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ESL/SSL Strategies that Bridge Content and Language in Science: Experiential Learning in an Environmental Education Workshop

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***Abstract*—This qualitative research study examines how 66 generalist and bilingual education pre-service teachers responded to and engaged during a dual-language environmental education workshop. Workshop facilitators-researchers designed the workshop to alternate the language of instruction throughout the daylong workshop. Since approximately half of the participants were monolingual-English speakers, the research question addressed by the study was: What teaching strategies did the pre-service teachers identify as essential and apply in order to comprehend the academic content of the dual-language environmental education workshop? The following components were identified and/or applied: bilingual pairs, multisensory approaches, use of visuals, and identification of Spanish/English cognates.**

***Index Terms*—bilingual education, teacher preparation, dual-language strategies, science education**

I. Introduction

International studies have shown that science achievement in the United States falls short in comparison to other industrialized countries (NCEE, 2006; PISA, TIMSS & PIRLS 1995-2003 in Lee, 2005). This shortfall in the science fields is mirrored at the national level, where the achievement gap between mainstream students and non-mainstream students, specifically students with little or no English and bilingual learners, continues to grow (Lee, 2005). This demographic reality calls for pedagogies that tear content and language barriers so that all students can learn science while they acquire English.

Scholars propose that teacher educators equip prospective teachers with methodologies and strategies that not only attend to students' linguistic needs but draw their interest to science fields. These prospective teachers will be placed in US schools where much importance is placed on science inquiry and development of a highly specialized scientific vocabulary or language (NRC, 1996). Coupled with that demand is the increasing ELL (English Language Learner) population. Lee and Buxton (2010) explain that the only approach to encourage support for cultural and linguistic awareness for teachers is to provide "teacher education that specifically addresses both pre-service and in-service teacher's beliefs and practices with regard to student diversity as it relates to subject areas" (p.113).

Moreover, experiential learning for prospective educators is an opportunity to address student diversity with a particular focus on subject areas. In this article, the authors propose that this urgent need can be addressed through a purposeful infusion of experiential learning in which linguistic accommodations and science are learned. Therefore, in this study, the researchers narrate the results of an environmental education workshop in which the authors modeled a variety of strategies and created opportunities for prospective teachers to practice and reflect as they designed ways to develop science concepts and vocabulary.

II. Research Question

In order to examine the development of strategic approaches in a dual language context, the following question was posed in order to understand and frame this study:

1. What teaching strategies did the pre-service teachers identify as essential and apply in order to comprehend the academic content of the dual-language environmental education workshop?

III. Literature Review

Strategy instruction can be instrumental for ELLs and bilingual learners due to the short amount of time to attain conceptual development in science. Lee (2005) states that "the need for such integration is especially urgent, given the climate of standards-based instruction, high-stakes assessment, and accountability facing today's schools" (p.492). Thereby, teachers must be aware that there are specific strategies that can assist bilingual learners in science learning and first and second language development. According to Lee and Buxton (2010) there are instructional strategies that are pivotal for science learning such as the activation of prior knowledge, the use of graphic organizers, the inclusion of science trade books, and comprehension of language functions (i.e. interpersonal, heuristic etc…) in relation to science process skills. In addition, gaining linguistic proficiency in a particular content requires such strategies as hands-on activities and realia for science concept development. Some examples of these multimodal strategies are "…gestures, oral, pictorial, graphic and textual communication" (Lee & Buxton, 2010, p.77). Le Pichon et al (2010) found that children, who experienced formal contexts, where multimodal strategies and linguistic strategies can be applied, accessed the use of more strategies than children who experienced the acquisition of language in informal contexts.

In addition to these instructional and linguistic strategies, there is also the use of a student's home language as an opportunity for different strategic and pedagogical uses for science learning. Therefore, code-switching and the use of cognates are useful strategies in communicating science understanding (Lee & Buxton, 2010) and comprehending scientific processes and reasoning. If teachers are familiar with their students' native languages, they may introduce key vocabulary and/or conceptual aspects in their native language(s).

Brown (2007) presented several strategies that are useful for ELLs in their development of content area learning. For example, she discussed implementing the use of graphic organizers such as content maps that point out the location of the main idea and draw students' attention to it. Guiding questions were also a useful strategy for students in order to focus their attention on the most important points of the theme being studied. Teachers also required that students activate their prior knowledge in their first language in order to engage in comprehension of a text or concept. Though these strategies were critical to students' conceptual understanding of the content however, Brown found that many teachers who teach content are not usually concerned with teaching the structure or grammar of a language since they view their task as only content delivery. Such a perspective is limiting for teachers of ELLs and bilingual learners because a lack of integration of content acquisition strategies that supports the development of academic language can reject opportunities to practice literacy and computational skills needed to develop scientific reasoning and arguments. Echevarria, Short & Vogt (2004) introduced a lesson design titled Sheltered Instruction Observation Protocol (SIOP) that approaches learning content with a focus on both language and conceptual development for ELLs.

Tran (2006) also focused on strategies for ELLs in the area of teaching vocabulary. She described how students could acquire new vocabulary through memorization of vocabulary words. If the instructional materials presented and emphasized the memorization of key vocabulary in science, that would also assist ELLs in acquiring and learning new vocabulary via pronunciation and repetition eventually leading to conceptual development. Tran also found that students should be exposed to explicit instruction of vocabulary in terms of interactive or cooperative instruction such as in cooperative grouping. Students can utilize dictionaries and vocabulary notebooks in order to semantically or visually develop a more advanced register in the English or Spanish language. Context clues were another strategy mentioned that would promote the acquisition of new vocabulary through the contextual reading of a text. Such a practice could assist students in understanding how particular words are utilized within a decontextualized content area. Finally, the use of summarization was also a helpful strategy for reviewing and reiterating new vocabulary that was just introduced.

To further examine the use of strategies to increase comprehensible input in science, Hampton and Rodriguez's study (2001) demonstrated interest in students' concept and vocabulary development through the use of science inquiry. In their research, students who were involved in a student-centered type of inquiry had more access to language and content learning. Students were allowed to examine science through their own worlds and engage in scientific processes (Hampton & Rodriguez, 2001). Through the use of science inquiry, students were able to utilize the following strategies "…observe, introduce variables, record, measure, predict, infer, inquire and explore" (Hampton & Rodriguez, 2001, p.464).

IV. Methodology

Participants

There were 66 students that participated in the study. The participants were mainly women with just a few men in attendance. In addition, the majority of the participants were Hispanic or White. All of the students were either pre-service bilingual education or general education teachers from a Hispanic-serving institution.

Data Sources

In order to attempt to discover the strategy use by these pre-service teachers in this dual context in the content area of science, a qualitative approach was conducted in order to view pre-service bilingual and general education teachers' use of strategy instruction. The qualitative data was collected from a narrative provided by a Project WILD facilitator and the bilingual and general education teachers' interviews. This data was transcribed and coded as themes for evidence of strategy use. Braun and Clark (2006) note that a theme "captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set" (p.87). Following up

the theme analysis, a deductive thematic analysis was conducted in order to deduce the strategy use from the data and understand the conceptual strategy categories being derived from the data. "Deductive reasoning is a theory testing process which commences with an established theory or generalisation, and seeks to see if the theory applies to specific instances" (Hyde, 2000, p. 82).

Additional data sources were collected from pre-service bilingual education and general education teachers through interviews and open-ended questions posed throughout the workshop. Finally, other data sources included reflection notes, workshop survey, field notes and Project WILD agenda (Figure 1, See Appendix A):

Context of the Study

The study took place in a local public park made up of 320 acres of hill country landscape within the southernmost part of the United States. This large sized setting houses a family public park, five miles of trails for hiking, jogging, and nature study. The park also includes wooded dry creek beds and rocky canyons. The park's large pavilion, restrooms, and surrounding nature trails made this setting appropriate for the environmental education workshop where bilingual education and general education pre-service teachers would learn about a curriculum, Project WILD that enhances their knowledge of conservation and environmental education with students in kindergarten through high school.

Project WILD

Project WILD emphasizes wildlife because of its "intrinsic value… and addresses the need for human beings to develop as responsible citizens of our planet" (Project WILD, 2013). The one-day workshop is designed to ensure that all students develop an understanding of key science concepts in environmental education. These concepts were identifying wildlife in/out of the classroom, understanding the ecological impact of human beings and nature on wildlife, and identifying eco-friendly ways that humans can promote advocacy for wildlife. Therefore, throughout the Project WILD workshop, pre-service educators were placed in cooperative groups adhering to effective practices such as bilingual pairing and a dual language or bilingual content approach to learning science. The following is the agenda that students experienced (Figure 1, See Appendix A):

Project WILD Facilitators/Researchers

The three professors/researchers in this study were faculty in large Hispanic-serving institutions. All three professors had experience working with pre-service teachers enrolled in science methods courses; during the spring 2012 semester attendance at the Project WILD workshop was required for pre-service teachers. The facilitators had experience teaching in the area of science education and are Project WILD facilitators. The guides in the study were students who had participated as Project WILD participants in the last two semesters and served as facilitators of the workshop.

Project WILD Workshop

The student groups were created as a linguistically mixed cooperative group. Moreover, the requirements of each were the following: one speaker of English, one bilingual speaker and an English or bilingual speaker. Each of these groups would later in the workshop be assigned a topic that they would have to deliver in a lesson format, before the last activity, in English or in Spanish.

This workshop has been integrated as a course requirement for pre-service bilingual and general education students. Funding from the pre-service students' institutions has been instrumental for student attendance. For the past eight years, our pre-service teachers have been receiving Project WILD training. However, they had always received the training solely in English if they were seeking generalist certification and bilingually only for pre-service teachers seeking bilingual education certification. This was the first dual language workshop where pre-service generalist and bilingual education teachers were paired up and received training bilingually (in Spanish and English). Therefore, two major modifications were made (1) deliberate use of collaborative grouping and (2) ESL and SSL modeling by facilitators.

1. Deliberate Use Of Collaborative Grouping

The use of collaborative groups provided project participants the opportunity to construct scientific meaning and develop pedagogical approaches for teaching science to all students. For example, the participants were placed in groups of different sizes (i.e. 3-5 students) by the facilitators in order to begin touring the natural environment through a nature hike guided by area naturalist volunteers. On the hike, the pre-service teachers were asked to observe the different types of plants and animals that coexist in this natural habitat. They were also asked to write down, take pictures and discuss any observations with their group members that may have provided them an understanding about this outdoor living environment. In these field observations, the pre-service teachers collaboratively discussed and began to develop questions and hypotheses about some of the characteristics found in this outdoor environment.

Following this activity, participants began to relate their observations and discussions during the hike to an activity titled "Wildlife is Everywhere". The participants were placed in collaborative groups and were asked to categorize an animal as domestic or wild. Students were given hula hoops to use to create a Venn Diagram and then categorize whether their animal or insect was domestic or wild according to its characteristics. From observational notes, it was noted that working in groups allowed both the bilingual and the monolingual speakers to collaborate and communicate using their languages to negotiate meaning and place the animal or insect in the correct category.

Another collaborative activity conducted in the second half of the workshop that provided the participants the opportunity to apply their learning, in reference to pedagogical approaches, were group presentations of a Project WILD lesson. Participants were required to collaborate in groups where bilingual educators and general educators worked in

groups of five. These students presented an assigned lesson activity from Project WILD in English or Spanish and demonstrated for the other participants how to effectively deliver science instruction. Participants presented on a range of environmental science topics such as physical characteristics of wildlife animals, wildlife habitats, interdependence among domestic and wildlife animals, and they incorporated the modeled strategies (i.e. cooperative grouping, use of realia and visuals) that made the science content more contextualized and comprehensible for their Project WILD peers.

2. ESL and SSL Modeling by Facilitators

In order to better understand these pedagogical approaches to science learning and strategy use, modeling was also employed by Project WILD facilitators. Such a method has been very beneficial for future educators because they are allowed to witness and experience these approaches first hand. Modeling for the participants aims to assist the preservice teacher to apply such approaches and strategies in their current and future educational settings. Since one of the goals of the workshop was dedicated to science learning, project participants were able to participate in different activities that assisted them in understanding outdoor science education. The dual language format served as an overlay of how the instruction would be delivered. Therefore, the Project WILD facilitators modeled bilingual content instruction using a dual language format throughout the entire workshop. Figure 1 (See Appendix A) demonstrates the 50/50 split of instruction in each respective language; English and Spanish. Therefore, participants learned through this workshop design how to engage students in science academic language development and learning. This occurs by the purposeful demonstration and actualization of learning language and content simultaneously. Such practice allows for the acquisition of a first and second language and aids in the comprehension of science concepts to encourage the use of academic language. Therefore, additional strategies modeled by the Project WILD facilitators are developing in an environment that supports science inquiry and questioning for clarification of science misconceptions and uncertainties. Facilitators also embedded additional science delivery strategies such as enunciating scientific terms clearly, repeating key concepts and informing the pre-service teachers with directions in the language of instruction.

IV. Findings: Teaching Strategies for Bilingual Science Conceptual Development

The findings indicated that through the engagement in collaborative groups and the observance of modeling of strategic instruction were key to the development science content learning and the development of scientific pedagogical approaches that are applicable in all settings. Moreover, the usefulness of the each of the strategies presented here was based on the needs of the learner during the different sessions presented. The needs of the learner were an important factor when considering which strategies were beneficial.

A. Bilingual Pairs: Bridging Linguistic Barriers

One of the strategies that were indicated in the pre-service teacher interviews by the majority of the participants in the dual language workshop was the use of bilingual pairs. In the literature, the strategy of using bilingual pairs or peer teaching is considered an effective strategy to facilitate the learning of a language and literacy (Angelova et al, 2006). Such a strategy prompted the workshop participants to develop cross-cultural relationships due to the pairing of bilingual and monolingual English speakers during different Project WILD activities. These collaborative groups provided the opportunity for the learners to communicate new information or prior knowledge using the content and/or a new language.

However, an interesting finding discovered through the pre-service educators' interviews was that the workshop participants referred to each other as bilingual partners and not pairs. For example, a general education pre-service teacher stated "It was a unique experience to be thrown into. I have a lot of background knowledge in Spanish…..but as far as it would be for a child in the classroom with no background knowledge, it would have been pretty difficult…it was nice to have a '*partner*' too. If you had no idea what they were talking about it was nice to have someone to clue you into what was going on" [Interview#3, 10/5/11]. Another general education pre-service student described her experience as "She was my 'partner' and she helped me because I don't know Spanish so I think to have a peer to explain because a lot of times the kids that don't know the language might get lost" [Interview #4, 10/5/11]. The use of the word "partner" seemed to be interpreted by the participants in the following ways: as a buddy who was empathetic and patient. The partners were also viewed as receptive, willing to share ideas and collaborated on developing many questions about the science concepts presented. Such partnership was also described as participants being immersed or included in an activity versus being submersed or forced in it. For example, a bilingual pre-service teacher described her experience as "I think that placing them in groups that [are] heterogeneous to where one person is strong in a certain subject so that they can help the person that [can't] keep up and help them when they have questions" [Interview#3, 10/5/11]. It was also described as an opportunity to share a cultural perspective to negotiate meaning in science. The partner was seen as a "cultural broker" (Aikenhead, 1996) and for many participants a short friendship was established due to the peer interactions. Partners became more comfortable with their peers because they each contributed to comprehending the science content. For example, a general education pre-service teacher made the following comment after being asked in an interview how they felt about the use of partners as a strategy for learning science. The participant responded "I think it makes it easier. I mean, I would prefer working with a partner than working by myself anyways so I personally like it. If I was by myself, then I definitely would have been lost because there was a lot of words that I didn't understand even though I do understand the majority of Spanish. I mean, I don't understand

everything so having a partner made it easier" (Interview#8, 10/5/11). Another general education pre-service teacher described working with her partner as "having group work peer interaction because children learn socially. So definitely whether bilingual or not, the big things was having us interact with each other because we learn from each other" [Interview #4, 10/5/11]. This pre-service teacher's partner added her thoughts about this topic "I liked how kids can look at nature differently, like for example, the food chain, that was really useful. And I really learned that having interactions and activities is key to the education" [Interview#4, 10/5/11].

However, there were some challenges noted in the pre-service teacher interviews that were faced by the bilingual partners at different times during the workshop. For example, some of the challenges were at times inaccurate translations by some partners, difficulty in hearing a partner in an outdoor setting, tension due to partner's personality, partner's background knowledge in science, and the responsibility sensed by the partner on the success of the task at hand. These findings should be explored further.

B. Multisensory Approaches

Another overarching strategy found during the implementation of this outdoor education workshop was the use of kinesthetic and fine-motor skills to develop scientific meaning. The following activities provided the context and engagement for the development of new scientific ideas and learning: role playing or dramatization, use of gestures or body language, interactive nature walk, and the use of music. The students' engagement in each of these activities lowered the anxiety and fear about learning science particularly in a dual language format. Pre-service teachers became more involved and it was observed that they used humor to offset their fears and concerns about science learning. The use of collaborative approaches coupled with the multisensory approaches assisted students in learning science. For example, one of the pre-service general education teachers stated "I liked the hiking. It was a lot of activity, a lot of movement, and a lot of doing [inaudible]…instead of just sitting there and not talking, we actually got to move. The hiking was awesome. It was visual, that was a lot of visual and I think that is the key also to learning, a lot of visual." [Interview#X, 10/5/11] This student's perception of being placed in cooperative groups in order to engage in these kinesthetic and fine-motor activities groups prompted students to interact, provide scaffolding to new science learning and allowed for lowering of the affective filter (Krashen, 1981) or the invisible barrier that allows information to be produced after true comprehension and language acquisition has occurred. More importantly, the student could use language, through the use of multisensory approaches, for the comprehension of science concepts and learning.

C. Use of Visuals

Visuals were also key to the comprehension of the different animals found in the environment and studied during the workshop. The pictures and photos about the different types of wildlife animals presented in the Project WILD manuals, in facilitator presentations and the materials created by project participants provided an understanding of the different characteristics that assist in identifying a wild animal. All participants did not have to entirely depend on oral or written communication but could rely on the visual cues provided by the different texts. For example one of the monolingual English pre-service participants mentioned in their interview when asked "What are some strategies you can use to meet the needs of bilingual students in your classroom?" This participant responded "Definitely, the pictures. Like that brings meaning a lot. Because like me is not knowing it. The pictures were the ones that helped and I like that." Another participant stated: "Thank God for the pictures too but also have the pictures combined with a peer actually more details like they were able to pick up." [Interview#4, 10/5/11].

D. Identification of Spanish/English Cognates

Another strategy frequently mentioned by the participants was the use of cognates during the content instruction. Cognates are words that have a similar structure and meaning, in terms of their spelling in two languages. For example, the Spanish-language cognates for observation, animal, habitat, and predator are observación, animal, habitat, and depredador. In the current study, this strategy manifested as described in the following example, a bilingual education pre-service teacher mentioned in her interview that "the similarities of the words like 'animal' that are spelled the same. Find those words or look for words that look alike to facilitate [for] the Bilingual learners" (Interview#1, 10/5/11). Thus the use of cognates was described to be an important strategy in dual language settings because a student has to identify when new science terminology in another language can be synonymous with prior terminology that has been conceptually developed. Such a strategy also reduces the amount of time needed to learn new science vocabulary.

V. Conclusions & Implications

The usefulness of a strategy depends on the needs of the learners and their understanding of how to apply it in the learning process. In this study, the project participants were exposed to specific strategies such as collaborative grouping and modeling that were applicable to learning science in a dual language context. Moreover, project participants were able to describe how their use of a strategy facilitated science content and language development in either English or Spanish. These strategies also assisted in facilitating science content and prompted scientific reasoning and argumentation during workshop activities. The following four strategies were identified in the study by pre-service bilingual and general education students as being useful in science content learning: bilingual pairs or partners,

multisensory approaches, use of visuals, and the identification of Spanish/English cognates. Such identification of useful strategies is an insight that is not commonly understood since a large portion of research has been conducted on teacher preparation with monolingual speakers versus a combination of monolingual and bilingual speakers (Loughran, 2007 in Abell & Lederman, 2007).

In addition, the pre-service teachers also provided a unique perspective or insight in the role of the learner in a dual language context. This is a significant contribution of this research because the articulation of the effectiveness of strategies as scaffolds to new learning can be more introspective when communicated by the learner. Moreover, this study expands and elaborates the result of this type of learning as articulated or interpreted by pre-service teachers to facilitate science content and academic language development.

An additional result of this experience was the pre-service teachers' engagement in collaborative activity with students who were culturally and linguistically diverse. Such a grouping provided all group members an authentic learning opportunity to develop a cross-cultural sensitivity as learners of science. Moreover, all the pre-service teachers were exposed to the challenges and difficulties experienced and communicated by group members. As demonstrated in the data, this experience prompted the pre-service teachers to expand their own notions about the pedagogical approaches and learning strategies that will provide their future student access to the science curriculum that may enhance their scientific understanding of the how their world works and begin the formation of scientific identity. Lack of access to the science discourse has been attributed by many (Echevarria, Vogt, & Short, 2004; Lee & Buxton, 2010; Gee, 2009) as missed opportunities for ELLs, bilingual learners, and educators to simultaneously encourage the development of science content and language development. Thus, this lack of opportunity has resulted in a low number of ELLs and bilingual learners seeking careers in STEM fields.

It is important to note that a limitation of this study was the length of observational time available to conduct this research. Even though this workshop has been conducted in a bilingual format for over five semesters, further research is warranted to study application of these strategies in the bilingual or general education classroom. This would require a researcher to observe Project WILD participants in their future classrooms or during their field-based residency experience. This next level of research is important for future study.

APPENDIX A

Figure 1. PROJECT WILD DUAL LANGUAGE WORKSHOP AGENDA

Hora Actividades

8:00-8:30 Registro de participantes/Registration

8:30-9:00 Bienvenida y presentación de guías del taller y participantes/Welcome and introduction of facilitators and guides (English and Español)

9:00-9:45 Repasando y explorando el libro de las Guías del Plan de Estudios de Proyecto Wild (Español)

9:45-10-45 Wildlife is Everywhere! (WILD: Hike through the park)(English)

10:45-11:30 GUW (Repasando y explorando la Guía de Actividades) (Español)

11:30-12:00 Wildlife is Everywhere! (GUW: Mighty Math) P24. (English)

12:00-12:30 Preparación de presentaciones de grupo mientras comemos. Working lunch

12:30-1:00 ¡Ah, mi querido venado! (GUW: Actividad de matemáticas y conexiones con la casa del hábitat) P.48 (Español)

1:00-1:45 Oh Deer! (WILD) P.39 (English)

1:45-4:00 Presentaciones de los grupos/Group Presentations (English and Español)

4:00-4:30 (Lapsit) Simulación física del hábitat Proyecto Wild P. 17 (Español)

Marco Conceptual	Actividad Proyecto Wild (Versión en español a menos que indique lo contrario)	Actividad GUW In English
Conciencia Ambiental	¿Qué significa silvestre? P. 4	¿Qué significa silvestre? P.22
Conocimientos Ambientales	¿Cuántos osos pueden vivir en el bosque? P.33	Comida para un oso P.26
Acción Ambiental	¿Cuánto le costó tu comida al medio ambiente? P. 68 Proyecto Wild Versión en inglés?	Menos es más P. 62

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