JOURNAL OF RESEARCH IN SCIENCE TEACHING VOL. 38, NO. 5, PP. 502–528 (2001)

Case-Based Pedagogy as a Context for Collaborative Inquiry in the Philippines

Elvira L. Arellano,[1] Tessie L. Barcenal,[1] Purita P. Bilbao,[1] Merilin A. Castellano,[1] Sharon Nichols,[2] Deborah J. Tippins[3]

[1]*West Visayas State University, La Paz, Iloilo City, The Philippines*

[2]*Department of Science Education, East Carolina University, Greenville, North Carolina 27834*

[3]*Department of Science Education, University of Georgia, 212 Aderhold Hall, Athens, Georgia 30602-7126*

Received 10 January 2000; accepted 15 December 2000

Abstract: The purpose of this study was to investigate the potential for using case-based pedagogy as a context for collaborative inquiry into the teaching and learning of elementary science. The context for this study was the elementary science teacher preparation program at West Visayas State University on the the island of Panay in Iloilo City, the Philippines. In this context, triple linguistic conventions involving the interactions of the local Ilonggo dialect, the national language of Philipino (predominantly Tagalog) and English create unique challenges for science teachers. Participants in the study included six elementary student teachers, their respective critic teachers and a research team composed of four Filipino and two U.S. science teacher educators. Two teacher-generated case narratives serve as the centerpiece for deliberation, around which we highlight key tensions that reflect both the struggles and positive aspects of teacher learning that took place. Theoretical perspectives drawn from assumptions underlying the use of case-based pedagogy and scholarship surrounding the community metaphor as a referent for science education curriculum inquiry influenced our understanding of tensions at the intersection of re-presentation of science, authority of knowledge, and professional practice, at the intersection of not shared language, explicit moral codes, and indigenization, and at the intersection of identity and dilemmas in science teaching. Implications of this study are discussed with respect to the building of science teacher learning communities in both local and global contexts of reform. © 2001 John Wiley & Sons, Inc. J Res Sci Teach 38: 502–528, 2001

This study began as a project to support research collaboration among science teacher educators from the Philippines and the United States. Over a period of 2 years, four science teacher educators from West Visayas State University (WVSU) in Iloilo, Philippines, collaborated with two U.S. science teacher educators to explore ways to bring about reform in science teacher education. In recent years, science teacher education within our respective institutions has been characterized by reflective practice and action research paradigms. These curricular orientations emphasized practices which placed value on teachers as generators of

Correspondence to: D. J. Tippins; E-mail: dtippins@coe.uga.edu

knowledge, the role of teachers as agents of change, and democratic ideals. These practices helped to legitimize the role of teachers as learners and constructors of their own knowledge. Yet as a research team, we sensed that these practices fell short in terms of creating truly transformative science teacher education pedagogy—practices characterized by dialogue and problem posing centered on the real-life concerns of teachers in today's science classrooms. At WVSU, reflective practice had enabled prospective science teachers to recognize and build on their prior knowledge and experiences as individuals, yet there had been few opportunities created for them to engage in dialogue as a community of science educators. The traditions and culture of student teaching at WVSU reinforced relationships in which student teachers deferred their knowledge to the expertise of critic teachers and teacher educators. Furthermore, geographical placement of student teachers in remote barrio communities created feelings of isolation. The lack of opportunities for dialogue contributed to a science teacher education culture in which group problem posing was not a norm of practice.

In the past decade, case-based pedagogy has emerged as a potential vehicle for building the kinds of teacher learning communities that reflect transformative curricular interests. As our research team explored ways to create opportunities for dialogue, we recognized a mutual interest in using cases as a curriculum for transformative science teacher education. Together with student teachers and critic teachers in the elementary science and health teacher preparation program at WVSU, we designed a case-based experience as an alternative curriculum and as a context for examining critical issues and tensions of science teaching and learning. The case experience provided an opportunity for research team members to learn alongside prospective and practicing elementary teachers as they wrestled with complex issues shaping science teaching and learning in their classrooms. In particular, three questions served to guide and inform our research:

1. What does the case experience reveal about dilemmas and tensions in science teaching and learning?
2. What does the case experience reveal about science teaching and learning as a culturally constituted practice?
3. How does the case experience serve as an intersection for creating a multicultural science teaching and learning community?

In our attempts to develop a more transformative vision of science teacher education, we were cognizant of tensions that mediate science education reform taking place worldwide. Broadly speaking, many tensions cited in research literature seem to be associated with issues of cultural struggle, empowerment and interests that promote social justice. Kyle (1999) asserted that although these issues may seem unrelated to science education, indeed, ''we must transform how we see science education so that it is congruent with both how we see science and how we see education'' (p. 256). Researchers, particularly those working in developing countries, have drawn our attention to recurring tensions that mirror similar issues of science teaching and learning in the Philippines. Some of the core tensions across these diverse contexts concern: local and school knowledge, Western science versus traditional knowledge, authority of knowledge, and everyday language and the language of science.

Glenn Aikenhead (1996), although not focusing on a particular country, discussed ways in which students experience cultural borders as they move between their life-worlds and school science. Building on the work of Costa (1995), he described cultural border crossing as a ''shift from being one person in one context to being another person in a different setting'' (Aikenhead, 1996, p. 273). In other words, for some students transitioning between their worlds in and out of school involves little risk, whereas other students may experience feelings ranging from a sense

of uneasiness to alienation. Aikenhead suggested that the hazards of cultural border crossing might be reduced by explicitly coaching students in ways that facilitate smoother transitions. His perspective helps science educators consider relationships between students' life-worlds and school experiences; however, this framework leaves science as an unquestioned ideology.

Waldrip and Taylor (1999), working in a Melanesian country, highlighted problems associated with the importation of Western science curriculum into schools of non-Western developing countries. In their study, science education policies effectively encouraged students to eschew their traditional world views in favor of values reflected in Western science. This created local tensions as school science conflicted with traditional practices and beliefs which have sustained the people of this country for generations.

Tensions of language and authority are apparent in Akatugba and Wallace's (1999) study of science learning in Nigerian physics classrooms. In their study, language dilemmas emerged when students perceived words used in class as alien to their everyday forms of communication. Students also had difficulty interpreting technical physics vocabulary because equivalent words did not exist in their vernacular dialects. Students were reluctant to raise questions in the classroom because they feared teachers would interpret their actions as disrespectful. Shumba (1999) and Jegede and Okebukola (1992) provided further evidence of tensions associated with the status of authority assigned to science teachers. In their studies, teachers were upheld as figures of authority who provided infallible information and solutions to problems. As a consequence, students were discouraged from asking questions or querying the knowledge and decisions of their teachers.

Tensions highlighted across these diverse contexts of study represent the complex nature of teaching in science classrooms of the 21st century. They also pose challenges for science teacher educators as they seek to develop teacher preparation programs that unravel familiar ways of thinking about these tensions—programs that value multiple perspectives and foster collaborative, critical, and caring pedagogy. In the sections that follow, we explore tensions situated in the context of a case experience unique to science teaching and learning in the Philippines.

Context of the Study

The Republic of the Philippines comprises more than 7,100 islands which are part of the Malay Archipelago in the Western Pacific Ocean. The majority of Filipinos (85%) live in rural settings, where they raise crops such as rice, mangoes, and coconuts. The teaching and learning of science is constrained by the linguistic confusion of eight major languages including the national language, Filipino (Tagalog), and some 75 tongues and 300 dialects.[1] Since the 1930s English has played a major role in curricula and the educational system of the Philippines (Smolicz, 1983), with students studying the language beginning in the elementary grades.

This study took place in the port city of Iloilo on the island of Panay in a semirural area of the Philippines. At one point in time, after Spanish conquistadors arrived in Iloilo in 1566, the city was a prosperous center of trade. Chinese, Arab, Persian, and Indian merchants, for more than 300 years after the Spaniards' arrival, bartered silk fabric, pottery, and gold for products such as sandalwood and cotton. Iloilo society was composed of families in extremes—a handful of elite landowners and hacienderos had an extravagant lifestyle, whereas ordinary Ilonggos tilled the land and carried produce on their shoulders. Eventually, as the city's economic force waned, people were compelled to adjust their lifestyles accordingly. Today, a new middle class of hard-working city entrepreneurs has surfaced, helping to close the gap between rich and poor. However, the majority of Ilonggos continue to live quiet rural lives centered on farming and fishing. Although Spanish is spoken by the older generation, this has gradually been replaced by

Ilonggo, as the local dialect is commonly called. However, in most rural barrio schools surrounding the city, a mixture of dialects is commonplace. If one travels a mere 10 miles outside Iloilo City, various Kinaray-a dialects are spoken and at times may not be easily understood by those speaking Ilonggo or other dialects.

West Visayas State University is centrally located in Iloilo City. Colorful murals illustrated by former education students adorn the surrounding walls of the university, a testament to students' commitment to upholding a sense of community pride. The elementary science teacher preparation program which serves as the local context for this study offers a degree in elementary science education with a specialization in elementary science and health. Students who major in elementary science and health participate in a twofold student teaching field experience. The first half of the semester they practice teach in the College of Education Integrated Laboratory School; the second half of the field experience takes place in community settings such as Ticud or Jaro I elementary schools. Ticud Elementary School is in a suburban section of Iloilo barely 5 min from the university. It is located near the Salog River, where flooding is a constant threat to the school's existence, with the South China Sea several kilometers away. Students attending the school are primarily from low-income families engaged in fishing, farming, and the coconut industry. Ninety five percent of homes in this community are built of light nipa and bamboo materials. Electricity and telephone service first reached the school 2 years ago. By contrast, Jaro I Elementary, typical of many public elementary schools in Iloilo, is located approximately 100 m from the town's plaza and 50 m from the town market. With a student population of 1,699, class sizes are large. Generally students come from low to average income families.

Shifting Research Traditions

West Visayas State University has a rich tradition of preparing the best public school teachers, particularly at the elementary school level, a role that was initially undertaken by the early Thomasites. With the opening of the graduate School of Education in 1963 and the creation of a Research Unit in 1979, issues of policy and research assumed importance within the institution. Nevertheless, most research being conducted focused on agricultural concerns and was based on quantitative research designs. As a result, quantitative research was assumed to be the norm for all research, including studies being conducted by science educators. In recent years, concerns for community and societal issues have prompted WVSU science education researchers to consider alternative genres of research. Narrative forms of research appealed to all members of the research team. In addition, we shared a common interest in improving the quality of science teacher education within our respective institutions. Initial discomfort with the emergent nature of the research design and lack of familiarity with group members quickly dissipated in an environment of trust and open-mindedness.

Locating Our Theoretical Perspectives

Our guiding theoretical perspectives are drawn from assumptions underlying the use of narrative and case-based pedagogy in science education and scholarship surrounding the community metaphor as a referent for science education curriculum inquiry.

Assumptions Underlying the Use of Case-Based Pedagogy in Science Education

In its simplest form, a case can be described as "a particular type of narrative which can be used to explicate and clarify the professional knowledge of teachers" (Koballa & Tippins, 2000).

It serves as a common text that prompts conversation and reflection on issues that invite a variety of interpretations. Dilemma-based cases, in particular, highlight the ambiguity and complexity of teaching and learning science. Whereas case-based pedagogy has a long history in many professions (Merseth, 1996), it was not until the mid-1990s that scholarship surrounding the use of cases in teacher education became prevalent (Merseth, 2000). More recently, the use of cases in science teacher education has been advocated by many as an important pedagogical and research tool for linking theory and practice and preparing teachers for the diversity and complexity of classrooms (Abell et al., 1996; Gess-Newsome & Southerland, in press; Howe & Nichols, 2000; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Tippins, Nichols, & Dana, 1999). Currently, teacher educators and science educators are attempting to define a strong empirical base for the use of case-based pedagogy in the professional development of teachers. This study is based on the assumption that case-based pedagogy can facilitate inquiry, enable learners to examine their own beliefs about science teaching, ''reason critically about classroom dilemmas,'' and ''value ethical, epistemological and social growth'' (Lundeberg, 1999, p. 4). A second premise of this study is that cases can serve as a powerful pedagogical strategy and context for understanding issues of cultural diversity in the building of science teacher learning communities. In this sense, case-based pedagogy has the potential to foster a learning environment which challenges science teachers to question traditional stereotypes, beliefs, and practices.

Classroom cases, as examples of the narrative mode, feature dilemmas which embody ''normative conflicts, not just technical hurdles'' (Smylie, Bay, & Tozer, 1999). These dilemmas can be described as ''conflict-filled situations that have no clear resolution'' (Cuban, 1992). Although cases are sometimes framed as models of exemplary practice, in this study teachers' cases are not intended to illustrate exemplary or ineffective practice. Rather, they reflect the inherent uncertainty and complexity of the world of science teaching and learning. The case examples in this study illustrate dilemmas that are found at the intersection of teachers' representation of science, authority of knowledge, and professional practice and at the intersection of personal and public knowledge of science teaching, moral codes, and indigenization. Two case narratives serve as a backdrop for highlighting and discussing the tensions that surround the teaching of elementary science at these intersections.

Case-based pedagogy embraces ideas that are grounded in critical curriculum inquiry and the importance of teachers' knowledge. In this sense, inquiry can include teacher's personal narratives as guides for curriculum decision-making. Given the current thrust toward creating national and international science education guidelines, there is a potential to overlook the knowledge that teachers hold and bring to their local communities and classrooms. In this study, the case was conceptualized as a window into the experiences and ideas of the authors and a mirror of the beliefs and attitudes of those who read, discussed, and participated in the case experience. The study is situated in the broader context of an ongoing dialogue which crosses international boundaries; a conversation which rests in the awareness of the need to learn more about the creation of science teaching and learning communities. It is a conversation which reflects physicist David Bohm's use of the term *dialogue* in which ''the image this derivation (of dialogue) suggests is of a stream of meaning flowing among us. . . a flow of meaning in the whole group, out of which will emerge some new understanding. . . . When everybody is sensitive to all the nuances going around, and not merely to what is happening in one's own mind, there forms a meaning which is shared'' (Bohm, 1992, pp. 16–18). Similarly, for members of the research team, it is a conversation whose spirit can perhaps best be described by the Ilonggo word *Paghinun-anon*, meaning an insightful dialogue and exchange of ideas. Throughout this study we were intrigued by the power of the case experience to support

learning in deep ways and act as a catalyst for the building of a science teaching and learning culture.

The underlying purpose of case-based instruction can be viewed in different ways which, in turn, influence how cases are used in science teacher education. Shulman (1986), in emphasizing the substance of the case, suggested that ''while cases themselves are reports of events, the knowledge they represent is what makes them cases'' (p. 22). For Shulman, the instructive power of the case rests in its structure and substance. By contrast, Welty, Silverman, and Lyon (1991) maintained that the substantive value of the case can not be separated from the discussions through which teachers ''learn to identify actual problems, to recognize the key players and their agendas, and to become aware of those aspects of the situation that contribute to the problem'' (p. 5). Merseth (1991), in *The Case for Cases in Teacher Education*, pointed out that content and process are inseparable in case-based pedagogy. She emphasized that ''to focus on discussion methods alone, without reference to the material being discussed, is analogous to approaches to teaching that ignore the content that is being taught. Conversely, concern for content alone, without attention to the process, denies the reality that how we teach is what we teach'' (p. 6). In this study, both the substantive content of each case and its role as a centerpiece for deliberation and discussion are embedded within the larger question of what it means to become a science teaching and learning community.

Community as a Referent for Science Education Curriculum Inquiry

Research suggests that science teachers become more reflective when opportunities to critique and struggle with the dilemmas of practice are grounded in a social constructivist framework (Grossman, 1992; Harrington, 1995; Howe & Nichols, 2000). From this perspective, personal and social knowledge is created, interrogated, and questioned through the mutual conversations of a learning community. Our use of case-based pedagogy as a curriculum for science teacher education situates teacher knowledge within a community of learners. Throughout this study, we attempted to move beyond superficial notions of community to develop a more critical understanding of its importance to case-based pedagogy. Roland Barth (1990) provided a starting point in his descriptions of community. In his text (1990), *Improving Schools from Within*, the concept of community is used as a referent for the reorganization of schools:

> Central to my conception of a good school and a healthy workplace is community. In particular, I would want to return to work in a school that could be described as a community of learners, a place where students and adults alike are engaged as active learners in matters of special importance to them and where everyone is thereby encouraging everyone else's learning. And I would readily work in a school that could be described as a community of leaders, where students, teachers, parents and administrators share the opportunities and responsibilities for making decisions that affect all the occupants of the school. (p. 9)

Barth's descriptions of community are a step away from First-World school cultures that tend to promote feelings of competition, isolation, and individualism; he emphasizes the building of collaborative relationships among learners engaged in inquiry to enhance teaching and learning. Community, when viewed through the lens of an individualism-collectivism construct (Hofstede, 1980), provides further explanation of how individuals and cultures are

situated along a continuum with respect to goals and actions. In the Philippines, a country which can be characterized by a collectivist orientation, the goals and needs of the group are the primary referent for research and actions. This stands in stark contrast to many First-World cultures wherein individual needs and values are the primary basis for the rules and norms that guide behavior (Gundykunst et al., 1996). However, even in cultures which can be characterized by collectivism as a dominant referent, individuals can have ''independent'' and ''interdependent'' views of themselves (Singelis & Brown, 1995).

More recently, Sergiovanni (1994) added to the conversation about the importance of building community in school, basing his framework on the writings of the sociologist Ferdinand Tonnies. Sergiovanni used the word *gemeinschaft*, meaning ''community,'' to look at three forms associated with terms that are pertinent to the building of science teaching and learning communities: kinship, place, and mind. *Gemeinschaft* by kinship comes from the unity of being, in the sense of a ''we'' identity that families and extended families provide. *Gemeinschaft* of place emerges from the sharing of a common habitat or locale: This is my class, my school, my colleagues...As a result of this common membership and this sense of belonging my being is enlarged from ''I'' to ''we.'' *Gemeinschaft* of mind refers to the bonding together of people that results from their mutual binding to a common goal, shared set of values, and shared conception of being. *Gemeinschaft* of mind further strengthens the ''we'' identity (1994, p. 6). Sergiovanni incorporated a fourth form of community he referred to as ''community of memory.'' Community of memory brings together the other three forms to exist, so to say, under an umbrella of endurement that allows for resiliency and sustainment of understandings over time as new and old members come and go.

Barth's and Sergiovanni's notions of community diverged from First-World metaphors reflecting systematic approaches to professional development. Their descriptions of community emphasize the place of teachers' personal and professional histories, the contextual nature of practice, and the need for building past and future legacies for science education.

Methods of the Study

> [Science educators] as they produce knowledge they remake their professional lives and rename their worlds. (Kincheloe, 1998, p. 1203)

At first glance, the plethora of qualitative research methods appear similar: They include gathering data, examining data, making first levels of interpretation by coding the text, making larger interpretations through the development of themes, and writing up what was learned in the study. However, subtle but significant differences in methods reflect underlying assumptions of the researchers. As a research team, we shared the belief that meaning is embedded in multiple contexts of an individual or group's history and culture. Furthermore, we recognized the importance of identifying shared meanings as a focus of inquiry. This stance led us to choose a narrative research approach (Connelly & Clandinin, 2000) with its emphasis on developing relationships between concepts and substantive theory. Both inquiry and interpretation were guided by our shared goal of enriching and empowering participants in ways which consciously avoided exploitation.

The narrative tools of inquiry which are at the heart of this study were derived from the nature of the research questions. A narrative research approach (Connelly & Clandinin, 2000; Polkinghorne, 1997) was used to transform discourse among the participants in this study and their practices and experience into a communicable praxis. Accordingly, our study

was framed as a type of research that creates community (Airini, 1999) and explores ways in which community understandings of life can inspire alternative and representational practices in science education curriculum research. The study was situated within two overlapping science education communities: a science teacher learning community composed of student teachers and their respective critic teachers and a science teacher education research community. At the heart of the work of both communities was an emphasis on the quality of the community known as relatedness. Some of the cross-cultural literature frames issues of culture in relation to science teaching in terms of dichotomies of communalism and collectivist/individualist concepts (Boykin, Yagers, Ellison, & Alburg, 1997). In this literature communalism is construed as an emic approach which ''seeks to describe and interpret phenomena in terms of the life experiences of a specific cultural group'' (p. 155). By contrast, collectivist/individualist concepts represent an etic approach ''which assumes the universal applicability of Western psychological constructs . . . and in turn invites the comparison and evaluation of diverse cultural groups in terms of externally imposed dimensions'' (p. 155). For us, as researchers, the dichotomies embedded in these constructs undermined the potential for gaining insights into relational aspects of cross-cultural research. Thus, instead of focusing on what might distinguish and separate members of our learning community, we purposefully sought to look for connections in our relationships through an emphasis on:

- research providing a full and just account of social realities
- developing original solutions to current curriculum issues (in science education)
- integrating community perspectives into our curriculum research
- involving emotions essential to critical judgment in curriculum, and
- identifying writing styles necessary for crossing boundaries of traditional inquiry and thereby advancing innovative research (Airini, 1999, pp. 40–41).

To this end, all members of the research community shared a common interest in exploring the potential of a case-based curriculum for studying issues of cultural diversity in science teacher education.

Participants

Participants in this study included six elementary student teachers, their respective critic (cooperating) teachers and a research team composed of four Filipino and two U.S. science teacher educators.

Because 10th grade serves as the final year of secondary education in the Philippines, the student teachers were relatively young females; the majority came from economically impoverished backgrounds and large families. For the most part, these student teachers described childhood as growing up in rural settings which were punctuated with strong images of informal science learning experiences. Odette, who grew up on a farm far from the city, learned about science through first-hand experiences with quail eggs and snake skins. Odette recalled her mother's use of the metaphor ''dress of the snake'' to explain the shedding of a snake skin. Mary Joy, born in the remote mountain province of Antique, noted how the lack of trained science teachers and materials led to improvisation (i.e., using the case of a ballpoint pen as a prism) in her early science learning experiences. Analyn, who came from a rural fishing and farming community, described how ''we survived on corn—nobody would lend us rice because we had no money.'' She recalled many of her early science experiences in the form of games such as

Lantay-Lantay, a game played by the shadow of the moon, or Lakad, Inom (Walk-over-Drink), a game which emphasized water as the basis of life. Lotis, who was raised in a community where ''people farm or drive jeepneys for a living,'' came from a poor home where ''we worked hard and prayed for a better life.'' Likewise, Lossel recalls that students in her rural Barangay near the mountains were actually rice farmers and animal caretakers. Only Cheryl, who entered the teacher education program by mistake when she checked the wrong box on an entrance exam, recalled little of her childhood science experiences.

The critic teachers in this study ranged in teaching experience from 4 to 24 years and included five females and one male. They had multiple roles within the school and university communities. Not only were they full-time elementary teachers; most taught late afternoon at the university or were involved in various educational activities within the Iloilo community. They expressed personal philosophies of science teaching through their descriptions of real or imaginary banners that were at the heart of their practice. For example, Marietta, a first-grade teacher, expressed the belief that ''parents and teachers should work hand-in hand in order to have a real science experience for children.'' Ruth, a fourth-grade teacher, described her guiding philosophy as one in which we should ''make science a way of life . . . what we are learning here should be applied in real-life situations. It is not only a student that will learn . . . it's you as parents—be our models.'' Similarly, Willa's motto that ''science is life'' reflected her belief as a kindergarten teacher that science teaching and learning should involve ''first-hand experiences and foster experimenting.''

The six members of the research team, drawn together by a common interest in science education reform, were women who have developed a sense of agency in moving forward to pursue life interests. As a team, our group autobiography was one of women who were willing to share, cooperate, disagree, compromise for the common good, and break down international barriers. We viewed our research collaboration as a long-term commitment framed by our openness to change in research traditions and a shared belief in the value of contributing to larger social goals. It is not surprising that as we began to discuss and write about what we were learning, we struggled with labeling ourselves as an international research team. Through the sharing of our individual autobiographical histories, we came to cherish and know how our diverse and unique experiences have crossed geographic, cultural, economic, and disciplinary boundaries, and ultimately we defined ourselves as a multicultural science education research community.

Tess, the only daughter of six children, was raised with her mother's love of farm life and her father's itching for adventure. In her dual role as Principal and Chair of the Department of Elementary Teacher Training at WVSU, she has encouraged the teaching of science in outdoor learning environments. Elvie, as the oldest girl in her family, was recognized as a wizard of figures at a young age and entrusted with the economic welfare of her family. Merl, the fourth child in a brood of 10, at an early age expressed curiosity about science, asking questions such as ''why can fish swim and I can't'' or ''Why does the rice boil when we cook it over the fire?'' Growing up in a *nipa* house (a traditional bamboo home) by a rice field during the Japanese occupation of the Philippines, she ignored her parents' admonishments not to play in the nearby river. Years later, as an experienced teacher, she still recalls her love for adventure and discovery in science and mathematics. Purita, one of seven children born to a family of educators, recalls the 3-km walk with her parents to school each morning. Eventually, her father built a small school on their farm, and even today, while serving as Dean of the College of Education, she finds time to visit this school. She recalls her burning ''desire to popularize science at the grassroots level among marginalized teachers.'' Sherry, one of six girls raised in a Southern Baptist family, became empowered to pursue science learning

later in life. Finally, Deborah grew up closely attuned to nature in the northern most part of Michigan.

Procedures: Data Construction, Analysis, and Interpretation

The research team initially spent significant time planning a case experience which would enhance learning opportunities for all participants. Six teams of student and critic teachers responded to the invitation to participate in the case experience as part of an initial attempt to explore the potential of a case-based curriculum for science teacher education. The case experience involved all participants in the following activities: (a) orientation meeting, (b) dilemma brainstorming and case-writing session, (c) development of written cases by six student teachers and six critic teachers, (d) large group sharing of two teacher-generated cases, (e) focus group discussions of two selected cases, (f) large group debriefing, (g) paired interviews, and (h) development of research team members' personal autobiographies. Participants were provided with written guidelines to assist them in the development of their case narratives. Data construction, analysis, and interpretation were ongoing throughout the study. Primary data sources, collected during the summer of 1999, included written cases featuring dilemmas of science teaching and learning and transcripts of large group and focus group discussions, paired interviews, and research team meeting reflections. Additional data sources included murals, documents, photo essays, artifacts, field notes, observations, and autobiographies. In the Philippines, schools are in session during the summer months and the research team met on a daily basis to discuss what we were learning. Initial team discussions of data and interpretations were followed by independent coding and analysis. The independent analyses were then exchanged among team members through a process of critique, debate, and validation. During the fall, when U.S. team members returned to their respective institutions, e-mail conversations, international phone calls, and fax and global express postal exchanges facilitated the analysis and interpretation process which ultimately led to a description of tensions that reflect the dynamic nature of the learning that took place. Although the research team focused on both the case experience process and the content of all case narratives, we highlight two cases in this article to illustrate tensions associated with science teaching and learning as a culturally constituted practice and tensions related to representations of science teaching practice in local and global communities. Members of the research team selected these two cases for discussion, believing that they best reflected qualities of an effective case—they were centered on dilemmas relevant to science teaching and learning, held the potential to create thought-provoking conversations, and were written in a coherent and expressive manner. In addition, care was taken to include cases written by both student teachers and classroom teachers for sharing within the larger group.

What We've Learned: In the Company of Friends

The cases that follow serve as a narrative context for discussing the findings of this study in terms of key tensions which deepen our understanding of complex issues that impact elementary science teaching and learning in the Iloilo community. Some science education researchers (Abell & Bryan, 1997) framed what they learned in terms of tensions that represent struggles as the basis of learning. We approach the use of tensions in a broader sense to include not only struggles, but the more positive aspects of teacher learning that took place for participants in this study. Our use of ''tension'' is one in which struggles are viewed as movements of excitement that spur us on to continue striving in our learning.

Research Question 1: What Does the Case Experience Reveal about Dilemmas and Tensions in Science Teaching and Learning?

> Case 1: Stick to the Book?
>
> by Lotis B. Bugna
>
> Student Teacher, West Visayas State University
>
> I'm a student teacher of Grade 1. As a teacher in science, there are times when unexpected situations will occur inside the classroom which create dilemmas. My dilemma is not really a big one, but when you look at it deeply, such a dilemma can create a serious situation that is hard to deal with in science teaching.
>
> One day, I taught a lesson about places where plants grow. I first presented places where specific plants grow in soil, water, air, wet, and dry places. The plants I used as examples were taken from the science book that we are using in class. The pupils were confused about whether the wet and dry places were the same. In real-life situation there are plants that can grow in both places, in wet and aquatic places. On a test I asked students to list two examples of plants that grow in soil, water, air, dry, and wet places. One child wrote *Kangkong* plant under ''wet'' places; I marked it wrong because the book implied that *Kangkong* would be an aquatic plant since it grows in water.
>
> The mother of one of our pupils came to the school. She had a correction for an answer her child had written that I had marked wrong. The mother protested saying that *Kangkong* can also grow in wet places. Because I followed what is written in the book, I marked it wrong. Besides, most of my pupils believed that the book is the source of knowledge. So if I checked or accepted other answers that are not found in the book pupils will conclude that books can't be trusted.
>
> Actually, I believe that books are not the only source of knowledge. You can gain knowledge from other people, and also from real-life situations. Answers that can be found in the book are also correct, but they are limited in the sense that other answers can also be found in other books.
>
> My problem is, am I going to stick to the book or consider other answers which are based on real-life situations? What will happen if I stick or depend only on the book? What should I do to help my pupils understand our lesson?

After Lotis read her case to the group of student teachers, critic teachers, and research team members, all participants divided into focus groups to discuss the case. Discussion was initiated by asking within each group: ''So, what was the case about?'' Initially, participants from the focus groups identified the central dilemma as whether the teacher should have marked the pupil's test response according to information presented in the textbook or according to the actual experience of the pupil. The conversations that followed twisted and turned as participants raised new issues and revisited ideas throughout the case discussions taking place. Ideas were extended as teachers shared similar experiences they had previously encountered in teaching, or personal experiences they had that related to topics explored. At times, discussions reflected global myths of science teaching practice—ideas that might be expressed by teachers of science most anywhere in the world. Participants also spoke from vantage points that seemed unique to the Iloilo province, or more broadly characteristic of Filipino culture. There were also moments when Filipino participants expressed ideas that contrasted with what the American colleagues in the group knew about science teaching in the United States. Overall,

discussions of this first case highlighted tensions involving three primary foci including: teachers' representations of science in the classroom, authority of knowledge, and teachers' professional practices. In this section, we look more closely at these tensions as referents of our emerging teacher community, and as cultural artifacts significant to elementary science teaching reform.

Tensions of Representing Science

Issues associated with teachers' practices of representing science ideas in classrooms surfaced across all focus group discussions and at other points in the study. In this case, Lotis described her use of the class science text to definitively introduce where specific plants grow. Her first-grade students recorded this information in their science notebooks, and it was expected that they would reproduce this science information, as given, on the class test. In one respect, the representation of plant life through the text became problematic as the students were given examples of single plant species growing in only one type of place (i.e., dry, wet, soil). Students were likely to be confused because there are several different species of *Kangkong* growing in various types of habitats around Iloilo. Also, there was ambiguity regarding use of the terms ''wet'' and ''aquatic'' as descriptors of plants that grow in water. To what extent were the first graders prepared to classify environments having water as either ''wet'' or ''aquatic''? Further complications centered on the use of language because the first graders' texts are written in English which is not their native language. Students speak both their native language or dialect and English in school, with English used only for the subjects of science, mathematics, and English. This issue is discussed more in depth in relation to the second case.

Beyond the semantic problems associated with textbook use in science teaching, teachers deliberated about using science texts as a resource for science teaching and learning. Most teachers indicated that they viewed science texts as a reference or guide to be used in the classroom, whereas others regarded texts as a tool to ensure that science concepts were presented error-free to students. Many teachers shared the assumption that books and multimedia were reliable sources of information to use because, as one teacher stated, ''they have been proofread and tested out already.'' Others shared views that reflected the tentative nature of science as they emphasized that textbook information is subject to change as scientists learn more and theories evolve. One teacher reiterated this point as she shared a case based on her own science teaching about the solar system. The text she had been using stated that Pluto was the smallest planet. Later, the teacher engaged students in research using additional texts to learn more about the solar system. A student commented to the teacher: ''Ma'am, in my book it is Mercury that is the smallest planet.'' The teacher, unsure about which answer was correct, had all students bring in several books to compare answers. The books contradicted each other in their records of which planet was smallest. The teacher instructed the students to use information from the book having the most recent copyright. Questions were raised about how to respond when inconsistencies are noted in textbooks or in learners' real-life experiences. In response, many teachers strongly advocated the use of direct experience (i.e., research) to confirm or disconfirm science information, as one student teacher commented:

> According to [the student teacher in the case] she got it from the book that idea that *Kangkong* lives in water. But looking at the practical side of it, you can always see *Kangkong* growing on land. So, you can always see that sometimes we cannot get information from books. You can see it on the real-life situations, direct experience. So, I think direct experience is better than vicarious experience.

The teachers' readiness to engage their students in plant research is understandable because many have had a great deal of experience growing plants. Interviews with individuals revealed that many had grown up in rural areas. They were often depended on to plant and harvest food for their families; schools customarily would release children for planting and harvesting of rice. Elementary schools visited by the research team were observed to have gardens that were integrated into the life and curriculum of the school. At one school, there was a mathematical garden, a medicinal/science garden, an environmental garden (which had a large environmental awareness mural painted beside it), and a garden from which local community members could purchase ornamental plants. One student teacher described how, in her elementary school years, her teacher taught students to make a natural insecticide from the poison of a plant, and how to make a water purifier out of bamboo. Across the groups, teachers reiterated the notion that in science learning experience is best to discover for oneself. Whereas participants seemed to feel strongly about the potential benefits of using direct experience to teach science, a more traditional expository teaching approach was used to introduce concepts to students. We wondered, why did participants not critique the teacher's apparent reliance on using the science text as a beginning point for instruction? Issues associated with teachers' practices representing science concepts converged with tensions associated with authority of knowledge.

Tensions of Authority of Knowledge

By "authority of knowledge" we refer to situations shaping what ideas are validated in classroom science learning. The *Kangkong* case prompted discussion about whether the child's experience outside of the classroom should be credited, and how teachers should respond when parents challenge teachers' decisions. At the heart of these dilemmas lies a deeper question about who determines what and how science ideas come to be valued and accepted in classroom science learning. Some participants felt that if a parent questioned the teachers' decision to mark a student's response wrong, the teacher should apologize to the parent and recognize that children have experiences outside of school that present viable alternatives to knowledge presented in the classroom. Other participants perceived that if a teacher admitted to making a mistake in how she marked a student's test response she would be seen as lacking knowledge. One student teacher commented: "If that should happen, well, of course I will not immediately admit that I'd given wrong information to them. Maybe I would suggest, well, the best thing we're going to do is research for the right answer." Still other teachers indicated that they would not only defend information they had given the student, but would also deny the validity of the parent's knowledge. One teacher's comment reflected this particular position:

> If a parent comes to me and complains to me about not giving a point to the answer of a child, then I will tell the mother that probably she mistakenly saw another plant which is not *Kangkong*, but just a relative of *Kangkong* actually not the plant. And then I will show the parent my reference. If I know that what is written in the book is really correct, then I will show to the parent, how we got the information.

Some teachers felt such a dilemma could serve as an opportunity to instruct parents about their role in reviewing science notebooks. One critic teacher indicated that if the parent had challenged her student teacher in this manner, she would help the student teacher defend her decision by upholding the information in the text. Further, she would encourage the student teacher to communicate to students the value in correctly citing information as presented in the science textbook, and as recorded in their class notebook by saying to the student and parent:

"We will consider it [the student's answer] this time, but next time put what was in the notebook as given." Such responses maintain the textbook and teacher as authorizers of knowledge, reinforcing the cult of expertise, and denying the experiences and ideas that parents and their children might bring to the table.

Although teachers were concerned that students may experience difficulty understanding the English used in texts, they used the mythology that textbooks tell truths when necessary to justify their teaching decisions. This mythology was mutually upheld by teachers, students, and parents. One teacher stated: "I realized that plants grow in water or wet places and both are correct. But the book says wet—in the water—and children believe books are truth." A variety of evidence suggested that students were encouraged to see science texts as purveyors of truth. Early in life, they are taught to respect books and the knowledge presented within them; even as young as kindergarten, students tote their books each day to and from school in rolling suitcases or large backpacks. The teachers' responses suggested that although they saw themselves as having the power to determine what science knowledge does or does not count, assessment practices were beginning to compromise their sense of autonomy in this regard. International (i.e., Third International Mathematics and Science Study [TIMSS]) and national (i.e., the National Elementary Assessment Test) tests are persuading teachers in intermediate elementary and upper grade levels to base their science instruction on science texts to improve student performance on these tests. Filipino students have not performed well on these science tests primarily owing to problems using English language. It is questionable whether these tests show that students have not acquired scientific understandings or whether they simply are more of an indication that they do not recognize contextual demands of scientific language conventions. Nevertheless, many teachers believe that because the Filipino science texts are written in English, these can be used to prepare students to use technical English language embedded in questions on the science tests.

The underlying concern affiliated with the tensions of authority and knowledge is that individuals in local communities may be losing their personal sense of agency to construct knowledge that fits the context of their everyday experience. Like most places, everyday life in Iloilo is on the verge of significant change as social, cultural, and political contexts shift within the larger global community. Professional tensions are increasingly challenging how teachers make decisions about what science knowledge might be relevant to learners in the community.

Tensions of Professional Practice

The profession of teaching in the Philippines has traditionally been a well-respected career. In the Iloilo region, teachers are highly regarded within their communities. Teachers typically assume multiple roles that benefit the community as they serve, for example, as counselors and leaders. They receive a relatively high salary, so families will often encourage their daughters to become teachers so that they can provide household incomes for their families. Science teacher educators reported that competition has greatly increased among university students attempting to be accepted into the teacher education programs at WVSU. Professional tensions associated with science teaching are like those experienced by many elementary teachers around the world. It is challenging to be a science teacher in Iloilo because class sizes typically have 37–50 students even in kindergarten. Children usually sit at desks arranged in straight rows—primarily because the desks are designed such that the students' writing top is attached to the back of the chair directly in front of them. Iloilo children try to please their teachers. They are hesitant to raise their hands because this would be seen as being boastful or pretentious. There is a sense that students and teachers share a moral code that promotes cooperation, value for learning, and

mutual respect in the classroom. Teachers repeatedly emphasized their lack of materials to support hands-on science teaching, and the need for more professional development to support teachers' science learning. As teachers shared about conducting experiments in relation to the *Kangkong* case, it seemed apparent that they were finding creative ways to overcome constraints to provide practical science experiences in the classroom. Teachers were using center-approaches and integrating science with the teaching of Philipino language instruction as ways to manage science learning taking place.

One tension particularly raised by the *Kangkong* case concerned teachers' decision making about what knowledge should be taught within the science curriculum. This issue was somewhat addressed as a dilemma concerning the authority of knowledge, but at the intersection of professional practice there is a commitment on behalf of teachers to support indigenization within the science curriculum. In the case of teaching about plants, for example, teachers must teach not only scientific ideas about plant life but also traditional cultural knowledge about plant use in their community. The growth of traditional medicinal herbs in the school garden, for example, integrates Philipino cultural beliefs and values into the science curriculum. As we will see in the next case, tensions at the intersection of personal and public knowledge reflect the significance of indigenization and moral codes with respect to science teaching and learning.

Research Question 2: What Does the Case Experience Reveal about Science Teaching and Learning as a Culturally Constituted Practice?

Case 2: The Birds and the Flowers

by Belen A. Castigador

Grade 1 Critic Teacher

I'm Belen A. Castigador, a Grade 1 teacher for almost 20 years at West Visayas State University Integrated Elementary Laboratory School in La Paz, Iloilo City, Philippines. This school year, 1999–2000, I have 38 pupils in my class.

Teaching Grade 1 is both fun and challenging. In our Science class, children love grouping, classifying, touching, feeling, and smelling objects in some activities. Once in a while we introduce practical work to enhance cooperative learning.

There's not much problem in teaching science concepts to kids. However, there's one topic, Parts of our Body, in which I find it difficult to give pupils the exact terms for the female and male sex organs. Let me share this story.

One time, in the midst of the discussion of all parts of the body, one pupil asked:

Boy: What's this part of the body here, Ma'am?

Teacher: Well, this is what we call "bird."

[I was supposed to say *penis* but I didn't have the courage to say it to the kids. I used the word *bird* instead.]

Boy: What is the "bird" for? [What's the use of the "bird"?]

Teacher: You urinate with your "bird" If you don't have one, you'll be an abnormal person or else you'll die. So take good care of your "bird."

Boy: [Curious]: How about the girls? What do you call theirs?

> Teacher: We call it ''flower.'' Girls urinate through their ''flowers,'' too. Your mothers gave birth through their flowers. So everybody in this world passed through their mother's ''flower.''
>
> This is always the problem—not telling the kids the exact terms for the sex organs as *penis* and *vagina*. Perhaps these words are considered adults' utterances which make it hard/difficult for me to say them to Grade 1 pupils.
>
> I confess, for my long years of teaching at WVSU, I haven't introduced the above terms—always *flowers* and *birds*. Anyway, kids love to hear the flowers, the birds, the bees, and the trees!

The Birds and the Flowers case, as it came to be called, prompted rich, emotive, and insightful conversations throughout the study. At first glance, the major dilemma in Belen's case was perceived to be one involving the use of everyday versus technical science language. However, it soon became apparent in focus group and paired interview conversations that teachers' personal and public knowledge of science teaching and learning was clearly intertwined with multiple levels of discourse. These layers of discourse reflected the tensions of not shared language, explicit moral codes, and indigenization.

The Tension of Not Shared Language

Whereas Philipino and English are the official languages of instruction in schools, the Birds and the Flowers case highlights the dilemmas that emerge when science teaching and learning take place in the context of triple linguistic conventions. Although Philipino (predominately Tagalog) is recognized as the official language of the Philippines, it is spoken by only 29% of the Iloilo population (Smolicz, 1983). Whereas English is the mandated language of science and mathematics instruction, social sciences and related subjects are taught in Philipino. At home, students may be speaking additional dialects. As Rollnick (1998) pointed out, ''the medium of instruction has long been a bone of contention in the Philippines'' (p. 130). As they discussed the case, several teachers described the ways in which language served to constrain the expression of scientific ideas. One teacher recalled her teaching of the reproductive system: ''I really showed them the right pictures . . . and told them the right names [penis and vagina]. Of course, some of the pupils giggled so I told them, 'I think you have this reaction because at home your parents or other people from your home use a different word instead of this. There's some malice behind your mind so we have to clear it out.'' The dilemma became even more apparent as a student teacher shared, ''You know, in our place we have many dialects, so another place has another word for the sex organs. . . . So we have varied terms for the sex organs. So the connotation of each group, sometimes it's not pleasant to the ear because it seems it is a vulgar language or dirty word. So in English we have that [penis and vagina] but I don't have the courage to use them because for me it is about language.'' Elaborating on this discussion, Willa, a kindergarten teacher, added, ''We know culture is one factor in how you teach science, especially the body parts. In our language there are different dialects . . . the thing is in some dialects, in our terms it is not good to hear because you know we were brought up like that. I think our culture really affects how we say it.''

Almost all teachers preferred to teach the English vocabulary because of the vulgar connotation of the words when translated into the vernacular. But whereas some teachers were clearly more comfortable using the Bird and the Flower metaphor, others expressed a preference for using scientific terms in discussing the reproductive organs. Issues of truth and honesty were at the heart of the dilemma for Ray, a sixth-grade teacher: ''In my case, it seems the right concept

is more important than hiding the real things.'' Ray went on to add, ''I will tell them, please don't talk about this in public because it's quite private.'' For Ray, there was a clear distinction between personal and public science knowledge that was captured in issues of local dialect. As he explained, ''You know the name for the female [part]. We also have a certain bread with that name in our dialect. Every time I go to the bread shop and buy this bread I just pronounce the first letter of the name. I don't pronounce the word because for me it is something quite different. So teaching and using the terms when teaching the concept is different from using it in everyday life''. Agreeing with Ray, Lotis, a student teacher, recalled a situation in which one of her students said to her mother, ''Oh mom, you're a liar. I don't believe you anymore. You're kind of dishonest because you told me it's a bird and it's not actually, the name is not actually a bird, it's a penis.''

Filipino members of the research team identified many scientific words that do not have Ilonggo translations: *electricity, chlorophyll, pollination, pollen, fertilization, stamen, pistil, orbit, axis, rotation, revolution, cell, zygote, ovum, egg, sperm, equator, latitude, longitude, germs, bacteria, virus, experiment, variable, leukocytes, and cardiovascular*, to name a few. Language, however, is far more complex than linking words with single ideas or definitions. It requires agreed-upon conventions of communication and an understanding of ''how words are supposed to be used in relation to each other and in context'' (Ostman, 1998). That the word ''electricity'' has no equivalent term in Ilonggo is not surprising; some elementary schools such as Paaralan ng Buhay in Tanglad do not have electric service and others have received service only in the past 2 years. In the attempt to explain the meaning of electricity as it is used in the English language, it becomes necessary to use additional new and unfamiliar words or to draw on additional language terms such as *curriente*, borrowed from the Spanish. Ostman (1998) described this process as one which is ''everlasting . . . the meaning of a word always will be some way ahead, located in the future.'' In the case of the Birds and the Flowers, we were reminded that words are not isolated entities. For many of the teachers, the dilemma of whether to use the scientific terms for ''penis'' and ''vagina,'' common metaphors such as ''bird'' and ''flower,'' or vernacular explanations for these words was expressed in terms of a second level of discourse in which ''we don't talk about these anyway.'' This issue of personal and public knowledge was reflected in the tension of explicit moral codes.

The Tension of Explicit Moral Codes

Throughout this study, teachers' conversations emphasized that language is embedded in culture and reflects the way in which community practices and moral codes shape how they make sense of elementary science teaching and learning. Science teaching practices in Iloilo take place in a community where the provision of daily needs is often uncertain; several student teachers and teachers commented on vivid memories of personal hunger and family dependence on their ability to provide income. In this context, as Purita explained, the teacher is viewed ''as a source of economic good.'' It also takes place in a community where moral sayings on the walls in classrooms, offices, and other facilities are constant reminders about the importance of maintaining one's physical health, moral fortitude, national pride, and spirit of service to the community. Signs and symbols such as the following were common in all schools and reflected the strong emphasis placed on character building and religion as moral codes:

Work Principles

1. Serve God the best.
2. Strive for excellence and productivity.
3. Promote public morality, command responsibility and accountability.

4. Live simply and decently.
5. Value people and help them grow.
6. Demand action and performance.
7. Search incessantly for innovation.
8. Focus work targets and prioritize.
9. Model a higher sense of urgency.
10. Promote a clean work environment.

Amidst this pervasive atmosphere of morality, we were acutely aware of the importance of the connections among teachers, schools, and communities. Teachers and schools were trusted to watch out for and be vigilant for the community. Consequently, as Ruth, a fourth-grade teacher explained, ''It's in the Filipino culture that students would like to please their teacher.'' Tess added, ''The school is part of the community and it becomes the responsibility of a teacher to work with a community. So we include that in preservice training—community immersion is a separate subject. We call it 'the student and the community.'' Merl went on to explain how ''The teacher must retain contact and communication with the community—in this way she earns respect and support. . . . The effectiveness of the school does not end within the formal walls of the school. Parental assistance with regard to the learning problems of children and advocacy for education and community must be part of the school.'' The significance of these moral codes in the preparation of science teachers was signified by Odette's description of the qualities of a good science teacher: ''I think a good science teacher is one who . . . is a teacher of heart, not only in mind . . . because sometimes we would just focus on science, as science itself. Sometimes we forget to realize that there's some situations that science cannot do.''

Moral codes were perceived as essential to preserving a teaching and learning community. As Purita commented, ''You know, the thing that keeps us united, keeps us very close to each other and what we are emphasizing in school is that the classroom is a miniature community.'' Ultimately, moral codes are essential to the educational process in the Philippines, as there are no safety nets or options for those who do not succeed in school.

The Tension of Indigenization

Some researchers regard an understanding of the learner's indigenous culture to be a prerequisite to initiation into the culture of science (Rutherford, 1993). As mentioned earlier, others such as Aikenhead (1996) emphasize the negotiation of epistemological and linguistic borders which enable learners to move between the world of home and school science. Rampal's (1992) call for a fundamental redefinition of scientific discourse recognizes that communication goes beyond conversation; it includes cultural, historical, and linguistic conventions that mediate thought.

For many teachers and members of the research team, the role of language in science teaching and learning occupied an ambivalent position situated in the discourse of indigenization. Both teacher and Philipino team members expressed the belief that indigenization and efforts toward globalization were at odds with each other: ''In the process of making change we intrude in our own culture, especially when it comes to science and technology which is trying to move us ahead'' (Purita). The politics of indigenization is at the crux of science education reform in the Philippines as well as the Iloilo community. While faced with increasing opportunities for globalization, teachers and Filipino term members viewed globalization as inextricably linked, initially, to the development and maintenance of an indigenous identity. In this context, research team members clarified their use of the term *indigenization*: ''It refers to adapting the curriculum

to the community. That is, when we teach science we fit it to the needs of the community. It involves the application of scientific principles and concepts that make use of community settings and locally available materials (i.e., the resources of fishing villages and coconut farms). And it is the inclusion of strategies and courses that will help develop the love of one's community and country.'' The concept of indigenization was discussed interchangeably with the idea of localization, a major reform initiative emphasizing the building of educational resources around local knowledge. Localization, as part of the social reform agenda, encourages teachers to return to their rural *barangays* to teach and live out their lives. Social structure and economic order occur at a slower pace in these rural communities where traditional norms and values continue to influence education such that development emphasizes regional interpretations of centralized curriculum.

From the perspective of research team members, indigenization was viewed as the opening of Pandora's box. Reflecting on the right of the university to introduce change through globalization, they pondered the significance of international assessments such as the Third International Mathematics and Science Study that are grounded in a global heuristic of science education reform. As Tess stated, ''The basic question is . . . should the University, who has a different culture, introduce [globalization] to a community that has never been touched or should the community teach us?'' Purita continued, ''In some ways you have to stick to something indigenous, and in some ways you have to go global. I mean, you have to compete globally.'' For team members, the notion of competing globally was based on a referent of equity. The concept of global competition centered on equal opportunities and equalizing the playing field. As Tess explained, ''It is not really competing; it's only becoming a part of an international standard.'' As another team member explained, in many ways the concept of community building, which is at the heart of Filipino education, ''prepares one to participate in but not compete in a global community.''

Teachers' reactions to the dilemmas of the Birds and the Flowers case further illustrated the potential for pressures of globalization to undermine the linguistic stability of Filipino children. In the Iloilo community, in particular, where English and Filipino languages exist alongside many non-Filipino vernacular dialects, these tensions continue to have educational, political, and economic ramifications.

Research Question 3: How Does the Case Experience Serve as an Intersection for Creating a Multicultural Science Teacher Learning Community?

When the research team initially conceptualized this research project, the agenda was to have teachers write and respond to cases about their teaching. It was assumed that the content of the cases would serve as windows on dilemmas that challenge science teaching in Filipino elementary classrooms. However, as we became more involved as a team working together and with teacher colleagues who wrote and discussed cases, the very nature of our experience learning with each other became an interesting situation to examine. The case experience presented an interesting context to learn about creating a community among a culturally diverse group of learners—in this case, of teacher-learners. Historically, scholars from the outside (i.e., Australia, Japan, United States) have been viewed as experts bringing needed knowledge. At first it was assumed that U.S. team members would play the role of experts in the research process. However, the research team initially invested a great deal of time and energy in getting to know one another and building relationships. We explicitly shared with each other our common interest in operating as a community of learners. This relational framework was extended to the interactions that took place throughout the case experience. Accordingly, the tensions of

teachers' identities and problems of science teaching played important roles in creating a unique relationship we came to regard as a teacher learning community.

Tensions of Identity

As the case sessions came to an end, participants began bringing notes of thanks and gifts to the research team. One student teacher gave the American colleagues a personal portfolio of appreciation for her experience in the case sessions. There was such an inexpressible sense that something special had taken place through the case-based approach—teacher learning quite unlike most professional development sessions we had previously experienced with teachers. We referred to this aspect of our research as tensions associated with our senses of identity. In setting up workshops and discussion groups, the research team members conscientiously avoided rituals that might assign a special level of status to individuals within the group. The case-writing workshop began with everyone introducing themselves instead of a formal introduction that might signify some persons as being more important than others. Iloilo colleagues also engaged in singing to bring participants together for meetings, and during moments of transition between meeting activities. We sang Filipino songs and some familiar English tunes, including ''Welcome to the Family'' and ''Make New Friends.'' Singing had the effect of creating a sense of informality and an upbeat spirit among participants; to American colleagues in the group, this practice was distinctly unique from their prior experiences in professional teacher learning. These practices, ever so subtle, seemed significant in creating a learning environment that encouraged participation among group members.

This was the first time teachers in the group had been involved in professional development of this nature—where teachers provided the contexts and knowledge to be considered for their teacher learning. Marietta, a Grade 1 teacher, and Ruth, a Grade 4 teacher, compared how critic teachers have historically been trained for student teacher supervision in contrast to their experience of teacher-learning through case-based pedagogy:

> Researcher: How are you prepared to supervise a student teacher?
>
> Marietta: We are given some seminars. We learn how to handle student teachers. If you are in your first year in the laboratory school, the usual practice is they don't give you a student teacher yet. You are going to make some observations until you develop some skills on how to supervise student teachers. So, you will be trained by teachers who have been in the service a long time—peer training . . . Researcher: So what surprises you about the whole thing [the case experience]?
>
> Ruth: It surprised me just to think you will be sitting with your student teacher side by side and discuss openly what you are inside. . . . This is the first time that we did [this] and the surprise came that there are all these little stories that happened in the room that are very significant in our own teaching process.
>
> Marietta: . . . I think it [case experience] is very important because that is the only way we can understand our student teachers better, and understand also, and we will also try to understand [ourselves] because we have our little things inside us which really puzzle us sometimes. So we are in favor of doing some case studies now and then.

The case experience was more than a novel professional development approach; it also created new ways for seeing each other: the notion that everyone had a dilemma to share worked toward, as one research team member described it, ''leveling'' everyone. One student teacher

reflected that hearing teachers talk about problems in their teaching helped her feel closer to experienced teachers because ''No one is above having problems.'' When we asked participants how they felt about their involvement in the case-based discussions, a number of student teachers, including Lossel, made comments such as: ''Being with the group, the teachers, I felt also like a real teacher. I enjoyed sharing with the different teachers, especially listening to their different ideas about things. Then I'm very happy, too, that they are here to help me learn how to deal with different problems that I might face inside the classroom.''

Experienced teachers indicated that the case experience shifted how they related to student teachers. Marietta demonstrated such a shift as a result of hearing her student teacher, Lotis, share her reflections through the *Kangkong* case. Before hearing Lotis share her case, Marietta had merely thought of learning to teach science as a matter of the student teacher ''following what the critic teacher did and using the class texts.'' Later, Marietta expressed feelings of regret for having asked Lotis to apologize to the parent for her decision to mark the student's test response as incorrect. Marietta had not realized the extent to which the situation had created feelings of distress for Lotis. Marietta began to see student teachers as more than apprentices passively adopting teaching techniques; rather, like herself, she began to view student teachers as individuals who bring personal history and heart to the classroom—in need of professional ''care'' (Noddings, 1992) to support their teacher learning. Ruth described the potential of case-based pedagogy in teacher education as a way to look beyond observable science teacher practices to consider the more intangible aspects of being a science teacher:

> I am also in favor of doing [case narratives] because in that matter we can monitor not only the technical aspect of teaching but most likely the emotional part—the psychological part which makes a teacher more confident—a better teacher, and a teacher that can relate well to others. I know if you have a deep set of problems within you, you cannot teach very well.

Involvement in the professional discourse of case sharing brought together a multicultural body of practitioners. Describing ourselves as a multicultural group highlighted our shared identities as teachers of science; it also was a reminder of the potential for mythologies associated with our diverse histories (e.g., stereotypes of American or Filipino culture, student teachers as novices, teachers as experts) to undermine ways we might relate with each other. When we asked Willa how she felt about being involved in the group sharing of cases, she responded:

> Willa: I felt comfortable about it. It's a nice experience for both teachers and student teachers because we're learning from them. Some of the things they're not telling us—they hide it. And some of the things that we don't know about the different classrooms—[we hide] from each other. There are some teachers we can't find the time to talk about science, so in that activity we have one common denominator—that is science. So we talk about the experiences, and some things that happen inside the classroom, so it gave us time to share our own feelings about the classroom, our dilemmas, about the students, about some such matters that we're having inside the classroom. And it's also relaxing to find somebody who can understand you in terms of—this is my problem, well, how should I handle this?
>
> Researcher: You don't feel alone.
>
> Willa: Yeah, you don't feel alone. And, oh! I am not depressed about it because she is also experiencing it! Because, if there's no activity such as this, you'll feel I'm the problematic person in this room because I can't handle it anymore. But through that activity I can say that—Ah, I think that I can solve this. She's not going to laugh at me because I have this

> kind of problem. And for the teacher, that's an encouragement that we have learned something from our colleagues—and for the student teachers also. It develops relationships. Openness that they have somebody there to be trusted.

Willa's comments articulate the sense of community that developed in the short time our group interacted together. The sharing of cases provided a shared context for diverse practitioners to vicariously gather around a place—the imagined classroom—to jointly think through the multiple and complex ways of dealing with a science teaching dilemma. The idea that dilemmas served as a nexus for teacher learning presented an additional tension significant in creating our sense of being a science teacher–learning community.

Tensions of Dilemmas in Science Teaching

Posing science teaching as complex webs of dilemmas created tensions as it represented science teaching as problematic. The narrative nature of our discussion also created tensions because it was difficult for participants to simply and comfortably adopt a position for looking at and talking about science teaching and learning. Seeing science teaching through dilemmas was a novel experience for many teachers and encouraged them to look more closely at the thinking and activities taking place in their classrooms. Willa commented: ''You have to learn from every day's activity and even some minute things that are happening in your classroom. You should really be a keen observer about it!'' Case sharing helped participants reflect more deeply on classroom practices through problematizing practices they might otherwise take for granted. As one student teacher, Lotis, commented:

> It [the case study] awakens me. It awakens me of all the things that are happening inside the classroom. Before, I didn't see any problems, but during our discussion I realized that it's really a problem and that it really happens.

Several participants described the cases as little stories or caselets that connected to larger issues in their science teaching practices. The narrative representations of science teaching created holistic ways of examining practice. Through the cases, Odette perceived the systemic nature of how classroom science teaching and learning dilemmas are situated in larger contexts beyond the classroom: ''I have come to realize that the dilemma not only arises when in the classroom situation but also it arises outside—not inside the school, but outside in the community.''

The discussions of cases gave teachers a chance to identify their own science teaching problems and see that knowledge for dealing with their dilemmas was available from among their colleagues. Hearing the different perspectives teachers brought to the discussions revealed multiple possibilities for analyzing and responding to problems. For one teacher, the case experience revealed science teaching and learning as a multicultural practice: ''I realized that behavior of a teacher can affect the learning of a student. Because, in our group discussion, we all have our points of view—different kinds of perception. . . . And I realize that there are some teachers who are like this and some teachers are like that.'' Such insights were extended by some teachers to consider the negotiation of curriculum they had experienced as a new way to reframe how science teaching and learning take place in their own classroom, as one teacher commented: ''I will also apply this [focus group format] to the student teachers as well as to the children—because the children also need discussion, just like we did last time. . . . It enhances creativity and critical thinking and a lot of observation.'' A sense of union or community developed among

participants through the case experience. We laughed together as we envisioned ourselves in the familiar surroundings of children learning about birds and flowers, and vicariously imagined the discomfort felt when confronted by a parent about a decision made in the classroom. The workshops could have been described merely as the assembly of novice and experienced teachers, or of Filipino and American science educators, or teachers and researchers; at times, such labels might have helped to characterize participants' expressions and actions. However, the identities nurtured through our interactions gave us a sense of community described by Sergiovanni as kinship, place, mind, and memory—ways of relating that transcended professional and national boundaries. The reconstruction of our identities and representations of science teaching as dilemmas enabled us to experience an alternative approach to teachers' professional development as a mode of curriculum inquiry.

Transforming Science Teacher Education through Cases: Implications for Research and Practice

This study describes several findings with implications for understanding the limits and possibilities of a case-based curriculum for preservice science teacher education. It is clear that the case experience brings to the forefront dilemmas and issues typically considered taboo. Both pre- and inservice science teachers in this study developed an awareness of assumptions that influenced how they made sense of dilemmas they encountered in their professional lives. It is also apparent that the introduction of case-based pedagogy stimulated aspects of critical reflection involving open-mindedness, responsibility, and wholeheartedness. Similarly, for all participants it required a rethinking of forms of cultural authority and negotiation of the language of science. On the one hand, this study points to the benefits of posing questions and producing case-based knowledge with significance in the development of a science teaching and learning community.

On the other hand, this study is also an evolving story of our lived experiences as a multicultural research community which can truly be characterized by *Gemeinschaft* of kinship, place, mind, and memory. It is a story which is developing, changing and being transmitted through our conversations and mediated by our interpretations. Because of the diversity of our interests and values, it is a story which has an inherent sociopolitical character. It is a story which involves negotiating collaboration and research among international partners and a rethinking of how science education researchers interpret science teacher education programs in diverse contexts. As all team members agree, it is a story without which our lives and practices would hold less meaning.

As we consider the call to teach science for all, we recognize it is challenging to educate prospective teachers about teaching science in ways that are negotiated, just, and authentically represent the nature of science. Cases can provide a virtual gathering place for teacher learners to consider complex dilemmas and multiple possibilities that might arise in teaching science informed through discourse involving the insights of others and experienced mentors. Case-based pedagogy can serve as an opportunity to teach critical inquiry practices by highlighting and critiquing deeply held assumptions that might otherwise go unnoticed, and that might inequitably affect science teaching and learning in classrooms.

In this study, experienced teachers were available to share their insights with prospective teachers as the cases were discussed. A critically important condition for using case-based pedagogy is ensuring access to multiple points of view, because this is a requisite of discourse in the fullest sense of the term. We would strongly suggest that if classroom practitioners cannot be physically available to provide input, alternative approaches should be used to represent their

viewpoints. For example, classroom teachers might write responses to cases that can be read aloud to classes or accessed via the Internet. It is hoped that dialogue among teachers will bring into view different interpretations, not all of which will be desirable for encouraging teachers to rethink science and learning practices. How can we engage prospective teachers in educative discourses that do not merely work to reproduce hegemonic science teaching practices? Historically, university science teacher educators have acted as censors and moderators of views presented in science teacher education curriculum. Such practices circumvent curriculum inquiry and might better inform science teachers' curriculum decision making. The processes of dialogue and critique experienced through case-based pedagogy can serve as a means for prospective teachers to envision ways they can engage students in curricular negotiations.

Curriculum negotiation is fundamental to case-based pedagogy inasmuch as it reinstates human agency as the heart of science teaching and learning. Agency concerns the way we construct ourselves as meaning makers and actors subject to relations of power and culture that shape our thoughts and actions (Gore, 1993). With the notion of agency in mind, we explored tensions associated with science education as a culturally constituted practice. Accordingly, we considered tensions generated as students and teachers interact within the nexus of complex narrative histories that shape science teaching and learning in schools. The currents of local to global discourses problematize enabling teachers' and students' sense of agency—particularly as tensions promoting globalization disenfranchise us from narratives that could envision science curricular goals and practices as they are important to local communities. Such tensions can be seen in issues arising as our Filipino colleagues juggle the caveats of pursuing participation in global marketplaces while striving to maintain indigenization.

The research team was acutely aware of the strong sense of moral consciousness expressed throughout the classrooms and community of Iloilo, particularly as it maintains a problematized discourse about local to global interests. Amidst a backdrop of rapid change, Ilonggo culture is in transition and traditional values are continually challenged by new ideas brought about by modernization and the complexity of today's world. Science teachers are specifically charged with ''the function of teaching what society wants in terms of building the moral and ethical standards of the group'' (Salcedo, Peralta, Ronquillo, & Espiritu, 1999, p. 38). American education seems to have lost this sense of consciousness and, by extension, a sense of agency in science curriculum decision making. Current emphases placed on state, national, and international assessments fuel the drive to develop and reproduce teaching practices that can efficiently teach students what is needed to improve their performance on these tests. The allure of capitalist gains that in turn promote global competition further encourages schools to adopt technical orientations toward thinking about school practices in general. The complex and systemic nature of problems represented in teachers' little stories offers an alternative view of teaching and learning that interferes with the productivity metaphor that currently drives how we envision the goals and roles of schools. The rhetoric of school reform, as it is embedded in larger economic and political contexts, creates dilemmas for teachers because their knowledge about classroom life may be unacknowledged or denied in discourse about ways to improve science education. Practices in science teaching and research that privilege particular viewpoints at the expense of denying individuals' personal knowledge and experience has helped proliferate hegemonies that undermine teaching science for all.

An important implication we feel our work encourages is the need for alternative genres of research to inform how we look at science teaching and learning in today's classrooms. Using the framework of community and a narrative methodology provided a context to learn about our different dilemmas and to learn from our experience as we explored dilemmas. We presented our study findings as tensions and intersections to reflect the nature of our research process as a

complex web of experiences. The nature of our work problematized the production of a grand narrative which might neatly allow us to compare and contrast science teacher education as Filipino versus First-World practices. Instead, our efforts to understand each other in light of our multiple identities as international colleagues, science learners and teachers, mothers, traditionalists, feminists, and so forth created a dynamic that continually challenged our assumptions about each other. This was an important reminder of the ways language, and specifically in this case, labels related to identity, constitute how we see ourselves and others. Accordingly, we need to give serious consideration to the ways science education research constitutes our perceptions of who we are and how we are evolving as science education communities. Multiple research approaches and foci are needed to maintain tensions that can sustain meaningful dialogue about science education reform in local to global contexts.

Note

The major languages of the Philippines, in addition to Tagalog, include Cebuano, Ilokano, Hiligaynon, Bicol, Waray, Kapampanhan, and Pangasinan. Although they are often referred to as the vernaculars or dialects, they actually constitute distinct languages. Throughout the Iloilo province, many languages and dialects are used interchangeably on a daily basis. As Filipino research team members explained, confusion is experienced as technical and cultural nuances vary across linguistic communities.

References

Abell, S.K., & Bryan, L.A. (1997). Reconceptualizing the elementary science methods course using a reflective orientation. Journal of Research in Science Teaching, 8, 153–166.

Abell, S.K., Cennamo, K.S., Anderson, M.A., Bryan, L.A., Campbell, L.M., & Hug, J.W. (1996). Integrated media classroom cases in elementary science teacher education. Journal of Computers in Mathematics and Science Teaching, 15, 137–151.

Aikenhead, G.S. (1996). Science education: Border crossing into the subculture of science. Studies in Science Education, 27, 1–52.

Airini (1999). Research that creates community. Journal of Critical Inquiry into Curriculum and Instruction, 1, 40–41.

Akatugba, A.H., & Wallace, J. (1999). Sociocultural influences on physics students' use of proportional reasoning in a non-Western country. Journal of Research in Science Teaching, 36, 305–320.

Barth, R.S. (1990). Improving schools from within: Teachers, parents, and principals can make the difference. San Francisco: Jossey-Bass.

Bohm, D. (1992). On dialogue. Noetic Sciences Review, 23, 16–18.

Boykin, A.W., Yagers, R.J., Ellison, C.M., & Albury, A.S. (1997). The communalism scale and collectivistic-individualistic tendencies: Some preliminary findings. Journal of Black Psychology, 21, 153–162.

Connelly, E.M., & Clandinin, D.J. (2000). Narrative inquiry: Experience and story in qualitative research. San Francisco: Jossey-Bass.

Costa, V.B. (1995). When science is ''another world'': Relationships between worlds of family, friends, school, and science. Science Education, 79, 313–333.

Cuban, L. (1992). Managing dilemmas while building professional communities. Educational Researcher, 21, 4–11.

Gess-Newsome, J., & Southerland, S.A. (in press). Teaching science for all. In S.E. Wade (Ed.), Preparing teachers for inclusive education: Case pedagogies and curricula for teacher educators. Mahwah, NJ: Erlbaum.

Gore, J.M. (1993). The struggle for pedagogies: Critical and feminist discourses as regimes of truth. New York: Rutledge.

Grossman, P. (1992). Why models matter: An alternative view on professional growth in teaching. Review of Educational Research, 62, 171–179.

Gundykundst, W., Matsumato, Y., Ting-Toomey, S., Niched, J., Kim, K., & Heyman, S. (1996). The influence of cultural individualism-collectivism, self-construals, and individual values on communication styles across cultures. Human Communication Research, 22, 510–543.

Harrington, H. (1995). Fostering reasoned decisions: Case-based pedagogy and the professional development of teachers. Teaching and Teacher Education, 11, 203–241.

Hofstede, C. (1980). Culture's consequences. Beverly Hills, CA: Sage.

Howe, A.C., & Nichols, S.E. (Eds.). (2000). Case studies in elementary science: Learning from teachers. Upper Saddle River, NJ: Merrill Prentice Hall.

Jegede, O.J., & Okebukola, P.A. (1992). Differences in sociocultural environment perceptions associated with gender in science classrooms. Journal of Research in Science Teaching, 36, 1–7.

Kincheloe, J.L. (1998). Critical research in science education. In B.J. Fraser & K.G. Tobin (Eds.), International handbook of science education (Part 2, pp. 1191–1206). Dordrecht, The Netherlands: Kluwer Academic.

Koballa, T., & Tippins, D. (Eds.). (2000). Cases in middle and secondary science education: The promises and dilemmas. Upper Saddle River, NJ: Merrill Prentice Hall.

Kyle, W.C. (1999). Science education in developing countries: Challenging First World hegemony in a global context. Journal of Research in Science Teaching, 36, 255–260.

Loucks-Horsley, S., Hewson, P.W., Love, N., & Stiles, K.E. (1998). Designing professional development for teachers of science and mathematics (pp. 103–113). Thousand Oaks, CA: Corwin Press.

Lundeberg, M.A. (1999). Discovering teaching and learning through cases. In M.A. Lundeberg, B.B. Levin & H.L. Harrington (Eds.), Who learns what from cases and how? The research base for teaching and learning with cases. Mahwah, NJ: Erlbaum.

Merseth, K.K. (1991). The case for cases in teacher education. Washington, DC: American Association for Higher Education and American Association for Colleges of Teacher Education.

Merseth, K.K. (1996). Cases and the case method in teacher education. In J. Sikula (Ed.), Handbook of research in teacher education (pp. 742–746). New York: Simon & Schuster/ Macmillan.

Merseth, K.K. (2000). A rationale for case-based pedagogy in teacher education. In M.A. Lundeberg, B.B. Levin, & H.L. Harrington (Eds.), Who learns what from cases and how? The research base for teaching and learning with cases (pp. ix–xv). Mahwah, NJ: Erlbaum.

Noddings, N. (1992). The challenge to care in schools: An alternative approach to education. New York: Teachers College Press.

Ostman, L. (1998). How companion meanings are expressed in science education discourse. In D.A. Roberts & L. Ostman (Eds.), Problems of meaning in science curriculum. New York: Teachers College Press.

Polkinghorne, D.E. (1997). Reporting qualitative research as practice. In W.G. Tierney & Y.S. Lincoln (Eds.), Representation and the text: Re-framing the narrative voice (pp. 3–22). Albany: State University of New York.

Rampal, A. (1992). A possible ''Orality'' for science. Interchange, 23, 144–227.

Rollnick, M. (1998). Language and science education. In W.W. Cobern (Ed.), Socio-cultural perspectives on science education (pp. 121–138). Dordrecht, The Netherlands: Kluwer Academic.

Rutherford, M. (1993, August). Making scientific language accessible to science learners. Paper presented at the First Annual Meeting of the Southern African Association for Research in Mathematics and Science Education (SAARMSE), Grahamstown, South Africa.

Salcedo, L.L., Peralta, A.R., Ronquillo, A.A., & Espiritu, S.C. (1999). Social issues. Quezon City, Philippines: Katha Publishing.

Sergiovanni, T.J. (1994). Building community in schools. San Francisco: Jossey-Bass.

Shulman, L.S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4–14.

Shumba, O. (1999). Relationship between secondary science teachers' orientations to traditional culture and beliefs concerning science instructional ideology. Journal of Research in Science Teaching, 36, 333–355.

Singelis, T.M., & Brown, W.J. (1995). Culture, self and collectivist communication: Linking culture to individual behavior. Human Communication Research, 21, 354–389.

Smolicz, J.J. (1983). Science education and values: Cultural and linguistic barriers to education in the Philippines (Occasional Paper No. 2). Quezon City: University of the Philippines.

Smylie, M.A., Bay, M., & Tozer, S.E. (1999). Preparing teachers as agents of change. In G.A. Griffin (Ed.), The education of teachers: Ninety-eighth yearbook of the National Society for the Study of Education, (pp. 29–62). Chicago: University of Chicago Press.

Snively, G., & Corsiglia, J. (1998, April). Rediscovering indigenous science: Implications for science education. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, CA.

Tippins, D., Nichols, S., & Dana, T. (1999). Exploring novice and experienced elementary teachers' science teaching and learning referents through videocases. Research in Science Education, 29, 331–352.

Waldrip, B.G., & Taylor, P.C. (1999). Permeability of students' worldviews to their school views in a non-Western developing country. Journal of Research in Science Teaching, 36, 289–303.

Welty, W.M., Silverman, R., & Lyon, S. (1991, April). Student outcomes from teaching cases. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.