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Sharing the Environment: Cultural Exchange through Inquiry-Based Environmental Education in Trinidad and Tobago (T & T) and the United States

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Abstract: This study examined the effects of Sharing the Environment (STE), a situated professional development pilot program that uses an inquiry-based approach to teaching Environmental Education (EE) to elementary students in the US and Trinidad. Inquiry is difficult to incorporate in both cultures because proficient performance on national tests is a priority. As a result, teachers must cover the curriculum via transmission of knowledge rather than its discovery. In order to capture an early understanding of the effects of this program on its participants, focus groups and ethnographic interviews were conducted with ten participating teachers from both countries. Using a grounded theory approach on the data sets, three themes emerged that describe conditions required for replicating this program: structural, cross-curricular, and cultural disconnections, technological needs, and environmental and sociocultural knowledge gains. The findings indicate that cultural factors had a significant impact on how Trinidadian and American teachers and administrators perceived, valued, and reacted to the concrete experiences they had in the course of their participation in the STE situated professional development program.

Keywords: Situated professional development; Environmental Education; inquiry-based teaching; distance learning; United States; Trinidad and Tobago; sociocultural

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Introduction

Inquiry-based teaching and learning has long been recognized as best practice in elementary science education (Bybee, 1997; Eisenkraft, 2003; Llewlyn, 2002; Yager, 2005). Yet for teachers, who are already subject to tremendous external pressures from administrators, parents, and policymakers to produce quantifiable evidence of student knowledge gains, trying to change from a traditional focus on teaching facts to a focus on "student understanding and use of scientific knowledge, ideas, and inquiry practices" (Yager, 2005, p. 18) can be a major struggle. Inquiry-based teaching and learning, with its focus on the construction of meaning through the learner's direct engagement with the phenomenon under study (Llewelyn, 2002), can be described as a replication of authentic scientific investigation and a means of channeling natural human curiosity towards specified learning outcomes. However, even though this approach has long been touted as an effective pedagogy, its application by elementary classroom teachers has been problematic.

In particular, the field of Environmental Education (EE) struggles with incorporating inquiry into classrooms and informal settings as well. But using inquiry may in fact help teachers and their students recognize and comprehend the essential content embedded in environmental science by using a variety of examples in very different geographical contexts to strengthen conceptual understanding. It is this conceptual understanding upon which environmental literacy and stewardship are based. Sharing the Environment (STE) is a situated professional development pilot program centered on inquiry-based instructional strategies that teachers can understand and implement as they help their students develop conceptual understanding of environmental concepts and associated problems. Since the goal of any professional development program is "to create a transparent link between the content found in a staff development workshop and a teacher's classroom" (Sugar, 2005, p. 550), STE's situated professional development approach focuses on specific teacher needs within the context of their very specific environments – classrooms in two different countries representing diverse ecologies and cultures.

Literature Review

What is Inquiry-Based Teaching and Learning?

The basis for classroom inquiry can be found within various traditions of constructivism and social constructivism, including a blend of ideas from Dewey, Herbart, Piaget, Vygotsky, and Bruner together with more-recent findings from misconceptions researchers (Moyer, Hacket and Everett, 2007; Bybee, Taylor, Gardner, Van Scotter, Carlson Powell, Westbrook, & Landes, 2006). A common thread amongst these underpinnings for inquiry is "the notion that all people normally try to make sense of their world. Although most of us operate with far less precision than does a scientist, we still seek to explain, predict, and control our experiences" (Moyer, et al., 2007, p. 12).

Learners constantly view the world through the lens of what they already know (Martin, Sexton, & Gerlovich, 1999; Shepardson and Harbor, 2006). New experiences often conflict with a student's prior knowledge and existing cognitive structures must be revised through assimilation or accommodation in order for the student to gain accurate understanding of his or her world. The assimilation or accommodation of new ideas into existing cognitive schemas is dependent on student-directed inquiry within a specific cultural discourse.

The Learning Cycle is a pedagogical model that translates the theories purported in the constructivist tradition because it utilizes students' prior knowledge to view all new experience. The Learning Cycle, originally conceived by Karplus and Thier (1967) holds that the premise of inquiry-based teaching lies in its reliance on student experience and engagement with phenomena. Through these direct

experiences, children use their innate ability to develop conceptual understanding that is scientifically accurate and developmentally appropriate. The Karplus and Thier model (1967) includes three phases: Exploration, Concept Development, and Application. In a later model, this framework grows to include the 5E's–Engage, Explore, Explain, Elaborate, and Evaluate (Bybee, 1997); and eventually the 7E's (Eisenkraft, 2003), where the Engage phase of the 5E model is split into Elicit and Engage; and the Elaborate and Evaluate phases of the 5E model become Elaborate, Evaluate and Extend.

Bybee's 5E Model of Inquiry has become the basis for many current US classroom resources (*Full Option Science System (FOSS); Science, Technology, and Children (STC)*; and *Insights*) as well as pre-service methods courses and in-service professional development programs. This 5E model formed the basis for teacher training in the STE project in the US and Trinidad & Tobago (T & T).

Issues with Implementing Inquiry Practices

Though 45 years have passed and much research has been conducted that examines inquiry as a viable and effective means of developing scientific proficiency in elementary aged children, US students still lag behind their international counterparts in science. In the US, the National Science Teachers Association (NSTA) recently described US improvements in science as "miniscule…When you consider the importance of being scientifically literate in today's global economy, these scores are simply unacceptable" (Wheeler, 2012, para. 3). The 2009 administration of the PISA (Progress for International Student Assessment) placed only 9.9% of all US 15 year olds at or above proficiency level 5 and 17.6% at or below proficiency level 2 for science (National Center for Education Statistics [NCES], 2009).

NSTA links this lackluster achievement to the need for high quality teachers with a "strong background in the science they are teaching, access to ongoing professional development, adequate resources, and time in the school day to plan with colleagues is critical if we want to increase student achievement in science" (Wheeler, 2012, para. 3). It is apparent that even though the resources for changing this situation are available, they do not appear to be within reach of elementary science teachers and their students in the US.

In Trinidad and Tobago, the status of science proficiency in schools is equally dismal. The 2009 PISA results placed only 2.3% of all T & T 15 year olds at or above proficiency level 5 and 44.8% at or below proficiency level 2 for science (NCES, 2009). Just as in the US, the status of teacher preparation in this country has also been scrutinized to determine its relation to students' poor performance. Lewin and Stuart (2003) describe teacher education in T & T as operating from a "banking view" where the acquisition of a tremendous "amount of subject matter knowledge and standard pedagogies can be applied uniformly in any school" (p. 177). Typically in T & T, primary school teachers are secondary school graduates who have completed nine months of On the Job Training (OJT) before gaining entry to the two-year teaching college (George & Quamina-Aiyejina, 2003). MUSTER, Multi-Site Teacher Education Research Project (George & Quamina-Aiyejina, 2003), a series of Education Papers issued by the Policy Division of the Department For International Development, describes the unanimous view that trainees and teacher educators have of their preparation in T & T. Trainees and teacher educators describe the teacher training curriculum as overcrowded and without sufficient time provided for deep understanding of content or pedagogy; they also agree on "the stressful nature of the teaching practice wherein trainees' performance is being assessed even from the first teaching practice session" (George & Quamina-Aiyejina, 2003, p. xi-xii). Therefore, teacher trainees in T & T experience difficulty entering into their primary science classrooms due to feelings of inadequate preparation and lack of mentoring/induction in under-resourced classroom settings. As a result, "newly qualified teachers have been found to focus on survival strategies in their

post- teachers' college teaching and to replace the recommended strategies they had learnt in college with practical solutions that provide some results" (George & Quamina-Aiyejina, 2003, p. xii).

Inquiry and Environmental Education

Within the context of Environmental Education (EE), frequently viewed as a subset of science and social studies education, the focus on student inquiry is even more elusive. In the US, federal legislation (*No Child Left Behind*, 2001) currently mandates annual standardized achievement tests and strict accountability rules; schools whose students do not meet minimum proficiency requirements are faced with a myriad of interventions toward accountability. This same legislation has also created criteria for effective professional development highlighting the need to improve teacher pedagogical content knowledge, knowledge of subject matter and understanding of specific learning difficulties and student conceptions related to this content. Though many teaching resources are grounded in accurate environmental science and best practices, professional development sessions are typically delivered by non-formal educators who are, more often than not, content specialists with little pedagogical training. In fact, insufficient and/or inappropriate training can be considered one of the predominant reasons K-12 teachers are not teaching EE even though it was identified as a curricular field for elementary and secondary school students in the National Environmental Education Act (1990) and was first defined as a curricular area in 1969.

In T & T, teachers experience similar difficulties with inquiry and EE. For example, in examining pedagogical practices in the Republic of Trinidad and Tobago, Armstrong (2005) describes how this island nation narrowly focuses on traditional subject areas that do little to introduce students to environmental issues and their related social components. Though the Ministry of Education has embedded EE in the new science and social studies curricula:

> The method by which teachers deliver these concepts has remained the same…[with a] heavy reliance on textbooks, note taking and regurgitation of information with very little critical thinking and linking of related concepts and ideas. In addition, students are confined to the classroom and inactive for the majority of the day – which is unnatural for any child. (Armstrong, 2005, p. 229)

This teaching method represents the norm in Trinidad and Tobago. It is deeply ingrained in the national culture, reinforced by an entrenched system that distributes higher education and employment opportunities according to students' performance on nationally administered standardized tests. It is not surprising then, that any attempts to depart from this norm are met with significant resistance from parents, teachers, school administrators, and students who recognize that, despite their shortcomings, traditional Trinidadian teaching methods remain effective for preparing students for the narrow range of knowledge covered in the battery of requisite standardized tests administered by the state.

According to the US National Staff Development Council, "increasing the effectiveness of professional learning is the leverage point with the greatest potential for strengthening and refining the day-to-day performance of education" (Learning Forward, 2012, p. 3). If professional development holds this capacity, then it is necessary to examine the most effective and efficient means of delivering these opportunities. Standards for effective professional development:

- Include a concentrated focus on professional learning experiences that must be based on content derived from standards.
- Include reflection, practice, and planning time for teachers,
- Are comprised of activities that build inquiry skills and demonstrate modeling of these skills.
- Highlight effective and consistent assessment activities.

- Address concerns regarding changes in teaching, school and students.
- Are intensive and sustained (Parsons & Summers, 2004; Supovitz & Turner, 2000; Danter, 2005).
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In both countries conditions are not conducive to teaching environmental material, which is of itself, very dynamic and encourages or even requires personal interaction with the material. Teachers in both the US and T & T are limited by their training as well as the rigid constraints of state-mandated standardized testing, which narrows curricula to the transmission of discrete facts that are part of each nation's assessment system rather than the construction of conceptual understanding.

Purpose of the Study

EE is grounded in ecological interrelationships (McHenry, 1993). Inquiry-based EE programs purposefully help students compare and contrast a variety of ecosystems so they can successfully develop conceptual understandings of how these systems work. Children need to see that ecologic principles are the same regardless of context. These different environmental contexts need not be separated by national borders, but they need to be diverse enough to provide multiple concrete examples of how common ecological dynamics exist across a wide variety of ecosystems. By examining two very different environmental contexts in the US and T & T, students can begin to recognize and understand common systemic features and effectively analyze the implications of human action on a variety of ecosystems.

Effective professional development programs are critical to giving teachers the requisite skills and dispositions to guide students to this level of understanding (Fleming, 2009). The purpose of this study is to examine the effectiveness of STE, a situated professional development program focused on inquiry-based teaching practices, by evaluating how cultural factors impacted the ways teachers and administrators perceived the concrete experiences they had in the course of their participation in the program. Specifically, this preliminary study focuses on the challenges surrounding connecting student populations situated in different environmental and cultural contexts and the critical role culture plays in mediating the experiences associated with this process. Cultural factors have received scant attention in the academic literature on inquiry-based learning yet Borko describes situative perspectives as those that "conceptualize learning as changes in participation in socially organized activities, and individuals' use of knowledge as an aspect of their participation in social practices… scholars have argued that the learning process is one of enculturation and construction (2004, p. 4). As the first study of the STE program, this research reveals potential issues produced by the real and perceived cultural differences between the various groups involved in the implementation of a transnational inquiry-based EE program. These potential issues may be critical to that program's future success or failure.

The Environmental Education and Training Partnership has identified qualitative methods, including interviews, questionnaires, focus groups, and ethnographic observation, as the most appropriate for evaluating the effectiveness of professional development programs that facilitate teachers' abilities to "teach and implement critical thinking skills, problem-solving skills, and inquiry" (Fleming 2009, p. 1). Unfortunately, previous studies of situated professional development tend to suffer from a number of common methodological issues (Kopcha, 2012), including an overreliance on teachers' self-reporting (Hew & Brush, 2007; Hixon & Buckmeyer, 2009; Lawless & Pellegrino, 2007) and a lack of attention to changes in teachers' attitudes and practices over time (Lawless & Pellegrino, 2007; Swan and Dixon, 2006). In designing this study, the researchers sought to avoid these issues by conducting a series of interviews and focus groups that examine shifts in teachers' attitudes and practices over the course of an academic year. The researchers also conducted a number of ethnographic observations in order to verify data obtained

from teachers' self-reports, improving the validity of our results and strengthening the conclusions drawn from them (Kopcha, 2012; Yin, 2009).

Project Overview

Creation of the Project

The idea for the transnational STE program originated with a Trinidadian, who grew up in T & T until leaving at age 14 and spending the remainder of her adolescence and adult life in the US. Coming from a series of US institutions that regularly used the limited environmental settings available to urban schools, it was her ardent desire to replicate constructivist and inquiry-based teaching techniques when she returned to T & T in 2009. Her time in the US had shown her the benefits of students being actively involved in their learning as opposed to the rote lecture style she experienced as a child in Trinidad, termed chalk and talk by the locals, which is still the norm there today.

She invited her former science methods professor, who served as program administrator and principal investigator of this study, to help introduce the pedagogical techniques of constructivism and inquiry to Trinidad's elementary school teachers. Together they shared their vision with administrators at two local educational institutions in T & T, one private school and the other a home for wards of the state. The professor had already begun similar pedagogical training in the US. With the support of the administrators and teachers in both countries, the transnational STE program was born.

Project Description

STE is a pilot program that has three primary components:

1. Training teachers in the US and Trinidad to use inquiry as the method of teaching environmental science to elementary school children. Teachers also learn to use current technologies for electronic field trips and associated activities.
2. Using inquiry and technology approaches in field trips into local environments.
3. Sharing and learning about those environments with children in another country with dramatically different ecosystems.

Elementary school teachers in the US and Trinidad attended a series of professional development sessions focused on the use of inquiry-based teaching practices in Environmental Education (EE) while using new technologies that included: electronic field trips, Wikis (a collaborative website where users can add, edit, or deleted content), blogs, and streaming video. Much of this learning was captured via the Wiki that was created as a means of collaboration among participants; all training materials were housed in this private Wiki. Once trained in the 5E model of inquiry-based teaching techniques (Bybee, Taylor, Gardner, Van Scotter, Carlson Powell, Westbrook, & Landes, 2006) and supported by instructional technology, the teachers and their students explored ecological concepts and learned about local environments in the US and Trinidad respectively. In preparation for and interspersed with these EE sessions, teachers and their students interactively shared their respective cultures in preliminary meet and greet sessions.

The environmental topics selected for these EE sessions were drawn from both countries' standards documents to ensure teacher buy-in, curricular coherence, and adequate and appropriate preparation for mandated standardized testing. Both sets of standards documents were carefully examined by the STE project administrators to determine where the best connections could be made between similarly aged classrooms. In T & T all topics selected for sharing were drawn from the Ministry of Education's strands (Primary School Curriculum, 2012), while Pennsylvania Academic Content standards provided the basis for US selection (Pennsylvania Department of Education Standards Aligned System, 2012). Once the content was selected, appropriate field trips were identified as modes for demonstrating these concepts in both countries. In Trinidad and Tobago, the strands that were covered

included: the 5 senses, germination, agriculture, and food webs. That same semester, the US school children studied life cycles, gardening, making soil, observing the natural world, and solar energy. Students then took field trips to their own school yards and local nature centers and farms to explore these topics in the field.

Project Implementation

Over the 2010/11 academic year, children in the US explored a variety of environmental concepts on school grounds and at the John Heinz National Wildlife Refuge (JHNWR) using web cameras, the Internet, and cellular phone video broadband to show children across the ocean in Trinidad and Tobago what their urban marshland looks like and answer questions posed by the Trinidadian children. Then, when the children in Trinidad were on their school's campus and also on field trips to Asa Wright Nature Centre (AWNC), the US children saw the local environment as well as the mountain rainforests of Trinidad and compared them with their own landscape.

Participating teachers and their students learned to use a range of up-to-date technology such as taking videos of their adventures in the field and in the classroom, uploading pictures and videos to the STE website, and creating iMovies using these resources (see *Field Trips* at http://ste.widener.edu). Before they shared their learning experiences, meet and greets were arranged so that children became comfortable with the technology and learned about the everyday lives of people in another country. Not surprisingly, during the meet and greets students only occasionally asked questions having to do with environmental science. As one US teacher remarked, "They really loved asking each other questions…they talked more about the people themselves than the actual science!" These cultural conversations represented a welcome break from the drudgery of the curriculum and students eagerly took these opportunities to query one another about the topics they were interested in, including comparisons of homework policies, school uniforms, sports, weather, food, language, and music.

In addition to these classroom meet and greets, the Sharing the Environment program participants in Trinidad and the US organized two sessions dedicated to exposing each other to their respective cultural similarities and differences. In the first iteration, US parents and children used Skype to connect with teachers in Trinidad, watched a number of film clips regarding Trinidadian music, dance, and performance, and enjoyed some Trinidadian cuisine. In the second iteration, parents and students from Trinidad were treated to a live performance featuring dance, poetry, singing, and short skits put on by their US counterparts via Skype. Each participating school shared their own backgrounds to highlight the strengths of each of these communities as well as things that they independently learned about their counterparts.

The pilot STE project may be capable of improving Environmental Education internationally by focusing on inquiry-based teaching approaches that can ultimately improve student learning. The pilot has also uncovered the importance of cultural exchange. Using these findings, further development of the STE program is possible and implications for international Environmental Education may emerge. STE has the capacity to provide some direction to EE in terms of inquiry while developing positive dispositions toward cultural diversity in elementary aged children.

Methodology

Research Design

There are two parts to the research design. First, in order to try to measure STE's capacity to transform teachers' attitudes toward and willingness to implement inquiry-based learning over time, the research team employed a longitudinal case study design using multiple methods to examine changes in teachers' perceptions and practices. Since case study research relies on multiple sources of evidence and the inclusion of pre-conceived theoretical constructs, this methodology is well suited to this investigation (Corbin & Strauss, 2008; Merriam, 1998). The researchers developed a mixed methods approach that

involved surveying, ethnographic observation, interviews, and focus groups. Surveys were administered at the outset of the situated professional development program. This allowed the project administrators to gather basic demographic information about the participating teachers. This data enabled the researchers to determine the ways gender, nationality, or ethnicity may have impacted how Trinidadian and American teachers perceived the concrete experiences they had in the course of their participation in the STE situated professional development program.

Second, in order to gauge the impact these cultural factors had on teachers and administrators as they underwent training and attempted to implement STE in their own classrooms, the research team conducted a series of ethnographic observations and interviews over the course of the STE training program. Ethnography is invaluable for the study of the sorts of processual changes individuals undergo as a result of long-term, situated professional development (Bohannon & Van de Elst, 1998; Kopcha, 2012; Yin 2009). Ethnography's unique capacity to capture nuanced patterns of change in thought and behavior is even more critical when studying populations with vastly different cultural identities, and, therefore, vastly different styles of self-reporting and self-representation (Stepick, Granier, Castro, & Dunn, 2003). The ethnographer conducted ethnographic observations at teacher technology training sessions held in Trinidad and the US, cultural exhibitions held at the US school, various meet and greet and science exchanges at the US school and John Heinz National Wildlife Refuge, and at STE professional development planning meetings. Ethnographic interviews were then conducted with the project administrators in the US as well as teachers in Trinidad to gather a variety of perspectives on the program's greatest challenges and successes.

At the conclusion of the situated professional development program, the researchers then conducted a series of focus groups with self-selected groups of participants from the US and Trinidad. These focus groups gave teachers an opportunity to report on their own reactions to the STE program. Focus group questions centered on the successes, challenges, knowledge gained, and recommendations for future implementation of STE (see Appendix A: Focus Group Discussion Prompts). All of the focus groups were audio-recorded, transcribed, coded, and then analyzed in order to determine teachers' reactions to and perceptions of the effectiveness of the pilot STE. This representational data was then compared to and combined with ethnographic data to create a more complete picture of the effects of the STE professional development on teachers.

Participants

The teachers, project administrators, and school administrators in the STE project were from two different countries. Five teachers from Trinidad (one was a teacher/administrator) and five teachers from the United States volunteered to participate in the research related to their experiences of a situated professional development program. The Trinidadian teachers were from a private school while the US teachers were from a public charter school. In both cases school administrators mandated all science teachers to participate in the situated professional development program.

In addition, there were three project administrators and one ethnographic researcher (see Table 1). Two of the authors of this study were project administrators who directed the situated professional development program in both Trinidad and the US. They also participated in the ethnographic interviews as subjects. Project administrator I is a US professor with degrees and certifications in both elementary and Environmental Education. Project administrator II holds dual citizenship and studied under project administrator number I in achieving a degree in elementary education. Project administrator III is a US professor with degrees in instructional technology and mathematics education. The ethnographer is

also a US professor of anthropology who conducted his dissertation research in T & T. Their roles are outlined below. The five teachers from each location were female. The majority of the US teachers were Caucasian, while the teachers from Trinidad identified as multi-racial.

Table 1. *STE Research Team*

Roles	Researcher/author	PD Coordinator	Research participant
Proj. Admin 1	X	X	X
Proj. Admin 2		X	X
Proj. Admin 3	X	X	X
Ethnographer	X		

Results

Survey

Although this study is based on data derived exclusively from a sample of convenience of female educators (10), it reflects the disproportionate number of females to males in primary education in both countries. In Trinidad in 2003 there was a 2 to 1 ratio of female to male teachers (George & Quamina-Aiyejina, 2003). This disparity has widened to 95.82% as of 2010 (Index Mundi, 2010). According to Education Week (2010) the population of teachers in the United States, which is predominately female, has grown from 82% in 2005 to 84 % in 2011 (Feistritzer, 2011). The Association of American Educators (2012) has reported that the U.S. Bureau of Labor has found that female educators comprise the majority of pre-K and kindergarten teachers (97.7%) and elementary teachers (81.7%) at the primary school level. These numbers are down from 2007, but suggest a clear female majority in the teaching profession, especially in the earlier grades (Association of American Educators, 2012).

Focus Groups: Challenges, Benefits, Recommendations

The focus group results are organized according to the structure of the instrument used (Appendix A) which was broken down into challenges, benefits and recommendations. In terms of challenges, participants from the US charter school perceived technology as the greatest challenge to the effectiveness of the project while teachers in Trinidad saw the difficulties associated with curriculum alignment to be the most difficult hurdle. According to a US teacher, "It's a good idea in retrospect, but I think the lack of technology on their end hinders our experiences and abilities to do…what we really actually want to do." One teacher in the US stated that while Skype is a very capable software in terms of capturing facial expressions, "it does not capture animal movement" in the field.

The benefits participants reported began with the sustainable nature of teachers' professional development. Having training sessions on inquiry and technology with follow-up conversations about those sessions made the teachers feel more confident in their performances. A Trinidadian teacher noted that participants "don't need [project administrators] anymore." This attitude provides some evidence that the sustained professional development structure and support provided scaffolding for teachers to build up to a level of independent application. In addition, one US teacher mentioned that each year "keeps building on for the next year;" another said that "STE left a good foundation that will lead to its continuation" again providing a glimpse into teacher attitudes about sustained professional development.

In addition to sustained professional development, focus group participants viewed sociocultural knowledge gains as a benefit to participants in both countries. Teachers and project administrators revealed that not only the students, but all of the key groups involved agreed that the strictly cultural interactions, like the meet and greets, were the most rewarding part of the program for the students. While students in both countries were excited about Skyping, parents were brought up to speed through two Skype sessions that provided an introduction to the STE program. From the US, a teacher noted

that, "It got the parents involved. That's the first time I feel like…parents…see a connection with what their kids are doing in the classroom."

Teachers and project administrators alike reported working hard to facilitate meaningful cultural exchanges, coordinating the planning efforts necessary to make them a reality. For the most part, even when they took place by default, teachers felt that these exchanges were overwhelmingly positive. For example one US teacher stated that her children,

> ….think it's cool that we are Skyping with another country…[be]cause most of them have just seen [their own city], especially when they're really small. To let them know that there's more out there and also see that there's more out there…just helps them wanna learn more.

Children in the US and Trinidad asked questions about their STE peer groups even during non-Skype times. A US teacher states, "I mean the kids in general, even when they weren't Skyping were asking…do you think they do this in Trinidad?" The US charter school asked questions about music, religion, homework, and vacations.

Teachers agreed that another STE benefit was an increase in students' knowledge of environmental topics. Though the timing of topics was problematic, one Trinidadian teacher noted that the presentations "enhanced the class and brought up topics they would cover later." Another Trinidadian teacher expressed that the Skype sessions "solidified prior knowledge…about content that they already learned." For example, after Trinidadian students shared their knowledge of Caribbean fruits and vegetables, a US teacher developed a measurement lesson on "mango chow." While US children made the chow, Trinidadian children were able to share their secrets regarding their novice counterparts' recipe. While there were certainly positive exchanges between classrooms, interestingly, teachers from both countries explained that when each class was preparing to present to their counterparts, they demonstrated a real desire "to understand their own presentations."

Since technology was constant source of difficulty in STE's first year of implementation, teachers came up with recommendations in this regard. They suggested trying other forms of communication software – i-chat or Google hangout and to publish iMovies on a private YouTube or as podcasts. In addition, several alternative instructional frames were suggested. One method involved the simultaneous use of two computers in both classrooms - one for Skyping and the other for sharing the iMovies. Another approach proposed multiple practice sessions between classrooms to become comfortable with the technology and its application. In terms of engaging students more fully in the technological aspect of the project, a US teacher recommended creating a Wiki page profile for each student where they could share photos and information about themselves with their counterparts privately and under the supervision of teachers and STE administrators. A US teacher suggested that the students could begin sharing personal facts and information about themselves year after year, "the kids could even start putting something together on the Wiki about themselves. Maybe they could share back and forth the pictures and things that they're doing and things besides the video….besides Skyping, [essentially] growing up together." Finally, several teachers saw the use of the Wiki or the STE website as repositories for piloted inquiry-based lessons or as a bulletin board for a monthly environmental theme or problem.

Scheduling was a major difficulty as teachers and project administrators tried to set up the meet and greets, the environmental science lessons, and field trips. Recommendations in this regard include at least four teachers' mention of the need for two liaisons on either side to act as the organizers of all STE activity.

Additional recommendations were made to improve the quality of the STE collaborative structures. Rather than looking only at age as a basis for collaboration, teachers brainstormed alternative frameworks that might allow for greater engagement and interest. These recommendations included small group communication (rather than whole class sessions); co-teaching where a teacher in one country may lead a lesson while both sets of students participate; and

focus on a common problem that both sets of students would address using the context of their own country.

Ethnographic Observations and Interviews

Ethnographic interviews suggested that timing was the primary challenge facing teachers at the Trinidadian school. "We lost a lot of time in class," one teacher stated. "We have a certain curriculum to teach and it was a problem for us to teach it based on what was given to us." They explained that the pressure on them to complete their curriculum is intense, as it comes not only from their school's administrators, but also from parents who "want to know that what we have to do is being done."

When interviewed, both teachers and administrators in Trinidad concurred that what teachers "have to do" above all else is to prepare their students for state-mandated standardized tests. This is the primary function of the Trinidadian education system, a teacher-administrator from the Trinidadian Private School reported. "So if there isn't anything students can sit down and review and drill for that exam, then parents question whether anything beneficial is being done." Not only do parents consider state exam prep to be the most critical pedagogical activity, but they also expect this preparation to be done in the traditional, talk and chalk style. When kids return home from school at the end of the day "parents want to see something tangible as evidence of learning," a teacher reported, "When we teach we need to give our parents the notes so they can see that my children did something at the end of the day."

Another major challenge that emerged from the ethnographic interviews and observations was the potentially destructive power of cross-cultural misunderstandings between the Trinidadians and Americans involved in the project. These misunderstandings surfaced a number of times throughout the situated professional development program. One Trinidadian teacher reported that during the meet and greets, for example, she regarded "some of the questions that the US students asked [like] 'Do you have cars?', 'Do you live in houses?'" as "offensive" and questioned why her American teacher counterpart had not taken the time to give her students a sense of what life was like in Trinidad. "They have no idea and they think of little children living in huts!" She remarked, shaking her head and adding proudly, "Our children know what it is to be American."

Beyond the meet and greets, Trinidadian interviewees identified the technology training session the project administrators held at the Trinidadian private school as the most memorable example of the potentially destructive power of cross-cultural misunderstandings, confirming suspicions the ethnographer noted while observing the session. The goal of the session was to train the Trinidadian teachers how to operate the equipment (laptops, built-in laptop cameras, external digital cameras, and portable wireless hotspots) and software (Skype, iPhoto, and iMovie) they would need to use to help their students create the visual presentations on various environmental science topics that were meant to comprise the substance of STE's science connections. The session was held during the winter break, and the Trinidadian teachers had volunteered to come in during their vacation time in order to accommodate the project administrators' schedules.

The group convened and, after brief introductions, project administrator I gave a short synopsis of the goals of the STE program and distributed informed consent forms for everyone to sign, explaining that by signing they were consenting to voluntarily participate in a study of the program and that any information they provided would be kept strictly confidential. The teachers eyed the consent forms apprehensively, but when asked if anyone had any questions about the consent forms or the study in general, none of them raised their hands. As project administrator I collected the consent forms project administrator III, the US instructional technology consultant, began her presentation. She commenced by administering a brief survey intended to gauge the technological competency of the teachers in attendance. The questions contained in the survey were fairly standard; respondents were asked to provide information on their gender, age, ethnicity, education level, teaching experience, and any formal technology training they may have

received before answering a series of questions on their opinions about email, the worldwide web, multimedia materials, and computer-use in the classroom. When presented with the survey forms, the teachers glanced around at one another uncomfortably, but still said nothing.

Once the surveys and consent forms were collected, the instructional technology consultant (project administrator III) proceeded with her presentation. In the interest of not excluding even the most technically inexperienced attendees, she demonstrated how to open and turn on the MacBooks. Some of the teachers covered their mouths to conceal their amusement. Clearly they had more computer knowledge than they were being given credit for. As the day wore on, the lesson shifted from hardware to software and the instructional technologist asked the teachers to go into the schoolyard and take photos, which they then put together into a video presentation using i-movie. The teachers caught on fast and demonstrated their proficiency by creating some quality presentations. At the conclusion, the project administrators deemed the training a success, aside from the oppressive heat of the non-air-conditioned building.

In an interview with a Trinidadian teacher/administrator it became clear that during the training the project administrators had unwittingly violated a number of critical cultural norms, deeply offending many of those in attendance. First and foremost, they found that the content was not relevant for their level of technological competency. In the words of this Trinidadian teacher/administrator,

> She probably could have invited more questions rather than assumed we didn't know…like the whole thing about the power button… she made a huge thing about it! It's a universal symbol! We know what it is!

Secondly, the teachers felt insulted by the tone of the presentation. The teacher/administrator said many of the teachers expressed a feeling that the instructional technologist was "talking down" to them and was non-responsive to their questions and comments. She explained that the teachers felt the instructional technologist's tone,

> kind of put your back up… It wasn't like she heard you and she chose to ignore you. It was like she heard you but she did not process it at all…[it] was like aren't you hearing what I am saying?

Even more offensive than the instructional consultant's presentation were the forms the teachers had been made to fill out and sign at the outset of the training. After the training the Trinidadian teachers approached their teacher/administrator who had been present and asked her, "Why were we made to sign forms? What do these forms mean? What are they going to do with the information?" The teacher/administrator explained that, like the teachers, she found one of the questions on the technology survey particularly invasive, "The questionnaire could have bordered on invasion of privacy. I know at least one question stands out that was one I don't think the average Trinidadian would have been comfortable with. It asked what ethnic or racial group you belong to. In Trinidad we don't have to do that." More horrifying than having to answer the ethnicity question itself was the thought of how that information might be used. She recalled the teachers inquiring "What does it matter? Why are you asking me that? It's not important!...is knowledge of that going to be used in some way to interpret the results [of the training]?... it kind of left an uncomfortable bad taste in your mouth."

Discussion

The purpose of this study was to examine the effectiveness of an inquiry-based EE situated professional development program, STE, by evaluating how cultural factors impacted the ways teachers and administrators perceived the concrete experiences they had in the course of their participation in the program. Researchers transcribed, coded, and derived categories and then themes from two data sets – focus groups and ethnographic interviews and observations. By examining the focus group and ethnographic data, three themes emerged: structural, cross-curricular and cultural disconnections; technological needs; and environmental and socio-cultural

knowledge gains. Of course future large-scale studies are needed to verify these findings.

Theme 1: Structural, Cross-Curricular, and Cultural Disconnections

Attempting to engage two very different educational institutions situated in different cultures using different academic structures, calendars, and standardized testing requirements, proved to be a challenge. Not only are the two schools very different in terms of their affiliation (US public charter school/Trinidadian private school), there are also significant differences in their institutional structures. In the US, classes are predominantly determined by age while in Trinidad, these levels are determined by a combination of age, aptitude, and achievement. In addition, the academic calendars of the respective institutions are very different–the US academic year typically runs from September through June while the Trinidadian school begins their school year in early April, ending its first term in early July with a six to eight week break in July and August and finishing in late March-making it difficult to find common, convenient times for the video chats. Differences in standardized testing schedules and the use of daylight savings time in the US but not in Trinidad added another level of complexity to communication. Even the academic labels used in the US and Trinidad required translation. For example, US elementary schools range from kindergarten to grade six whereas in Trinidad, primary school begins at stage one and ends at prep five. A designated liaison with experience in both systems proved invaluable for providing the sort of "cultural translation" that enabled teachers, school administrators, and project administrators to navigate through the marked differences in schools' systemic structures.

The disconnections that exist between the two sets of curricular requirements for the US and Trinidadian schools provided another major obstacle for teachers. Though many environmental topics are the same in each mandated curriculum, the scope and sequence in which they are to be presented differs widely. A disconnect between the content being taught in each country per academic level and the timing of the environmental exchanges was difficult. Often students of the same academic level in Trinidad and the US were studying different topics. For instance, kindergarteners in the US were studying life cycles while their counterparts were studying the five senses. As a result, the two populations of participating students did not have similar background knowledge in some of the subjects and had a difficult time coming up with appropriate questions for one another.

Though the presenters learned their content via inquiry, their counterparts received this information via transmission. Though children of different ages can improve their own learning by teaching about the same topic (Miller, 2001), peer teaching "involves students learning from and with each other in ways which are mutually beneficial and involve sharing knowledge, ideas and experiences between participants" (Longaretti, Godinho, Parr, & Wilson, 2002, para. 1). STE's peer teaching seems to have had the expected positive effects on the presenters, yet a similar result was not experienced by receivers. Students in both countries created presentations based in their inquiry experiences; their counterparts received the information via direct instruction yielding a lack of requisite background knowledge on the receiving end, a basic requirement for true inquiry. Consequently, these sessions yielded richer learning experiences for those presenting than those on the receiving end. In other words, students ended up learning more about their own local environment than that of their distant counterparts. Teachers from both countries explained when each class was preparing to present, they demonstrated a real desire "to understand their own presentations." This idea was reinforced by a Trinidadian teacher, who noted that prior to making their presentations, her own students "did not know that we have a rainforest [on the island]."

According to Llewelyn, "Many students prefer to solve their own questions rather than answer someone else's" (2002, p. 56). He also noted that, "students are engaged in investigations that interest them through prompting and mediation from the teacher. As a result, students demonstrate open-mindedness and curiosity; they also gain an appreciation for and positive attitude toward

science" (2002, p. 59). In fact, many studies have shown that causes for lack of interest in science can be correlated to how these subjects are taught. Early positive contacts with science can act as a predictor for positive attitudes later in life (Eurydice, 2006; Osborne & Dillon, 2008; Rukavina, Zuvic-Butorac, Ledic, Milotic, & Jurdana-Sepic, 2012). STE has the capacity to increase student interest if the curricular connections are re-examined.

Ethnographic observations revealed that students engaged on a cultural level in much more explicit ways than they did on their sharing of environmental concepts. Possible explanations for this may be found in Bruner's description of how culture "shapes human life and the human mind…[it] gives meaning to actions by situating its underlying intentional states (beliefs, desires, intentions, commitments) in an interpretive system" (1990, p. 34). Since all students make and use meaning in the context of culture, their shared unfamiliarity with each others' cultures actually became the common ground on which the children connected. They had questions drawn from "normative descriptions of 'how human beings tick,' what our own minds and other minds are like" (Bruner, 1990, p. 35). Teachers perceived that their students' cross-cultural understanding improved, a finding that outpaced the desired increase in the understanding of environmental science. The shared frame for culture yielded greater comprehension of these concepts because the schema were already in place; those for environmental concepts were not necessarily developed enough for receivers to incorporate new information into their existing cognitive structures.

Teachers' concerns over curriculum alignment were compounded by the enormous emphasis their respective institutions placed on standardized testing the preparations for which were viewed as being interrupted by STE video-exchanges. In both countries there is widespread agreement that teachers' most fundamental responsibility is to prepare students for state- or nationally-administered standardized tests. In the US charter school system, achievement of "adequate yearly progress" per school determines funding and charter renewal. Without requisite achievement, charter schools cannot only lose much needed funding but lead to eventual closure. In Trinidad, achievement on a battery of national tests determines whether or not students will be admitted into the so-called prestige schools whose graduates have access to the most lucrative educational and employment opportunities on the island.

Teachers in both countries are aware that the inquiry-based methods they learned through the STE program are more effective in promoting conceptual development. However, since these techniques are not associated with enhanced performance on standardized tests, they are equally aware that the regulatory bodies, populations of parents, and other interested parties to whom their institutions report are not going to value inquiry as learning. According to Amrein-Beardsley,

> Too often in the public eye reports celebrating phenomenal gains in student test scores are celebrated…[but] those gains were ultimately determined to be more mythical than marvel, manufactured by educators who today can take credit for pioneering some of the system-gaming strategies we are now observing. (2009, p. 18)

Given this prevailing cultural attitude toward the function of education, it is no surprise that many teachers and parents prefer strict adherence to the traditional chalk and talk method of pedagogy, despite their concession that this approach "doesn't always mean that everyone understands as well" as they would if they used an alternative method, such as the 5E model of inquiry.

Theme 2: Technological Needs

Baylor and Ritchie (2002) have demonstrated that teacher confidence and competency with technology is improved through training and sustained use with competent mentors as their guides. This principle is at the heart of STE's situated professional development program. Yet despite the presence of competent mentors, faculty faced several issues when communicating resulting from varying facility with the software (Skype) or hardware, unclear understanding of the instructional technology objectives of the instructional technology portion of the STE program, inability to view images clearly, and poor

Internet connection service/lack of broadband for program purposes. According to Internet World Statistics (2005), there is far less Internet use in Trinidad compared to the US. 78.3 % of the population of North America uses the Internet vs. 36. 2% of Latin America/Caribbean population.

One of the greatest difficulties with technology was the quality of videos provided in real time. Unfortunately, the quality of the video did not allow for viewing clarity of the Trinidad rainforest or the US wetlands and the intended science connections very rarely went as planned. When the intended lesson could not be conducted, teachers on both sides would fill the time by having their students take turns approaching the camera to ask each other sociocultural questions. For students, these impromptu exchanges were by far the most exciting and rewarding part of the program, as they would suddenly find themselves being encouraged to satisfy the curiosity that consumed them from the moment they'd set eyes on each other. In the absence of prepared questions, students would suddenly find themselves in control of the interaction, engaging in cultural conversations far more engrossing than the planned lesson. When viewed in this light, it was not in spite of, but, ironically, because of the near-constant technology failures that the most valuable cultural exchanges between the Trinidad and US students were able to occur. This finding is supported by a study in which multicultural exchanges/learning over the Internet was very productive between 11-12 year old students in Scotland & US (Thurston, 2004). Nevertheless, if the STE program was to perform its intended function, these technological challenges had to be overcome and teachers in both countries offered many suggestions, an attestation to their growing comfort in this technological context and plans to continue the collaboration

Though technology presented the most poignant problems for the program, it also enhanced the students' experience by inadvertently opening up opportunities for additional cross-cultural exchange. Armed with new awareness produced by the technological difficulties, the various groups involved in the project have made tremendous progress toward resolution of these problems. In Trinidad, a concerted effort is presently being made to improve connectivity at both the school and in the field. The Trinidadian teachers are using the Wiki not only for sharing student work but also as a means of furthering their professional development goals. Since the STE program's inception, this Wiki has acted as a repository for all readings, agendas, sample lessons, contact information, blogs, etc. All of this material is available to any participant in the program at any time.

Theme 3: Environmental and Sociocultural Knowledge Gains

Teachers perceived two types of knowledge gains in their students. The environmental knowledge gained can be examined in the i-movies that each group of students created as a result of their STE participation (http://ste.widener.edu). Students in the US and Trinidad shared their environments in real time when they went on field trips in their respective countries. For example, several classes of Trinidadian children Skyped from a montane rainforest at Asa Wright Nature Centre and Nariva Swamp while US children Skyped from John Heinz National Wildlife Refuge, 1200 acres of freshwater marsh and surrounding habitats. Each class also created presentations representing their learning on field trips or in the classroom. Topics included life cycles, plant growth, bones/exoskeletons, alternative energy sources, the five senses, and agriculture.

The STE program brought opportunities for sociocultural knowledge gain that proved essential to enabling the project to achieve its intended goals, but contained in these opportunities were also hidden risks for cross-cultural misunderstandings that had the potential to derail the entire project. Daggett and Pedinotti describe core teaching standards that stress the importance of recognizing that "all students arrive at school with varying experiences, abilities, talents, and prior learning, as well as language, culture, and family and community values that are assets that can be used to promote their learning" (2011, p. 4). It became evident over the course of the study that allowing students to develop personal familiarity and cultural sensibilities through the meet and greet sessions provided the requisite context to engage with one

another on more substantive topics; therefore, these meet and greets were not distinct from, but rather an essential foundation for meaningful science connections. This resonates with Zeiss and Isabelli-Garcia's (2005) study, which determined that in computer-mediated communication, students learned more about daily life, food, and culture than merely the subject under study. As a result of the meet and greets, students in both the US and Trinidad gained not only a greater appreciation for the ecological and cultural diversity of their world, but also a level of personal and cultural comfort with one another that enhanced the STE program's intended environmental science exchanges.

The students were not the only disparate groups STE brought face-to-face with one another. Indeed, the process of cultural exchange encompassed by STE stretched far beyond the confines of the classroom. The training session held in Trinidad, the sharing of ongoing program evaluations and instructional materials on the Wiki, and, of course, the actual Skype interactions themselves all involved a deeper, more significant level of cultural interaction and revealed that cultural considerations were far more critical to the success of the program than anyone anticipated. Acting as mediators between the various groups of students and teachers in Trinidad and the US involved, the project administrators learned the importance of facilitating cross-cultural exchanges that promoted mutual respect and understanding. When they were successful in this effort, students and teachers came away with both new knowledge, and a new respect for each other's respective cultures. When they failed, they risked alienating the Trinidadian teachers and administrators whose voluntary participation was essential to the project.

Recommendations

Theme 1: Structural, Cross-Curricular and Cultural Disconnections

In terms of STE organizational and collaborative structures, there is currently a STE liaison at the Trinidadian school while the US liaison has moved to another institution leaving a gap in the organizational structure on the US side. Plans are currently under way to engage one of the US teachers to act in this capacity as the project administrators have found that this position is inexorably linked to effective planning and execution of the program.

Based on pilot findings, classroom connections are not necessarily best made by age but rather by common topics to allow for a more cohesive approach to curricular alignment. In order to build on these findings, the STE team connected classes based on common concepts rather than academic level. Both countries agreed to investigate a common problem (trash and waste management 2011/12 and human impact on the environment 2012/13) and different-aged classrooms shared based on common topics within this thematic structure. The STE liaisons have agreed that while ecological content is important, the content associated with global environmental sustainability is the ultimate goal of STE. For example, students are currently examining policies and practices in both countries that result in environmental conditions like the Great Pacific Garbage Patch; agricultural practices in both countries and it effects on local ecosystems; and biomass energy and alternative forms of waste management as means of returning materials back to the Earth's natural cycles.

Theme 2: Technological Needs

Alternative forms of technological connections were also investigated so that the best, clearest software and hardware could be used. In 2011/12, the STE tried google hangout with varying measure of success. In the 2012-13 academic year, the STE project administrators decided to switch to Adobe connect, a university-purchased software that is much more reliable and clearer than the free version of video chat that had been used to date. The format of the sharing sessions was also altered. In 2012/13, teachers uploaded their videos to a University-sponsored Vimeo.com account and students in each connecting class watched their counterpart's video and then prepared questions for their colleagues – all one week prior to the real time session solving many of the technological issues that teachers mentioned.

Theme 3: Environmental and Sociocultural Knowledge gains

Since STE began as an attempt to improve teachers' use of inquiry and concomitantly improve student appreciation and understanding of global environmental issues, knowledge gains continue to be a focal point of the program. The environmental knowledge gains are now connected to the alignment of classrooms by topic/theme rather than by age/academic level. Finally, the sociocultural knowledge gains, though unexpected, provide a rich fabric upon which all other knowledge can be built. Since culture is something that the children can easily share and relate to, continued use of cultural connections will be promulgated to support the development of environmental problem solving abilities and a shift toward global environmental stewardship.

Conclusion

The three themes that emerged from this study provide implications for future professional development in inquiry-based teaching techniques for global Environmental Education. It is apparent that inquiry-based training and the accompanying technology training did affect teachers in both countries. Active engagement is certainly at the heart of this inquiry process because current definitions of environmental literacy include ecological content knowledge as well as positive dispositions and actions toward our planet. One of the most important insights gained from this study was the program's lack of focus on human impact on the global environment. In its early iterations, the children and their teachers learned about ecological principles that are the basis of ecosystem interactions, but they did not necessarily study the impact of human actions on the global environment. The surprising result was the significant role culture played in these interactions and the ways in which people on both sides navigated through these communications. STE continues to evolve based on the findings of this pilot study. The focus of STE will continue to be placed on the intersection of cultural and scientific understanding in an attempt to capture and engage the minds of primary school children and their teachers. Though these findings are preliminary in nature and derived from the first study of this program, its outcomes point to culture as an important consideration in the development of EE programs that cross international borders.

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Appendix A. Focus group discussion prompts

- What was your overall impression of the STE program?
- What were the greatest challenges you faced as a teacher?
- What were the greatest challenges the program posed to the students?
- Of all the STE connections you were a part of this year, which do you think was the most valuable/beneficial? Why?
- Of all the STE connections you were a part of this year, which do you think was the least valuable/beneficial? Why?
- Do you feel your students benefited academically (in terms of an enhanced appreciation for and understanding of environmental studies) through participation?
- Do you feel your students benefited culturally (in terms of an enhanced appreciation for and understanding of what

daily life is like for counterpart students) through participation?
- In terms of overall time/effort spent, do you think the STE program was worthwhile? Why or why not?
- Can you think of any ways the program could be improved? If so, please explain.