Chapter 20
Closing

Jack Hassard

> *I believe that education, therefore, is a process of living and not a preparation for future living.*
>
> John Dewey, 1897

I am honored to write a closing to this book edited by Michael Dias, Charles Eick, and Laurie Brantley-Dias, each of whom I know from our work together at Georgia State University (GSU). Michael and Charles were former students in our graduate science education program, Charles earning his master's degree and Michael his Ph.D.; Laurie did her doctoral studies in instructional technology and is now a professor at GSU.

New Beginnings

A "closing" of a book, or a career, is an opportunity to reflect on not only what we have learned but also what we take with us to chart our future. The contributors of *Science Teacher Educators as K-12 Teachers: Practicing What We Teach* have given us much to reflect upon to help us along our journey as teacher educators. One of the most important ideas that I take away from these narratives is how the professional images of these science educators changed because they were willing to take risks and work in a culture that was very different than the one afforded by academia. In crossing cultures from academia to public school and informal science settings, these professors put themselves in the environment of teachers, who in a way were more knowledgeable about the practice of teaching science than they were. Vygotsky's (1986) theory of social development is an important construct

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when we read the narratives and see that these science educators pushed themselves into a new zone, leading to changed beliefs, attitudes, abilities, and skills.

There is richness in these reports, as well as creativity, and above all else, there is courage as evidenced by these teacher educators' willingness to leave the safety of university life and immerse themselves in the world of K-12 classrooms (May 1974). Many of the authors took this step to find out how it feels to be back in a school in today's classroom and how this experience might affect their work as teacher educators. Implementing inquiry-based instruction and constructivist approaches was also a central goal of most of the authors. They also hoped that thoughtful reflection of their experience through the writing and critique of their chapters in this book would provide the assuredness and self-confidence to change their views and impact their university colleagues and their students.

In my effort to write a closing, I do so from the perspective of an emeritus professor of science education, a writer, and author of a progressive science education and policy weblog (Hassard 2005–2013) and suggest that this body of work reveals many new openings not only for the authors of these chapters but those of us who read and study their work. In the closing that follows, I have tried to touch on some of the conceptions and new realities that these teacher educators realized and put them in the context of contemporary issues facing K-12 science teaching and (science) teacher education.

Education policy and practice are being radically transformed in American education, and teacher preparation programs in colleges and universities are being pressured to fall in line with the marketization and privatization of K-12 schools. In teacher preparation this is evident by looking at proposals to privatize or deregulate the education of teachers, in the increasing reductive entry and exit tests for prospective educators, in differential funding to those teacher preparation institutions whose students score higher on high-stakes examinations, and in the increasing growth of home schooling because of various reasons, but perhaps the desire to reject formal schooling and indeed professionally educated teachers (Apple 2008).

The authors of these chapters described their experiences through a process of collaboration and/or self-reflection. Their immersion into the lives of students and teachers showed the complexity of teaching and, in some cases, the difficulty in being successful in the classroom. These were experienced teacher educators with strong backgrounds in science and pedagogy, yet they experienced a variety of problems. Ken Tobin revealed,

"I lacked the essential knowledge that contributed to my immediate failure as urban, low-track science teacher." Kimberly Lott found that because students were not used to doing hands-on activities, they became too excited leading to the breakdown of classroom management. Neporcha Cone realized that not taking into account students' diverse backgrounds could lead to problems of mundaneness and disconnectedness. Edward Shaw points out that his biggest challenge was to take the content that he knew and teach it in a constructivist, hands-on manner that very young students could understand. Dr. Shaw indicated that assessing this kind

of learning was a challenge. Imagine what kind of challenge this is for interns or first-year teachers or teachers who receive 6 weeks of training.

These science educators' experiences highlight the importance of teacher education. Yet, education, K-12, and teacher education are under assault (Giroux 2011). Unfortunately government and corporate leaders simplify teacher education, claiming that teachers can be prepared in summer camp-like alternative programs. The authors of *Science Teacher Educators as K-12 Teachers: Practicing What We Teach* tell a different story. These educators do describe the practical and experiential nature of their return to the classroom, but they go well beyond this. Henry Giroux (2011) is helpful here in illuminating how dialogue and critical pedagogy are crucial to real reform in education and teacher education. He writes:

> Critical pedagogy becomes a project that stresses the need for teachers and students to actively transform knowledge rather than simply consume it. At the same time, I believe it is crucial for educators not only to connect classroom knowledge to the experiences, histories, and resources that students bring to the classroom but also to link such knowledge to the goal of furthering their capacities to be critical agents who are responsive to moral and political problems of their time and recognize the importance of organized collective struggles. At its most ambitious, the overarching narrative in this discourse is to educate students to lead a meaningful life, learn how to hold power and authority accountable, and develop the skills, knowledge, and courage to challenge commonsense assumptions while being willing to struggle for a more socially just world. In this view, it is necessary for critical pedagogy to be rooted in a project that is tied to the cultivation of an informed, critical citizenry capable of participating and governing in a democratic society. As such, it aims at enabling rather than subverting the potential of a democratic culture.

It seems to me that, although Giroux appears to be speaking about K-12 teaching, his ideas are relevant to teaching at any level, including science teacher education programs. We meet Giroux's challenge when we create teacher education programs and courses that educate teacher education students to lead meaningful lives, learn how to hold power and authority accountable, and develop skills, knowledge, and courage to question the neoliberal and corporate assumptions of education and see teaching as manifest in a democratic society.

The authoritarian standards and test-based reforms that dominate education policy are a challenge to science teachers who embrace an experiential and inquiry-based philosophy of teaching science. We saw in the writings of these science educators that inquiry, constructivist learning, and problem-based teaching were high on their list of priorities, and they wanted to test their philosophies in science classrooms. Assessment policies for implementing standards-based reform may present barriers to inquiry-based science teaching (Wallace 2011). This is a continuing issue that challenges the science education research and practice community.

The achievement and authoritarian mentality of American education has a direct consequence for teacher education. A more democratic role for teachers is needed to make decisions about pedagogy and curriculum, not to be clerks and technicians as prescribed in the current milieu (Giroux 2011). Robertson (2008) argues that teacher education institutions need to be sustained as autonomous from social and political centers, which would turn teacher preparation toward their own interests. The social and political context that we find ourselves in today has implications for

science teacher educators, and especially the pedagogical goals of authors of the chapters in this book. As teacher educators, we need to think about how these realities influence our work: the polarized political climate, the educational assessment and accountability movements, and challenges to schools of education (Robertson 2008; Cody 2012; Hassard 2012b).

There are many narratives of growth and inspiration in the chapters of this book. To close the book, I identify and discuss four of them as symbols of this body of work of practicing what we teach.

Mingling Practice with Theory

In 1896, the laboratory school of the University of Chicago opened its doors under the directorship of John Dewey (Fishman and McCarthy 1998). Dewey's idea was to create an environment for social and pedagogical experimentation. Theory and practice should mingle, and the laboratory school as Dewey conceived it would be a place for teachers to design, implement, reflect on, and evaluate learner-centered curriculum and practice. All of the authors of this book mingled theory with practice and as a result have provided a rich source of accounts of the enduring goal of narrowing the gap between theory and practice. Theory and practice are integral to the preparation of teachers. For many of these writers, theory should emerge from practice, especially in the context of dialogue in real classrooms. I focus on two of the authors in this section, Charles Eick and Ken Tobin, each of whom has created narratives that are powerful, and provide science educators ways to improve their own teaching, but to glean the insights from these two science educators.

Charles Eick gives us his insights into realistic teacher education, a model of teacher education based on the work of Korthagen and Kessels (1999), that draws upon constructivist and inquiry-oriented science education in which teacher education moves from practice to theory, instead of the norm for teacher education in which prospective teachers learn theory and strategies first, followed by practice during internships and student teaching. In reality, theory and practice are entwined, and Charles provides ample evidence of this. Charles Eick asked Michael Dias, from Kennesaw State University, to work with him as the lead collaborator in documenting his experience in the classroom. The Eick/Dias collaboration provides a model for other science educators planning to return to school to "practice what they teach." Working together reflectively, Eick and Dias were able to describe for us how they modified the curriculum to meet the needs of their students by including more practical activities, activities that characterized Charles Eick's middle school teaching and Michael Dias' high school biology teaching when I visited them years ago. Although Eick closely followed the *Interactions in Physical Science* conceptual change curriculum, it became quite evident to Charles and Michael that opportunities to grapple with societal issues and to seek creative solutions by means of technology and creative arts were woefully absent and much needed to sustain student interest.

One of the important aspects of this chapter by Eick, and the others, is the goal of democratizing teacher education by encouraging the "mingling of minds" (Robertson 2008). By going back to the classroom, these teacher education professors show a willingness to expand one's views on teaching and perhaps move away from "ivory-tower" disconnectedness to the real fulfillment of teaching, which arises from daily interactions with youth. As Eick points out, this is an important aspect of realistic teacher education. Eick explains how perceptions change when one commits to a realistic teacher education approach:

> We learn to accept that the classroom teacher is the expert in practice and we are the experts in theory on how to improve the practice of others to maximize student learning. They live in the 'real world' and we live in the 'ivory tower'. However, when one has become both the professor and the teacher through recent classroom teaching experience, this arrangement changes. These traditional lines begin to blur. Teachers in the classroom begin to see you as having expertise in both areas. You have earned the respect as someone who 'walks the talk.' And this fact not only enhances your professional credentials, but also allows entrée into further school-based research, collaborative work in teaching and learning, professional development, and many other possibilities for innovative arrangements that benefit both school and university programs.

As I think about the work of Charles Eick, I realize that I have worked with a great teacher and that his research will be a valuable source of teacher education knowledge for the present and future generation of science teacher educators.

Ken Tobin, in his chapter, explores how collaborative self-study can mitigate the top-down reform efforts that as he suggests, "ignore structures associated with curricula enactment and seem impervious to the voices of teachers and students." Tobin's discussion of co-teaching (cogenerative dialogue or cogen) is a model that is relevant when we think of mingling theory and practice but more importantly of professors' willingness to learn from others who typically would not have been considered sources of knowledge about teaching—high school students. And in Tobin's case, it was a teenager from an urban school, whose population was 90 % African-American, and many of them living in poverty, that provided a way forward. Tobin is quite open about his initial failure as an "urban, low-track science teacher" and as a result recruited a high school student (as he had asked his teacher education students) for ideas on how to "better teach kids like me." Respect (acceptance & trust), genuineness (realness), and empathic understanding appeared to be crucial aspects of the cogen activity that emerged from Tobin's struggle to work with urban youth. Tobin puts it this way:

> Although it took us some time to label the activity cogen, we created rules to foster dialogue in which participants established and maintained focus, ensured that turns at talk and time for talk were equalized, and that all participants were respectful to all others. The end goal was to strive for consensus on what to do to improve the quality of learning environments. In so doing all participants would endeavor to understand and respect one another's perspectives, their rights to be different, and acknowledge others as resources for their own learning.

One intriguing notion to take away from Ken's research was his willingness to give voice—listen—if you will, to students. Are we willing to listen to our teacher

education students? Could our courses at the university level integrate the principles of "cogen" such that students' voice is lent to determining the nature of syllabi, agenda topics, and types of investigations? Should our teacher education courses be co-taught with experienced science teachers? As Tobin explains, "cogen is an activity that explicitly values the right to speak and be heard." It is also implicitly based on democratic values and on the ideas of Roger's theory of interpersonal relationships (Rogers 1961). Being heard is a progressive or humanistic quality that can create an informal classroom environment, enabling students who struggle in the formal straightjacket of the traditional class a meaningful chance of success (Hassard 2012c).

I started this section referencing John Dewey and his desire to create environments for social and pedagogical examination. A contemporary science educator who speaks the language of Dewey is Dr. Christopher Emdin. Emdin is an urban science educator and researcher at Teachers College, Columbia University. His research on teaching science in urban schools focuses on Reality Pedagogy. Like Dewey, Emdin's pedagogy extends beyond any existent approach to educating urban (hip-hop) youth. Emdin's approach is a biographical exploration of how he mingled theory and practice in urban science classrooms (Emdin 2010). One of his ideas that resonate with Eick's and Tobin's accounts is this:

> Becoming a reality pedagogue not only requires an understanding of the hip-hop students' ways of knowing, but also an attentiveness to the researcher/teacher's fundamental beliefs. This involves awareness that one's background may cause the person to view the world in a way that distorts, dismisses or under-emphasizes the positive aspects of another person's way of knowing. This awareness of one's self is integral to the teacher/researcher's situating of self as reality pedagogue or urban science educator because an awareness of one's deficiencies is the first step towards addressing them. The teacher whose students are a part of the hip-hop generations must prepare for teaching not by focusing on the students, but focusing on self. The teacher must understand what makes her think, where the desire to be a teacher come from, and what the role of science is in this entire process. (Emdin 2010)

The researchers who wrote these chapters were willing to deal with the untidiness of teaching and realized that there is not a simplistic way to reenter the classroom and apply ivory-tower pedagogy.

The Inquiry-Based Teaching Conundrum

The authors of this book have strong beliefs that inquiry learning should be the cornerstone of science teaching. Indeed, as Anderson (2007) suggests that inquiry teaching is based on constructivist theory, and so as we continue our discussion here, inquiry and constructivism will be the focus. Returning to school was a chance to test out their beliefs about inquiry-/constructivist-based science teaching, but within the context of real classrooms. Some of the authors share with us the conflicts that they had to deal with and how they worked their way through the maze of regulations and standards.

Lee Meadows wrote a convincing chapter showing how inquiry-based teaching has become the major emphasis of his work in teacher education, workshops for teachers, and in his writing. Although he returned to the classroom 10 years ago, he helps us realize that his experience in the classroom was a "catalyst" for his science education endeavors thereafter. His experience teaching resonates with my own experience teaching science, but that was 40 years ago. Like Lee, I taught in schools outside of Boston that fostered inquiry and, indeed, for sites for the field testing of NSF curricula including PSSC Physics and ESCP. My own career was deeply influenced by these experiences, and from those early days, I began to experiment with inquiry and constructivist teaching at the university in science education and geology. Lee Meadow's account can be used to compare and contrast our own philosophy and practice of science education. Lee provides a message that inquiry learning is indeed a cornerstone of science education.

The interplay of standards-based reform coupled with high-stakes testing has created a conundrum for science teacher educators that advocate inquiry and problem-based learning (Minner et al. 2010; Eick et al. 2005; Dias et al. 2011) and those that would submit that students' lived experiences ought to be the starting place for science learning (Aikenhead 2006, 2007). This interplay was addressed by a number of authors in this book. Carolyn S. Wallace, in her chapter on policy and the planned curriculum, chronicles how policies and the standards-based accountability system create conflicts for inquiry-oriented teachers. Don Duggan-Haas, in his chapter, *The Nail in the Coffin*, tells us how returning to the classroom actually killed his belief in schooling (but not public education). I'll come back to Don's chapter a bit later in this section. First, I'd like to talk about Carolyn Wallace's research.

I knew Carolyn Wallace when she was a colleague in science education at Georgia State University in the 1990s and was familiar with her groundbreaking research in science education. Carolyn brought to the science education faculty at GSU a research background that was exceptional and valued, and she had a profound effect on our doctoral students. For nearly 10 years I've been writing articles on progressive science education on The Art of Science Teaching Blog (Hassard 2012a). While searching for related research on the standards-based and high-stakes movement, I found an important article on the authoritarian science curriculum standards in the Journal of Research in Science Teaching. It was an article by Carolyn Wallace (Wallace 2011). I wrote to the author, not knowing it was the Carolyn Wallace I knew at GSU (as she was Carolyn Keys in those days). I was surprised and happy to reconnect with her.

In a courageous and compelling chapter in this book, Wallace takes us on a journey that in my opinion is a realistic portrait of science teaching in an American high school. Going through the hiring process, and then being assigned to teach biology at the high school level, Wallace gives us insight about the conflict that exists between the desired goal of teaching by inquiry within the context of authoritarian science curriculum and high-stakes testing. Using a progressive teaching style that included a learning community orientation, questioning, active collaboration, and task engagement (Darling-Hammond 2006), Wallace was ready

to implement reform-minded science teaching. However, her account details a different picture:

> As I attempted to implement innovation in my own classroom and engage in discourse with other teachers about innovation, I often felt that I was "up against a brick wall." Constraints of the mandated curriculum and testing regimes, along with social pressure to conform to the school culture, proved to be much more profound than I had ever imagined as a university academic.

The analysis of her day-to-day teaching experience was profound. According to the critical realist social theory that she used to examine and explain the various structures affecting schooling, she indicated that the social forces most affecting her life as a biology teacher included the power of the state legislature and the state Department of Education to determine what she could do in the classroom.

Wallace outlines the dilemma that exists between the science education community's enduring belief that science should be taught using inquiry and problem-based approaches and the fact that teachers are held accountable to a planned curriculum that doesn't allow for flexibility and adaptation. Although not an easy task, she was successful in wading through state standards and testing barriers and was able to engage students in inquiry-based activities, which she describes in her chapter, but always with an eye on the fact that the students would have to pass end-of-course exams.

A major implication of her experience for me is what she learned and shared about how the political climate, which is centered on high-stakes standardized testing, affects the day-to-day lives of science teachers. As she suggests, more research is needed in this area, and there needs to be efforts to democratize the participation of teachers in the use of standards by enabling more flexibility and plurality (Wallace 2011). Teachers need to be freed and empowered to design inquiry-learning experiences suited to their particular setting, starting with relevant dimensions of student culture, interests, and out-of-school lives. Perhaps the "common" implementation of standards along with the accountability movement abates innovation and flexibility, causing administrators to be unwilling to be open to teachers adapting and modifying standards to reach out to the needs of their own students. Carolyn Wallace explains that instructional goals that encourage inquiry are in direct conflict with the authoritarian curriculum, which by its very nature is rigid, technical, and decontextualized.

Don Duggan-Haas, who became a science teacher educator after teaching science in a New York high school, decided to return to high school teaching. He, like Dr. Wallace, left academia and took a position in an urban charter high school. Many of us can relate to his frustration after spending 20 years working with struggling schools that very little progress had been made in improving science teaching. He questions the profession by asking, "Have school outcomes improved in any demonstrable way as a result of science education research?" What resonated with me was Don's honesty in reporting his experiences, especially at Charter High School. I think many of us agree with him when he says:

> To put 25 teenagers into a room with a single adult who is tasked with teaching them about a topic with which they have virtually no interest (I believe the topic of the day was convection) is a ridiculous notion.

I connected with Don at many levels. I too taught high school earth science and did my Ph.D. in science education and geology. I read his account of his teaching university and high school carefully. Anyone who names his dissertation, *Scientists Are From Mars, Educators Are From Venus: Relationships in the Ecosystem of Science Teacher Preparation*, has to be read carefully.

Don highlights an important issue that faces public education and that is the rise and expansion of charter schools (Hassard 2012d). Lisa Delpit offers some understanding of the dilemma that Don faced in his work at urban charter school. Delpit suggests that the original idea of a charter school has been corrupted. She explains that, originally, charter schools were designed to be "beacons" for educational excellence. Charter schools were to be designed to develop new approaches to teaching, especially for the most challenging populations of children. Their results were to be shared with other public schools. She writes:

> Now, because of the insertion of the "market model," charter schools often shun the very students they were intended to help. Special education students, students with behavioral issues, and students who need any kind of special assistance are excluded in a multiplicity of ways because they reduce the bottom line. (Delpit 2012)

I am not sure if Don would agree with Dr. Delpit, but that isn't really important. Don had a real experience in a large charter school, and although he thought some aspects of the school were helping the English Learning (EL) students, he still felt compelled to leave. Dr. Duggan-Haas found himself in a charter school that was dysfunctional. In the midst of this environment, an "epiphany" was an "ah ha" moment (or ah s***), when he realized that putting 2,000 kids in this school was almost inhumane. And to top it off, he could find little research to point to that showed how science education research was helping to solve a problem in which he was stuck.

Don's remarkable chapter reminds me of what Carl Rogers (1969) said about teaching and learning. Rogers came to the conclusion that he could not teach another person how to teach or indeed anything that was not inconsequential. He turned his attention to learning. He pronounced that he was only interested in learning and especially in groups. And he indicated that the only way to behave—as difficult as it may be—is to drop his defensiveness and be open to learning. Don came to a similar conclusion, one that was also expressed by Carolyn Wallace. Don writes:

> I suspect I will remain enamored with learning and how to foster it for the rest of my days, and that this infatuation will continue to be at the center of my professional work, but, like Wallace (this volume), "…I no longer have the desire to promote and research classroom interventions that may result in better science learning." Or at least, I no longer delude myself that these efforts will have the desired effect on any kind of broad scale. I am no longer primarily focused upon improving either teacher education or improving schools.

And finally, I want to explain another way in which I relate to Don's "coming out of the closet." For nearly 10 years, I have written a blog on science education under the title the Art of Teaching Science, which is the title of a book I wrote with Michael Dias.

My blog has brought me in contact with many educators who share Don's thinking about schooling. For myself, Don's view of rejecting the neoliberal approach to schooling is refreshing. His new career in informal science education will enable him to write, think, and act on values that are closer to those espoused by other progressive thinkers such as Dewey, von Glasersfeld (2005), Rogers (1969), and Delpit (2012).

Communities of Practice

Communities of practice refer to groups of people working together collectively learning, solving problems, and assisting each other about a common area of interest or practice. The classroom can be a community of practice if there is open dialogue and exchange of ideas among all of the participants (Lave and Wenger 1991, Wenger 1999). Underlying the community of practice is the interpersonal relationship research and theory of Carl Rogers (1961, 1969). Rogers' theory of interpersonal relationships explained that people need relationships in which they are accepted and respected. In teaching, Rogers explained that empathy and unconditional positive regard were core conditions for helping others develop the capacity for growth and change. Several authors in this book underscore the importance of communities of practice in their journey into the K-12 classroom.

MaryKay Orgill tells the story of her first year of teaching high school science in her university's laboratory school after she earned her Ph.D. in science education. Her story, written in collaboration with Pat Friedrichsen, should humble us. We all had our first year of teaching, and surely we can equate her experiences with our own. But what is important to take away from this chapter is how Orgill set out to become a member of a community of practice among science teachers in the school in which she taught. After initially being rejected by her colleagues, she started to "invest time, resources, and emotions" into her school and colleagues. She also approached an experienced teacher at the school, and they ended up co-planning and co-teaching. We cannot underestimate how co-planning and co-teaching can be a powerful teacher preparation strategy with aspiring teachers.

Paul Jablon not only went back to school as science teacher but also as appointed science department chair. As department chair, he tried to engage the science teachers in discussions of adolescent needs and how students can really be engaged, reflect on the science curriculum and teaching, and how students learn best. According to Paul Jablon, "These teachers were so intimidated and torn down by the administration in the district that it was a Herculean task to attempt to create a community where teachers would try things, dream, believe, or invest." But Jablon persisted, and he discovered that the kits of science materials for hands-on activities that he constructed were a hit with the ninth grade teachers. Instead of simply building science kits for himself, he built science kits for each of the other science teachers and shared them. The ample supply of teaching materials in each kit led the teachers to try out new activities and begin talking about teaching and learning. Jablon believed that creating a community of teachers would lead to improved

teaching and learning. Yet the isolation that is so common in schools—where teachers are largely isolated from each other—became a challenge for Jablon. The opportunities for teachers to learn from each other are rare in the present structure of schools.

Joel Westheimer (2008) in his summary of research on teacher communities points out that teacher educators began to apply ways student construct knowledge to the social and interdependent learning of teachers. Jablon tells us about his attempt to create a cross-disciplinary community among teachers in his school. With the principal's go ahead, the community of teachers that he organized met over several months and presented a 100-page proposal for a "pilot" program to begin the following year. Jablon, who had the support of the principal, thought the proposal would be a way to bring teachers together to explore new possibilities for learning and teaching. The proposal was rejected at the end of the school year. Jablon suspected that teacher entrepreneurship and innovation was not welcomed in the district.

G. Nathan Carnes highlights his work in a larger community of practice, or network of professional development schools. As he notes in his chapter, this kind of community of practice requires that university professors "shred and discard his/her cloak of omniscience," to become one part of a collaborative process, as in the spirit of Rogers (1969) and Wenger (1999). Dr. Carnes identifies why this kind of collaboration is so important to science teacher educators:

> The establishment and maintenance of collaboration with colleagues at school partner sites can be advantageous for science teacher educators. It is a dramatic shift from a "don't do as I do, do as I say" mentality. To the contrary, it sends a message to teachers about what is possible and how they might integrate theor y into practice. This appears to be one of the solutions to stem the high turnover rate of new teachers within the first three years of their profession that we have witnessed in the past. Furthermore, it is important for science teacher educators to remember that K-12 students, young adolescent learners in this case, are the ultimate recipients of our professional service.

I once participated in an outdoor workshop session at Princeton University presented by Carl Rogers. His goal was to create a community of practice among the 2,000 people that surrounded him like a theater-in-the-round by waiting and listening. Within 20 min, talk and discussion emerged and continued for hours. He would certainly applaud the work these science educators are doing to create more humanistic learning environments and foster the importance of acceptance and trust in the learning environment.

Nonschool Learning Environments

John Dewey believed that "nonschool learning" could be used to provide the kind of energy that learning in school would require to engage students (Fishman and McCarthy 1998). Science educators and researchers strive to understand "informal learning" opportunities including field trips, museums, community organizations, media, and summer camps. Nonschool learning was a term that John Dewey used for "informal experiences" that he felt helped learners acquire attitudes, values, and knowledge from daily experiences. Many students come to science class from a

cultural world view that makes learning science much like the crossing of a cultural border. These are progressive values and are the world view of teachers who believe schooling should be based on progressive approaches to learning (Lakoff 2006; Aikenhead 2006; Hassard and Dias 2009).

Molly H. Weinburgh (a former colleague of mine at GSU), Cecilia Silva, and Kathy Smith described their work with a school district over a period of five summers to design and implement an enrichment program for fourth and fifth graders. Although the program was housed in elementary schools, summer gave the program informality, especially since participation was not required.

Sherri Brown shows how she partnered in an urban school environment in multiple informal environments with informal educators. An outdoors education enthusiast, Brown created a summer camp environment for students from low socioeconomic families with outside funding. A power plant, water company, sewer waste treatment facility, zoo, forest, and arboretum constituted the sites for the summer camp experiences. The pedagogical implications of this research showed how sociocultural theory could be applied in an informal science program. The nonschool environments that Brown used to engage the "campers" and her use of technology created a problem-based learning environment for students over many summers.

Connecting our students to nature does not have to involve traveling to a park. Simply going outside one's school will bring you and your students in contact with nature. In my own experience as college teacher, I taught in the center of Atlanta's urban environment. The urban environment was rich with experiences for my students. We were able to study the geology of building stones that not only included rocks from various parts of the world but also many of the sedimentary building stones included fossils. We did scavenger hunts looking for change, living things, biodegradable substances, various types of rocks and minerals, plants, animals, mineral processes, evidence of physical and chemical weathering, and other phenomena. We even looked for stalagmites and stalactites that formed when water trickled through cracks and fissures in the underground parking garage.

According to Dewey, learning environments that tend to be more informal in nature than formal use elements of nonschool learning that in the end bring the students closer to the [science] curriculum, perhaps making border crossings less hazardous. In this context, learning is tied to "use, to drama of doubt, need and discovery" (Fishman and McCarthy 1998). In formal learning settings, scientific ideas and concepts are presented as if they were bricks, and we are tempted to try and pass out ideas, because like bricks, they are separable. Concepts are taught without a context, without connections, and without relevance to the students. Yes, there are some students who will learn science very well in formal environments. But many students, who will not benefit from such formality, thrive in informal learning environments. Working on topics of their own choice, collaborating in cooperative groups, or discussing the relevance of the content—each of these ideas will contribute to the informality of the classroom.

Nonschool environments can be used convincingly in teacher education programs, especially when there are opportunities for aspiring teachers to plan

activities and actually work with students. Weinburgh, Silva and Smith, and Brown have designed nonschool models that would be robust sites for teacher education.

One More Thing

When I met Michael, Charles, and Laurie, each was a teacher in the metro-Atlanta area. Laurie was a media specialist in a middle school and did her doctoral work in Instructional Technology at GSU. She was an impressive educator, so much so that the faculty of Instructional Technology hired her for a tenure track position in the Department of Middle-Secondary Education and Instructional Technology.

Charles taught middle school science while he did graduate work at GSU. As a teacher, he was an innovator who believed that students needed to be involved in meaningful projects. I visited Charles in his middle school science classroom. His inquiry style of teaching stood out like a sore thumb in his school, and I got the feeling that some of his colleagues wished he would stop this style of teaching and just stick to the text. Not Charles. His progressive style of teaching resonated with me, and I felt fortunate to have seen him in action. He finished his graduate work at GSU and moved to Auburn, where he earned his Ph.D. in science education. He was an inspiration for me, and he reinforced for us at the university that he was the kind of teacher we needed in our schools. Charles' publications on inquiry science teaching were important to my own work while writing *The Art of Teaching Science* (Hassard and Dias 2009).

I met Mike Dias the day he was interviewed for admission to the Ph.D. program at GSU in science education. I had the honor of being Mike's advisor during his Ph. D. program. But there was much more. At the time, we had developed TEEMS (Teacher Education Environments in Mathematics & Science), an inquiry-based, constructivist teacher education program in secondary mathematics and science (Hassard 1999). It was a four-semester master's level initial certification program that was based on previous work at GSU in "alternative certification" funded by the Georgia Professional Standards Commission. Mike was teaching high school biology at a school in Cobb County, a school district NW of Atlanta. I asked Mike if he would be willing to be a mentor in the TEEMS program. It turned out that the entire science faculty at Mike's school embraced the TEEMS program, and during the Spring Semester of each year, the science department mentored five to ten science interns.

I spent a lot of time in Mike's high school biology classroom. Mike's classroom was an inviting environment for high school students. One of the aspects that was important in the TEEMS program was the notion of co-teaching and mentoring. We asked mentors to work collaboratively with TEEMS interns by being actively involved in their planning, teaching, and evaluation. Mike's classroom, like all of the other mentor classrooms around the metro-Atlanta area, was a clinical environment that encouraged deep exploration of learning.

Mike was also one of several co-teachers in the TEEMS curriculum at GSU. Throughout my career at GSU, we asked high school teachers (many of whom were doing graduate work) to co-teach with us in our teacher education courses. Not only did this bring the classroom experiential knowledge to our courses, but also it provided legitimacy to the inquiry-based and constructivist orientation of our program. By involving high school teachers in our teacher education program, we hoped to narrow the gap between theory and practice and also offer relevant and high quality programs. Mike's research on constructivist teacher education contributed to our understanding of science education (Dias 2000).

Michael, Charles, and Laurie have brought together the experiences of 24 science educators who shared their beliefs about teaching and learning as a result of returning, visiting, or reflecting on teaching in a K-12 science classroom. The authors recognize the vital importance of teacher education and were willing to challenge their beliefs and abilities of education by experiencing real classrooms, real students, and in concert with classroom teachers. Teacher education is one of the most important aspects of higher education in the context of education in a democracy. Giroux (2011) is helpful in this regard, and perhaps his words are a way to bring this chapter to a close. He writes:

> Education is fundamental to democracy and that no democratic society can survive without a formative culture shaped by pedagogical practices capable of creating the conditions for producing citizens who are critical, self-reflective, knowledgeable, and willing to make moral judgments and act in a socially responsible way.

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