose for a group picture at the end of class. After all of my students are dismissed, a few stay behind to congratulate my mom and sister for their courage and example. Mom asks them to use what they have learned to become better teachers, to do things right. They all commit to make a difference. One even decides to write a paper for another course inspired by Marianna's story. Another calls the whole lesson an inspirational act of courage (certainly not mine, I must say). To this day, we still run into people who recognize Marianna long after that class. We tell ourselves that increased contact indeed leads to decreased prejudice, something that research has already established (Fishbein 1996).

Lessons (L)earned

It is a popular belief that biology has taught us that our genes (i.e., DNA) contain information that specifies all living beings. Therefore, many students and other non-professional scientists still hold the idea of genes as objects containing the plans for executing the development of an entire organism. This is conceptually wrong for two reasons: (a) it ignores the influence of the social, cultural and physical environments (or ecological, somatic or genetic [Williams 1966]) on the development of individuals, and, (b) confuses the essential participation of genes in one's developmental process with their reportedly (but non-existent) unique responsibility to one's abilities (Maturana and Varela 1998).

There is a need to move from a structural approach to discrimination to a systemic one. The former would insist that DS individuals are destined to a life of misery and suffering imposed by their cognitive and physical limitations. On the contrary, the latter will state that genes are complex enough to make it difficult to predict and control (Wray et al. 2007). As a social species, our behaviours are only partly determined by our genetic makeup (Wilson 1980). If my mom (and all of us for extension) had adopted a structural approach to understand Marianna, she would have never achieved such great personal success in her life. It was our 'systemic stubbornness' that helped Marianna get where she is now. This is the same tenacity I hope to nurture in my students, so that they can help others with whom they cross paths in their classrooms to excel, no matter what their genes say. Even though that might not affect DS individual's life expectancy—which has been increasing anyway (see, Center for Disease Control at http://www.cdc.gov/ncbddd/features/keyfindings-dS-survival.html)—it has the potential to improve the quality of their lives and help reduce abortion rates, which would promote life as one of the fundamental human rights (Universal Declaration of Human Rights, article 3). That too is part of a just society. Changing discrimination and prejudice require people to be more actively involved in embracing the 'different from themselves' at the earliest age. It also means changing the language currently used to refer to those individuals. According to Halliday (1993), "language is the essential condition of knowing, the process by which experience becomes knowledge" (p. 94). Once our knowledge changes, it should also change our language.

On the other hand, some might argue that genetic counseling (Sheets et al. 2011) and genetically modified organisms (eventually applied to humans) carry the potential to correct and/or prevent any 'anomalies' like DS. A similar example would be the cochlear implants for infants and the arguments from the proponents of the Deaf culture that they are losing their culture (Tucker 1998). What if we all looked the same? Isn't diversity part of our human nature? Although an interesting discussion—one that could branch out into the fields of bioethics, child adoption and even religious morality—it is out of the scope of this chapter. The considerations made here are meant to provoke the rethinking of current approaches to life as it happens to exist *after* a child is born.

Our survival "is dependent on many key issues such as economic justice, human rights, peacekeeping and conflicts, social and political movements, and ecological

balance" (Watt et al. 2000, p. 108). Marianna's story is but one example of how our society can confront the most crucial issues facing our times and work towards a more sustainable and just society. It remains "immensely important that we do not make presumptions about a person's health or ability on the basis of their genotype, but rather look to see what they can actually achieve. It is a matter of fundamental human rights [and social justice]" (Sulston and Ferry 2002, p. 251). Moreover:

> The purpose of public schools ought to be to develop citizens who are prepared to support and achieve diverse, democratic and sustainable societies because these are keys to our very survival. Further, these principles support ways of living with each other that are the most fair to all living beings. That means that we must help to prepare students at all levels to think critically and carefully—that is to say ethically about the patterns of belief and behavior in our culture that have led to destructive relationships and practices harming the natural world as well as human communities (Martusewicz et al. 2011, p. 8).

Even though there exists support for a (evolutionary) basis for discrimination (Nguyen 2006), the same is true that "most, if not all creatures live in an environment of choice to some degree or another" (Nelson 2000, p. 12). Whether our discriminatory actions are 'innate' or 'social' (learned) behaviours, culture seems to play a major role in how modern human societies respond to differences between members of our own species. Therefore, our most vulnerable individuals may continue to endure suffering as the result of misinformed decisions, miseducation, and opinions that the general public might have on their uniqueness. And an ecojustice philosophy allows one to argue against the progressive trend in science and technology that advocates that fixing all living organisms considered 'error' is natural and desirable.

Sharing Our Efforts to Promote Ecojustice

According to Dalke and Grobstein (2007):

> Humans continue to create binaries, and with them an associated belief that they represent conflicting stories, one of which must prevail at the cost of the other. At a time in history when the price of such conflict is measured in terms of the suffering of very large numbers, and potentially in the extinction of the human species, there may be no more important classroom task than to help students develop and appreciate an alternative perspective: different stories need not be oppositional. It is our task, as educators and world citizens, to help our students and ourselves develop the skills needed to continually create and recreate a human story from which no one feels estranged (p. 111).

In other words, the narratives of our educational experiences—whether in the Arctic, a Canadian Native Reserve, or within Ontario teacher education—are meant to challenge the type of 'binary thinking' that suggests that our choices or ways of perceiving are limited. In co-creating learning experiences with our students that aim to (re)create educational narratives that embrace alternative and multiple perspectives, we become more mindful of the "floating signifiers" of culturally generated meaning (Hall 1997). Beyond developing an enhanced understanding that we are "diverse people living together in one finite world" (Greenwood 2009, p. 278),

our three stories collectively shared in this chapter highlight what is learned through intersubjective experiences, including "spaces of collective youth engagement" (McKenzie 2008, p. 361). In sharing our efforts to promote ecojustice through our professional actions, we aspire to advance the belief that it is possible to live curricula outside school in ways to promote citizenship science and youth activism to / with whom they matter the most.

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