Action in Teacher Education, 36:192–210, 2014

ISSN: 0162-6620 print/2158-6098 online
DOI: 10.1080/01626620.2014.917364

Routledge
Taylor & Francis Group

Using Visual Literacy to Teach Science Academic Language: Experiences from Three Preservice Teachers

Charlease Kelly-Jackson
Stacy Delacruz
Kennesaw State University

This original pedagogical study captured three preservice teachers' experiences using visual literacy strategies as an approach to teaching English language learners (ELLs) science academic language. The following research questions guided this study: (1) What are the experiences of preservice teachers' use of visual literacy to teach science academic language with ELLs in an elementary classroom? and (2) What are the strengths/limitations of incorporating visual literacy into the classroom with ELLs? Data revealed that preservice teachers recognized the significance and benefits of utilizing visual literacy as a method to teaching science academic language to ELLs. Results also indicated that elementary students employed self-discovery, knowledge, and the contextual use of academic language during three different lessons. Findings from this study suggest that even though there were some limitations to incorporating visual literacy strategies into the science classroom, preservice teachers find the approach helpful to teaching academic language to ELLs. Along similar lines, teachers of this study appeared to be motivated and eager to use the strategy again in the future. Implications for practice and further directions for research are discussed.

INTRODUCTION

Classrooms' demographics across the nation are continually changing with no sign of stabilizing. Immigrant children, children of color, and children from low-income families represent an overwhelming percentage of the student population (Dale, 2010; Lee, Deakor, Enders, & Lambert, 2008; Villegas, 2008). Teachers no longer have classrooms comprising just Black or White students—students from mainstream backgrounds; they have increasing numbers of Hispanics, Asians, Central Americans, Russians, Africans, and more (Cox-Petersen, Melber, & Patchen, 2012).

With classroom changes, there come classroom challenges for the teacher and the student. Teachers are faced with an unprecedented responsibility of teaching students who speak a language other than English whereas English language learners (ELLs) are faced with the task of learning English as a language at the same time as learning the academic content and process

Correspondence should be addressed to Charlease Kelly-Jackson, Kennesaw State University, Department of Elementary & Early Childhood Education, 1000 Chastain Road, MD #0121, Kennesaw, GA 30144. E-mail: ckellyja@kennesaw.edu

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/uate.

of the language (Amaral, Garrison, & Klentschy, 2002; Lee et al., 2008; Lee & Fradd, 1998; Stoddart, Pinal, Latzke, & Canaday, 2002).

Language learning is a vital component in the building of a students' academic foundation. For the most part, students who come to school speaking a home language other than English tend to have a challenging time academically (Diaz-Rico, 2012; Gutiérrez & Vanderwood, 2013). For instance, there is an achievement gap between non-ELL and ELL peers in fourth- and eighth-grade National Assessment of Educational Progress (NAEP) reading scores. From 2002 until 2011, NAEP reading scale scores for non-ELLs at these grade levels were higher than their ELL peers' scores (National Center for Education Statistics [NCES], 2013).

Low academic performances among ELLs are not only present in reading but also in math and science (NCES, 2011). Science, in particular, is not always taught in a manner that is culturally relevant to the lives and experiences of ELLs. Therefore, engaging in meaningful science inquiry can be difficult for students developing English language proficiency and literacy (Fradd & Lee, 1999). To help reduce the gap, ELLs need to develop English language and literacy skills (Lee, 2005; Lee & Fradd, 1998). English language proficiency allows students to have knowledge of and the ability to make effective use of the conventions of literacy (e.g. vocabulary, syntax, punctuations) (Lee et al., 2008). In science, proficiency involves academic language functions such as formulating hypotheses, planning investigations, collecting and analyzing data, making conclusions, and communicating results (Casteel & Isom, cited in Lee et al., 2008).

"Ideally, subject area instruction should provide a meaningful context for English language and literacy development, while advancing English skills provides the medium for engagement with academic content" (Lee, 2005, p. 492). For this study, we used the framework instructional congruence as our theoretical foundation. This framework speaks to the notion of academic content and students' cultural and linguistic experiences intersecting to make content more accessible, meaningful, and relevant for students (Lee et al., 2008; Lee & Fradd, 1998; Luykx & Lee, 2007). This original pedagogical study was based on an action research project that took place during a science methods course and field experience of three preservice teachers. The study focused specifically on how these teachers approached teaching for diversity in an elementary science classroom using visual literacy strategies.

PURPOSE OF STUDY

Twenty percent of U.S. K–12 students come from a home where English is not the native language, and by the year 2030, that student percentage will grow to 40% (Crawford, 2000; Thomas & Collier, 2002). With these changing demographics, preparing teachers to teach for diversity is even more essential in meeting the needs of these students, ELLs specifically. On a recent survey, graduates from exemplary teacher education programs "rated themselves less well prepared to work with ELLs" (Darling-Hammond, 2006, p. 65). This corroborates literature that contends very few teachers have been trained to meet the needs of ELL students (Calderon, Slavin, & Sanchez, 2011; Rojas, 2007; Tisington & LaCour, 2010). Research further suggests that programs with a coherent focus in multicultural education would improve teacher candidates' abilities to work with diverse students (Darling-Hammond, French, & Garcia-Lopez, 2002; Nieto, 2000; Villegas & Lucas, 2002). In fact, there is a growing interest in issues of culture and language in science instruction (Lee et al., 2008; Lee & Fradd, 1998). Recognizing the need for teachers to promote students' English language and literacy development, the focus of this study was to capture preservice teachers' experiences using visual literacy strategies to teach science academic language to ELLs. The following questions guided this study:

1. What are the experiences of pre service teachers' use of visual literacy to teach science academic language with English Language Learners in an elementary classroom?
2. What are the strengths/limitations of incorporating visual literacy into the classroom with ELLs?

THEORETICAL FRAMEWORK

Science content knowledge is an integral part of being an educated citizen in this global and technological society of the 21st century. Consequently, there has been a sense of urgency to recognize student diversity in the science classroom (Lee, 2005). ELLs, in particular, face challenges in the science classroom partially because of the high volume of vocabulary; the complex sentence structure and multistep activities found in the textbooks; the large amounts of reading; and simply, the way the content is taught (Cox-Petersen et al., 2012). Considering most science instruction is generally tailored to Western values, thoughts, and traditions, many nonmainstream students find the values and norms of science more unfamiliar than their mainstream counterparts (Eisenhart, Finkel, & Marion, 1996; Fradd & Lee, 1999; Lee & Fradd, 1998). This study relies on the instructional congruence framework that focuses on the process of developing congruence between science content and students' cultural and linguistic experiences (Lee, 2005; Lee et al., 2008; Lee & Fradd, 1998; Luykx & Lee, 2007; Md Zain, Samsudin, Rohandi, & Jusoh, 2010).

According to Luykx and Lee (2007),

> instructional congruence aims to help students acquire scientific understandings, inquiry practices, and discourse by taking into account the relation of these three domains to students' home culture and language, and by devising instructional strategies that address both the discontinuities and the continuities between the two broader bodies of knowledge (i.e., school science and students' prior linguistic and cultural knowledge). (p. 425)

This framework supports the notion that effective science education for all students is more likely to be attained if students' cultural and linguistic backgrounds are reflected in science instruction (Md Zain et al., 2010). To establish instructional congruence, teachers need to know who their students are, what kinds of language and cultural experiences they bring, and how to support students during their science understanding (Lee & Fradd, 1998; Md Zain et al., 2010).

For the purpose of this study, we captured the experiences of three preservice teachers who chose to address diversity in the science classroom by intersecting science academic language and visuals (pictures/graphics) found in their students' lives. Through the instructional congruence model, teachers make academic content meaningful, relevant, and accessible for diverse students. The visual literacy strategies used in this study involved pictures that were pulled from magazines or taken with a camera by the student and/or teacher. Each picture was directly related to the science concept being studied. Allowing students to pull their pictures from magazines or take a picture of an everyday object or event provided a sense of relevancy and ownership.

REVIEW OF RELATED LITERATURE

Qualitative and quantitative studies have advanced the growing body of literature on teaching science to ELLs (e.g., Amaral et al., 2002; Fradd & Lee, 1999; Lee, 2005; Lee et al., 2008; Lee & Fradd, 1998; Luykx & Lee, 2007; Merino & Hammond, 2001; Tobin & McRobbie, 1996). Recently, attention has moved from planning and implementing science instruction to how communication can be delayed or advanced for ELLs. While examining if classroom communication supports ELLs, three key elements for second language development must be considered: input, interaction, and output (Nutta, Bautista, & Butler, 2011).

Second Language Acquisition

According to Stephen Krashen (1985), learned and acquired competences develop differently. He believes that language acquisition develops "exclusively" through "comprehensible input" (Krashen, 1985; Tricomi, 1986). *Comprehensible input* is verbal input that is supported by nonverbal cues. Verbal input is somewhat higher than the learner's current level of language proficiency (Nutta et al., 2011). *Input* is described as "the linguistic forms (morphemes, words, utterances)—the streams of speech in the air—directed at the non-native speaker" (Long, 1983, p. 127), whereas the "analysis of interaction means describing the functions of those forms in (conversational) discourse" (Long, 1983, p. 127). The learner has access to input through any medium (listening, reading, or gestural in the case of sign language) (Gass & Mackey, 2006). By connecting meaning to new vocabulary and structures and exposing second language learners to language that is understandable and meaningful, language competence can be acquired (Nutta et al., 2011; Tricomi, 1986).

Conversational interactions between the learner and the teacher and the learner and other students are of equal importance for second-language acquisition (Gass & Mackey, 2006; Long, 2006; Nutta et al., 2011). During interaction, the learner understands language input and produces language output while negotiating meaning with another person. In other words, interaction considers input as exposure to language whereas output is the production of language (Gass & Mackey, 2006). Output, a key element to language proficiency, is demonstrating meaning by presenting information or knowledge on an assessment (Nutta et al., 2011).

Considering input, interaction, and output while teaching science, teachers must adjust any verbal input to match the learners' level of proficiency and increase nonverbal input (Nutta et al., 2011). For example, providing handouts or other individualized instructional materials that include simple language and/or highlighted key vocabulary would be ideal. A study conducted by Brown and Ryoo (2008) revealed that ELLs perform better when they are taught using scientific concepts in the everyday language prior to introducing it as a scientific term. Science (interaction) engagement is more than asking and answering questions. It should be more meaningful and require new ways of thinking and organizing instruction (Fradd & Lee, 1999). Science instruction should consider and include students' prior understanding, connect students' native language to vocabulary and involve more hands on instruction that allow students to "experience" science (River & Krajcik, 2008). In efforts to promote language development and science learning for ELLs, it is important for teachers to understand the role students' language and cultural experiences play in the understanding of science academic language.

Academic Language

Academic language has proven to be a challenge for ELLs (Collier, 2008; Short, Vogt, & Echevarria, 2011). "For students unfamiliar with the language or style of science, the deceptively simple act of communication can be a barrier to understanding or becoming involved with the science" (Hines, Wible, & McCartney, 2010, p. 447). To address this issue, teachers of ELLs must focus on three key areas: vocabulary development, talking science, and writing science (Ballantyne, Sanderman, & Levy, 2008; Dobb, 2004; Nutta et al., 2011). According to Lemke (1990) and Gibbons (2003) teachers should talk directly with students about scientific discourse and provide more time for students to practice speaking about science. These conversations should initially begin informally, using everyday language so that students understand the concepts being taught.

"[E]ducators have begun to realize that the mastery of academic subjects is the mastery of their specialized patterns of language use, and that language is the dominant medium through which these subjects are taught and students' mastery of them tested" (Lemke, 1988, p. 81). Science learning involves knowing (making meaning of science knowledge and vocabulary), doing (manipulating materials, observing, proposing explanations, interpreting data), and talking (engaging in formal and informal discussions) science (Lee & Fradd, 1998). Learning the language of science is a complex process that involves developing relationships among ideas, terms, and meanings. This process becomes more complex when comparable terms do not exist across languages (Fradd & Larrinaga McGee, 1994). Science language "describes attributes and characteristic events of general classes of objects . . . ; it compares categories . . . ; and it explains phenomena" (Honig, 2012, p. 32). It has a specialized set of vocabulary terms that may not be found in other subjects, which make it more difficult for ELLs to connect with prior knowledge. Nonetheless, there are various strategies that have been proven effective in teaching ELLs.

Teaching Strategies for English Language Learners

It is necessary for ELLs to acquire English language proficiency to participate and be successful in mainstream classrooms (Lee & Fradd, 1998). Without the proper support and resources, teachers of ELLs cannot effectively meet the needs of these students. Consequently, ELLs fall further behind academically (Harris, 2003). It is essential that teachers of ELLs have the necessary tools and techniques to support these learners (Facella, Rampino, & Shea, 2005).

Vocabulary acquisition is important for ELLs (Llach & Gómez, 2007). Strategies that focus on academic vocabulary development include word walls, semantic webs, structural analysis, demonstrations, illustrations, and art projects (Short & Echevarria, 2005). Literature also credits graphic organizers and visuals as effective strategies for ELLs (Goldenberg, 2008; New Teacher Center, 2005).

Using visuals in instruction is an important approach to consider because so much learning involves visual imagery (Smaldino, Lowther, & Russell, 2012). Literature on teaching ELLs asserts that visual input is needed to teach content (Britsch, 2009; Peregoy & Boyle, 2005). To help ELLs make sense of new academic vocabulary, pictures and photographs can provide visuals to match with unfamiliar words (Sibold, 2011). As an example of visual literacy, "photography can work as a sign making tool that validates what the children themselves see as important, and captures their interests which words alone may not convey" (Britsch, 2010, p. 174). Other examples of visual literacy found in the 21st-century classroom include drawings, charts, graphs, film, Web 2.0 tools, graphic symbols, and signs (Britsch, 2010; Felten, 2008; Smaldino et al., 2012).

In this action research project, we focused on a participatory action research method known as photovoice to teach ELLs science concepts. "Photovoice is a method by which people can identify, represent, and enhance their community through a specific photographic technique" (Wang & Burris, 1997, p. 369). It allows the participant to capture photographs of significant themes in and around their community (Aslam et al., 2013). This methodology puts photographs at the center of the discussion while the participant (student) serves as the "expert" or initiator of the conversation (Luttrell-Rowland, 2006). Photovoice complements the instructional congruence framework as both focus on making an experience meaningful and relevant to the participants' lives.

Photovoice is built on the pillars of documentary photography, feminist research theory, and Freirian empowerment in the public health arena (Wang & Burris, 1997). It is described as an action-oriented method that is nonthreatening to participants (Young & Barrett, 2001). Participants use photographs to capture and identify pressing concerns in their communities and to voice their feelings and anxieties. Subsequently, the power of representation shifts from the researcher to the researched (Luttrell-Rowland, 2006). This methodology has been proven successful in studies involving children and youth (Findholt, Michael & Davis, 2010; Jacobs & Harley, 2008; Strack, Magill & McDonagh, 2004; Zenkov & Harmon, as cited in Morojele & Muthukrishna, 2013).

METHOD

Course Context

This research evolved an undergraduate science methods course for early childhood majors at a large public university in the southeastern region of the United States. As part of the design of the teacher education program, preservice teachers enroll in four methods courses (mathematics, social studies, science, and reading/writing/literacy) as a cohort during their senior year. The design is referred to as Teaching of Specific Subjects (TOSS). During TOSS, students are allowed to preselect a cohort with a particular emphasis—technology, social justice, or ELLs—that served as the overarching framework for the methods courses. Students enrolled in these specialized cohorts were placed in schools/classrooms that worked closely with the cohort instructors and truly embraced and emphasized the cohort's theme. This study stems from an action research project that was conducted during the science methods course of the ELL cohort.

Many teacher preparation programs embed capstone or action research projects into their curriculum to allow preservice teachers to grow professionally and develop a strong voice in conversations for change (Phillips & Carr, 2010). As an action research project, three candidates utilized aspects of photovoice to demonstrate the importance of science in rural and urban contexts and how science academic language can "show up" in students' lives. Photovoice was appropriate for this study because it allowed the students to visually communicate and identify science concepts they see in their everyday lives. With the use of images and visual aids, limitations caused by vague verbal statements are minimized (Aslam et al., 2013). Each student received an equal voice through the photograph. Handheld or cell phone cameras were used to take pictures of science concepts around the school or in the students' lives. The final product was a visual presentation of science academic language from the student or photographer's lens.

For the purposes of this study, we were interested in the experiences of the preservice teachers' use of visual literacy to teach science academic language to ELLs in an elementary classroom and possible strengths and limitations of incorporating the strategy into the classroom of ELLs?

Participants

The ELL cohort consisted of 21 students; three students under the pseudonyms *Darla, Haley,* and *Stephanie* consented to participate in the visual literacy study. The teachers were middle-class, White females between ages 22 and 44 from the southeastern region of the United States. Each was in their senior year of college with no prior teaching experience completing their field experience in the neighboring school district within 25 miles of the university. The participants agreed to submit a lesson plan, complete the presurvey questionnaire, and participate in an interview.

Setting of Study

Darla was placed at a Title I, fine arts–based school with a population of approximately 700 students. Thirty percent were categorized as ELLs, and more than 80% received free/reduced lunch. For the year, Darla was assigned to a first-grade class of 22 students (13 ELLs). The languages of the students in her class were English and Spanish. All the students in her class were pulled out once a day for approximately 45 minutes to work with an ESOL teacher on science and social studies content. Several of her ELLs were pulled out for an additional time to focus on reading and/or math.

Haley was assigned to a Title I elementary school with a population of 760 students. The school comprised 87% ELLs, and 95% of its students with free/reduced lunch status. Haley was placed in a fifth-grade class with 28 students, 14 of whom were ELLs. Haley was in an inclusion classroom where 13 of the 28 students in her class had a learning disability. English and Spanish were the languages spoken by her students. In this classroom, two teachers—one an ELL specialist and the other a special education expert—cotaught all lessons. Many of the ELL students were pulled from the classroom for language enrichment and math. The students left every day for 40-minute blocks during the subject time.

Stephanie's field placement was at a Title I elementary school with 760 students, 87% of whom were categorized as ELLs and 95% received free/reduced lunch. During her yearlong experience, Stephanie was assigned to a kindergarten class of 21 students (20 ELLs). English and Spanish were the languages of the students in the class. Students received a push-in ESOL service every day for 30 minutes during the allotted reading time. This was conducted in small group settings.

Data Collection and Analysis

We chose to address our research questions using qualitative research methods. We began data analysis by compiling the questionnaire data to form a general profile of the participants. The questionnaire data included basic demographic information such as the name of the student teacher's school and assigned grade level, the number of students in school/class, the number of ELLs in the school/class, and any special services available for ELLs.

Next, lesson plans were collected and reviewed to provide a snapshot of how the student teacher planned to use visual literacy to teach academic language in her particular class. The lesson plan provided the objectives, the amount of time the activity would take, key vocabulary terms, essential questions, and the instructional sequence. The lesson plans were primarily used to triangulate data obtained during the interview.

Interview questions were emailed to the students prior to their scheduled interview date. Recorded interviews were transcribed, individual transcripts were sent to each participant for review. Transcripts were coded and analyzed using standard qualitative research methods (Bogdan & Bilken, 1992; Miles & Huberman, 1994). Miles and Huberman (1994) proposed the reading of the transcript or listening to the recorded tape a number of times while noting the patterns, common issues, themes, and subthemes that emerge. In this study, we listened to recorded interviews and separately noted the patterns, common issues, and emerging themes and subthemes. Ongoing analytical memos were taken to make sense of the data sources (Glesne & Peshkin, 1992). After coding the data, we wrote analytical memos that synthesized themes from each code. We later came together to compare codes and discuss findings. The discussion process involved sometimes relistening to the tapes to ascertain a common interpretation, though sometimes compromises had to be done to reach an amicable conclusion. During this process, the research questions were kept in mind and also used to guide the process. Below we report findings that emerged from the data analysis process.

FINDINGS

A common theme among the data was that visual literacy allowed elementary ELLs to make self-discoveries in science. Haley commented, "The students were engaged at a different level. You went out of a science classroom lecture and you let them do that self-discovery of figuring something out." Haley's lesson involved her fifth-grade students identifying physical and chemical changes. She allowed her students to use magazines to sort through to find pictures of chemical and physical changes. Once the students found an example, they needed to explain why it was a certain type of change and describe how the picture supports it as an example. Her students self-discovered content vocabulary as they found examples of evaporation, combustion, radiation, and absorption. When students needed assistance to identify the vocabulary word, they consulted their science vocabulary books. These vocabulary books started blank at the beginning of the year, and students would add scientific language as they encountered them in their science lessons. The picture example made students "discover" the vocabulary on their own in a real-life example.

Darla also corroborated with the statement that her first-grade students made self-discoveries. The science standard required students to recognize sources of light and explain how shadows are formed.

> My class could not wait to get their hands on the camera. It taught them independence through using the camera on their own. It was more like self-discovery because they could find a shadow on their own; it wasn't me telling them where it was.

Her first-grade class studied light and shadows so Darla wanted to provide them with a hands-on activity that would be meaningful and demonstrate their knowledge of the science academic language. She worked with groups of five children while they walked around the school to pick out shadows they saw. Once they found a shadow they had to write what the light source was and where it was located. They used clipboards and took notes as they walked with Darla, who helped them take photographs of various shadows (Figures 1, 2, & 3).

FIGURE 1 Table shadow.

FIGURE 2 Cone shadow.

FIGURE 3 Side of building shadow.

The next day, Darla printed out the pictures so the students would have a hard copy. In reading, the class had being studying what captions were, so Darla asked them to caption their photo. As they captioned their pictures, another effect of using visual literacy emerged. Darla witnessed her ELLs using the science academic language to describe concepts. She noted, “The students learned the words light and shadow as they used that academic vocabulary in their captions. They learned what a caption was too.”

Stephanie integrated her view of visual literacy with a class field trip to an aquarium. Because she was assigned to a kindergarten class, she decided to have the students pick what they wanted a picture of while she took the picture. When they returned to the classroom, she had the students write about the animals and their experience to the aquarium. The science standard aligned to the activity involved comparing the similarities and differences in groups of organisms. The students were able to demonstrate their knowledge of academic vocabulary in their comparative writing samples of aquatic life they saw at the aquarium (Figures 4 & 5).

Stephanie recalls,

> I remember a little girl who compared and contrasted two fish in two of the pictures I had taken. Knowing the color words in kindergarten is huge and she noticed a clownfish was a vibrant orange compared to the other fish she saw.

After completing the lesson, Stephanie allowed her students to create a word wall of the academic language they acquired from their trip to the aquarium (Figure 6). In Darla and Stephanie’s classrooms, the students continued to use the academic vocabulary learned through the visual literacy activity throughout the school year.

When asked about their students’ use of social language versus academic language during the activity, all the teachers noted that their students felt more comfortable using social language rather than the science academic language of the lesson (e.g., shadow, light, different, similar, physical change, chemical change). They agreed that their students eventually began using the key

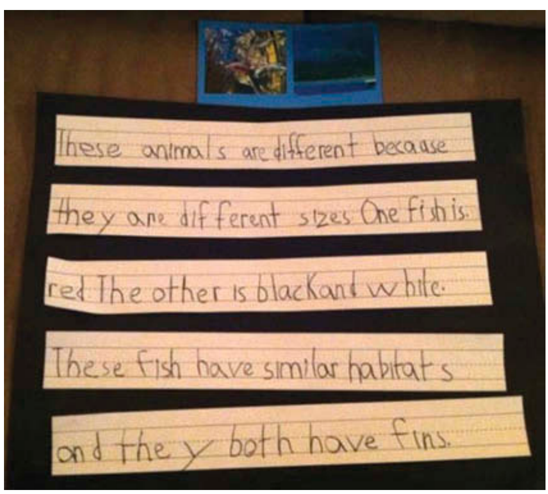

FIGURE 4 Similarities and differences of fish.

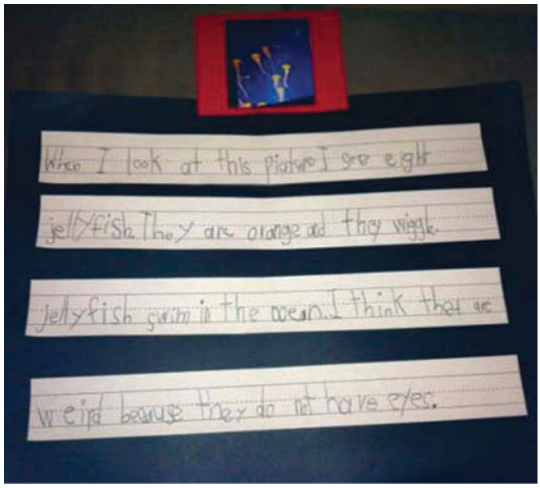

FIGURE 5 Similarities and differences of jellyfish.

FIGURE 6 Word wall of aquarium academic language.

science vocabulary, but social language dominated the discussion. Each recognized that science academic language typically did not show up in the home setting; therefore, students tended not to use it outside the class.

Data also showed that the teachers believed that visual literacy activity was an effective approach to teaching science academic language to ELLs because it allowed the students to connect objects they may see on a daily basis with science vocabulary and concepts. Haley noted, “Photographs helped the students make real life connections to the material.” Darla expressed that she now introduces science concepts by connecting them to students’ prior knowledge or lived experiences:

> I always start with taking something they already knew and building on it to introduce something new. This works because they always have something from their past to make a connection with. I use a lot of pictures when I am explaining new content so that they can make a visual connection.

The second research question addressed the strengths and limitations of the teachers approach to incorporating visual literacy into the science classroom. All three teachers commented that they would definitely do a visual literacy project again while teaching science; however, they all agreed that they would have the students take a more personal approach. Stephanie felt that the students could take pictures of science-related concepts in their immediate world: “Since I am working with fifth graders this year, they could take pictures when they walk around the school. We have a garden now and we could integrate science and literacy within the unit of plants and living things.” Stephanie’s comments show thoughtful reflection and assessment of the resources within her own school that students could make connections.

Haley also expressed her interest of doing the project again but with a few modifications. She noted that she would have her students to take their own pictures instead of pulling pictures from magazines. She asserted that her class was full of diverse children and that they could compare and contrast their picture with their peers while illuminating and recognizing cultural differences amongst one another, “I think it would bring stuff that was in their immediate worlds into a different perspective to them. They could share their own perspective on a science topic because everyone’s different.”

The teachers felt visual literacy allowed the students to participate in a more hands-on, engaging, meaningful activity within science. Darla was impressed with how the content stayed with the students even far after the unit was complete: “It was a hands-on project and the vocabulary actually stuck with them because I remember walking through the hallway several weeks later and they were telling me about the light sources and shadows they saw.” The visual literacy project in Darla’s class made an impression on her students and she believes it helped them gain background knowledge on the scientific concept of light and shadows.

Two major limitations that appeared in the data were the lack of resources and the students’ familiarity with cameras. Two teachers used their personal camera whereas one chose a different approach due to lack of resources. Haley noted that if she had more money, she would have sent disposable cameras home with the students to capture pictures of the science concepts. Darla mentioned that due to a lack of resources, she had to take the students out in groups of five while her cooperating teacher remained with the class. “What I did in first grade was I brought in a camera and I let the kids each have a turn. We walked around the school in groups of five.” Stephanie echoed the need for more cameras in the classroom for students to make that more personal connection but voiced the concern about students’ ability to use particular cameras.

Each teacher expressed a concern about the students’ particular grade level and their familiarity with cameras. Stephanie mentioned how nervous she was while allowing the students to handle their cameras while Darla commented on her moments of excitement and gratification:

> I was feeling excited for the students because I knew it was probably a new experience for most of them. Despite it being a new experience, I also felt confident that they would be able to use the camera. I also felt proud of how serious they took the project. They knew that they were working with a piece of technology that they had to be gentle with and also put a lot of thought into what they wanted to take a picture of.

Stephanie noted,

> For having the students use the cameras, it was challenging because they were so young, and they were not comfortable with it. It was hard for them to get a still image worth using. However, with a little help from me, it wasn't a big inconvenience. It was more important to me that they captured the image they wanted, so I would actually "snap" the camera if I had to.

DISCUSSION

As the number of ELLs in the United States increases, the need for teachers who are prepared to teach them also increases. But the fact remains, many teachers are not prepared to meet the needs of ELLs especially when research shows that it will require additional skills to teach them effectively; skills that go beyond what is used to teach students whose first language is English (Echevarria, Short, & Peterson, 2012; NCTE, 2008; Téllez & Waxman, 2005). This is especially true in science, a discipline that is more than just experimenting and observing natural phenomena but one that involves technical terms and associated concepts, written and oral instructions, content-specific academic language, and textbook reading (Short et al., 2011). However, there are several important factors that influence students' development of academic skills. These factors include students' proficiency and educational history in their home languages, their social and cultural backgrounds, in addition to classroom-level factors like quality of instruction (Francis, Rivera, Lesaux, Kieffer, & Rivera, 2006; Pianta et al., as cited in Brouillette, 2012).

In this study, the synergy between academic language and language development was made visible through the incorporation of visual literacy strategies in the science classroom. Research shows that instructional supports and strategies for ELLs such as extended explanations with information like gestures, pictures, and other visual cues tend to maximize students' language learning (Goldenberg, 2008). The study illuminated the experiences of three preservice teachers' approach to teach for diversity by integrating visual literacy strategies into their science lessons. Data revealed how pre service teachers were able to "recognize" the significance and benefits of visual literacy as a method to teaching science academic language to ELLs. Results indicated that students employed self-discovery of academic language, knowledge of academic language, and the contextual use of academic language.

Developmental in nature, academic language increases in complexity and sophistication as grade levels increase (Anstrom et al., 2010). It does not operate in isolation but within a sociocultural context. Although students' backgrounds and experiences need to be considered, the classroom sometimes serves as the sociocultural context for learning academic language (Gottlieb & Ernst-Slavit, 2013). Data show how students were able to connect terms like light source, shadows, radiation, evaporation, animals, like/different to pictures of physical and chemical changes found in magazines, aquatic animals from their trip to the aquarium, and shadows around the school. Each teacher mentioned that discussions and writing assignments (e.g., journaling, writing sentences) were designed to make the activity more meaningful and link familiar experiences to the concept. These data support the framework of instructional congruence which speaks to the notion of connecting students' everyday discourse to science discourse (Md Zain et al., 2010).

Teachers who support cultural congruence recognize the rich experiences students bring to the science classroom from their home languages and cultures (Luykx & Lee, 2007). Each preservice teacher agreed that the visual literacy strategy was an effective approach to teaching science academic language to ELLs. They recognized that visual literacy allows the learner to "understand, produce, and use culturally significant images, objects, and visible actions" (Felten, 2008, p. 60); however, they pointed out several limitations. The teachers commented on the lack of resources (individual cameras) that would have made the activity more personable and engaging as well as the students' unfamiliarity of using cameras. Nevertheless, each mentioned they would use the strategy in the future.

To prepare students for the 21st century, they must not only be verbally literate, but also visually literate (Brumberger, 2011). This approach to teaching science academic language is just one way of many that engages the learners while making science learning meaningful and relevant. Using photovoice methodology gave students the opportunity to take photographs of things that represented particular elements seen in their everyday lives; students were able to respond to the theme or essential question of the lesson (Young & Barrett, 2001). In the study, students identified shadows and light sources as well as recognized similarities and differences between aquatic animals. Oral discourse allowed students to give understanding and interpretations of their photos (Wang, 1999) that lead to more use of the academic language.

As Britsch (2010) explained, "Language does not develop as an isolated mode of communication; it has a relationship with visual imagery" (p. 171). Findings from this study suggest that even though there were some limitations to incorporating visual literacy strategies into the science classroom, preservice teachers find the approach helpful to teaching academic language to ELLs. Along similar lines, teachers of this study appeared to be motivated and eager to use the strategy again in the future.

Limitations

This study focused on three preservice teachers' experiences using visual literacy as a strategy for teaching science academic language to ELLs in an elementary classroom. This study has several limitations that need to be addressed in future research. One such limitation is the small number of teachers to participate in the study. Due to other research interests and commitments, it was difficult to get other students to consent to participate. To learn more about the impact of visual literacy as a strategy for teaching science academic language to ELLs, a larger and more diverse sample should be studied. In addition, a greater number of student teachers would increase generalizability of the study.

Another limitation of the study was that all the work samples mentioned in this study were from students who spoke Spanish as their first language. Although Spanish is the most frequently spoken language for ELLs, there are more than 460 languages spoken in the United States (Garcia, Kleifgen, & Falchi, 2008; Kindler, 2002). Additional research on the implications of visual literacy with students who speak other languages is needed to compare this data.

Implications for Practice

The findings of this study have significant implications for practice. Teacher preparation programs need to place a greater emphasis on diversity especially with the growing population of

ELLs, especially as it related to science instruction. Demonstrating effective strategies to teach ELLs science would reduce the number of well-meaning but inadequately prepared teachers from sabotaging their own efforts by error. Subsequently, ELLs would experience more meaningful instruction in general. Pre service teachers should be provided with the necessary tools to teach all students effectively.

One recommendation for teacher preparation faculty would be to create opportunities for preservice teachers to develop or use visual literacy strategies in content area learning and understanding during their field placement classrooms. These opportunities can be introduced during courses such as science methods and/or reading and literacy methods and implemented as a course assignment or action research project. The more exposure preservice teachers have to teach for diversity, the more prepared they will be in the profession.

Moving Forward

As we continue to prepare preservice teachers to teach for diversity and model meaningful science instruction, it is necessary for us to recognize the nature and practice of science in combination with language and visual literacy. Future work can build on the findings of this study. Consequently, data gathered from this study will be expanded. All students enrolled in the ELL TOSS cohort will be required to implement the visual literacy assignment during their field experience. Artifacts will be uploaded onto the course management system, and students will participate in focus group discussions to share discoveries, successes, and challenges of the assignment. With a larger data set, broader conclusions can be drawn. So future work is needed to add to the emerging body of research on ELLs' language acquisition, science academic language specifically. We hope that other educators find this study useful and look at it as a blueprint that sparks similar projects/assignments in their respective teacher preparation programs.

CONCLUSION

This pedagogical study focused specifically on how these teachers approached teaching for diversity in an elementary science classroom, highlighting visual literacy strategies specifically. We chose to focus on visual literacy strategies for this study because of the various examples found in today's 21st-century classrooms (e.g. drawings, charts, graphs, film, photography, Web 2.0 tools, graphic symbols, and signs; Britsch, 2010; Felten, 2008; Smaldino et al., 2012); however, there are numerous strategies to teach ELLs. Although the participant sample is small, we believe that this study adds to the emerging literature on ELLs and academic language in science, technology, engineering, and mathematics education. We offered an example of how teacher preparation programs can address the "teaching for diversity need" in the science classroom from which discussions can begin. It is our responsibility as teacher educators to model effective approaches to teaching for diversity in our courses; if we do not, we are doing our preservice teachers a huge disservice.

REFERENCES

Amaral, O. M., Garrison, L., & Klentschy, M. (2002). Helping English learners increase achievement through inquiry-based science instruction. *Bilingual Research Journal*, *26*, 213–239.

Anstrom, K., DiCerbo, P., Butler, F., Katz, A., Millet, J., & Rivera, C. (2010). *A review of the literature on Academic English: Implications for K–12 English language learners*. Arlington, VA: The George Washington University Center for Equity and Excellence in Education.

Aslam, A., Boots, R., Link, S., Pearson-Beck, M., Mayton, H., & Elzey, D. (2013). Effective community listening: A case study on photovoice in rural Nicaragua. *International Journal for Service Learning in Engineering*, *8*(1), 36–47.

Ballantyne, K., Sanderman, A., & Levy, J. (2008). *Educating English language learners: Building teacher capacity*. Washington, DC: National Clearinghouse for English Language Acquisition. Retrieved from http://www.ncela.gwu.edu/practice/mainstream_teachers.htm.

Bogdan, R., & Bilken, S. (1992). *Qualitative research*. Boston, MA: Allyn & Bacon.

Britsch, S. (2009). ESOL educators and the experience of visual literacy. *TESOL Quarterly*, *43*(4), 710–721.

Britsch, S. (2010). Photo-Booklets for English language learning: Incorporating visual communication into early childhood teacher preparation. *Early Childhood Education Journal*, *38*, 171–177.

Brouillette, L. (2012). Supporting the language development of limited English proficient students through arts integration in the primary grades. *Arts Education Policy Review*, *113*, 68–74.

Brown, B., & Ryoo, K. (2008). Teaching science as a language: A content-first approach to science teaching. *Journal of Research in Science Teaching*, *45*(5), 529–553.

Brumberger, E. (2011). Visual literacy and the digital native: An examination of the millennial learner. *Journal of Visual Literacy*, *30*(1), 19–47.

Calderon, M., Slavin, R., & Sanchez, M. (2011). Effective instruction for English learners. *Future of Children*, *21*(1), 103–127.

Collier, L. (2008). The importance of academic language for English language learners. *The Council Chronicle*, March, 10–13.

Cox-Petersen, A., Melber, L., & Patchen, T. (2012). *Teaching to culturally and linguistically diverse elementary students*. Boston, MA: Pearson.

Crawford, J. (2000). *At war with diversity: U.S. language policy in an age of anxiety*. Clevedon, UK: Multilingual Matters.

Dale, J. (2010). Needs of diverse students. Statement to U.S. Congress, House Committee on Education and Labor Subcommittee on early childhood, elementary and secondary education, March 18, Washington, DC.

Darling-Hammond, L. (2006). *Powerful teacher education: Lessons from exemplary programs*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L., French, J., & Garcia-Lopez, S. P. (2002). *Learning to teach for social justice*. New York, NY: Teachers College Press.

Diaz-Rico, L. (2012). *A course for teaching English learners*. Boston, MA: Pearson.

Dobb, F. (2004). *Essential elements of effective science instruction for English learners*. Los Angeles, CA: California Science Project. Retrieved from, http://csmp.ucop.edu/downloads/csp/essential_elements_2.pdf.

Echevarria, J., Short, D., & Peterson, C. (2012). *Using the SIOP model with pre-K and kindergarten English learners*. Boston, MA: Pearson.

Eisenhart, M., Finkel, E., & Marion, S. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, *33*, 261–295.

Facella, M., Rampino, K., & Shea, E. (2005). Effective teaching strategies for English language learners. *Bilingual Research Journal*, *29*(1), 209–221.

Felten, P. (2008). Visual literacy. *Change*, *40*(6), 60–64.

Findholt, N., Michael, E. Y. L., & Davis, M. M. (2011). Photovoice engages rural youth in childhood obesity prevention. *Public Health Nursing*, *28*, 186–192.

Fradd, S. H., & Larrinaga McGee, P. (1994). *Instructional assessment: An integrative approach to evaluating student performance*. Reading, MA: Addison-Wesley.

Fradd, S. H., & Lee, O. (1999). Teachers' roles in promoting science inquiry with students from diverse language backgrounds. *Educational Researcher*, *28*, 14–20, 42.

Francis, D., Rivera, M., Lesaux, N., Kieffer, M., & Rivera, H. (2006). *Practical guidelines for the education of English language learners: Research-based recommendations for instruction and academic interventions*. Portsmouth, NH: RMC Research Corporation, Center on Instruction.

Garcia, O., Kleifgen, J., & Falchi, L. (2008). *From English learners to bilinguals. Equity matters: Research review No. 1*. Teachers College, Columbia University. Retrieved from: http://www.equitycampaign.org/i/a/document/6468_Ofelia_ELL__Final.pdf.

Gass, S., & Mackey, A. (2006). Input, interaction and output: An overview. *AILA Review*, *19*, 3–17.

Gibbons, P. (2003). Mediating language learning: Teacher interactions with ESL students in a content based classroom. *TESOL Quarterly*, *37*(2), 247–273.

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction*. White Plains, NY: Longman.

Goldenberg, C. (2008). Teaching English language learners: What the research does-and does not-say. *American Educator*, Summer, 8–44.

Gottlieb, M., & Ernst-Slavit, G. (2013). *Academic language in diverse classrooms: Mathematics, grades K–2: Promoting content and language learning*. Thousand Oaks, CA: Corwin.

Gutiérrez, G., & Vanderwood, M. L. (2013). A growth curve analysis of literacy performance among second-grade, Spanish speaking, English language learners. *School Psychology Review*, *42*(1), 3–21.

Harris, J. L. (2003). Toward an understanding of literacy issues in multicultural school-age populations. *Language, Speech and Hearing Services in School*, *34*(1), 17–19.

Hines, P. J., Wible, B., & McCartney, M. (2010). Learning to read, reading to learn. *Science*, *328*(5977), 447.

Honig, S. (2012). Teaching science, teaching language. *Illinois Reading Council Journal*, *40*(3), 32–39.

Jacobs, S., & Harley, A. (2008). Finding Voice: The Photovoice Method of Data Collection in HIV and AIDS-Related Research. *Journal of Psychology in Africa*, *18*(3), 431–435.

Kindler, A. (2002). *Survey of the states' limited English proficient students and available educational programs and services: 2000-2001 summary report*. Washington, DC: National Clearinghouse for English Language Acquisition and Language Instruction Educational Programs. Retrieved from http://www.ncela.gwu.edu/policy/states/reports/seareports/0001/sea0001.pdf.

Krashen, S. (1985). *The input hypothesis*. New York, NY: Longman.

Lee, O. (2005). Science education with English language learners: Synthesis and research agenda. *Review of Educational Research*, *75*(4), 491–530.

Lee, O., Deakor, R., Enders, C., & Lambert, J. (2008). Impact of a multiyear professional development intervention on science achievement of culturally and linguistically diverse elementary students. *Journal of Research in Science Teaching*, *45*(6), 726–747.

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English language backgrounds. *Educational Researcher*, *27*, 12–21.

Lemke, J. (1990). *Talking science: Language, learning, and values*. New York: NY: Ablex.

Llach, P. A., & Gómez, A. B. (2007). Children's characteristics in vocabulary acquisition and use in the written production. *Revista Española de Lingüística Aplicada (RESLA)*, *20*, 9–26.

Long, M. (1983). Native speaker/non-native speaker conversation and the negotiation of comprehensible input. *Applied Linguistics*, *4*, 126–141.

Long, M. (2006). *Problems in second language acquisition*. New York, NY: Routledge.

Luttrell-Rowland, L. (2006). A photovoice relationship: Collaboration and difference in photovoice methodology. In *Proceedings of the National Conference on Undergraduate Research (NCUR)* (pp. 3079–3084). Asheville, NC: The University Of North Carolina at Asheville. Retrieved from http://www.ncur20.com/presentations/15/1543/paper.pdf.

Luykx, A., & Lee, O. (2007). Measuring instructional congruence in elementary science classrooms: Pedagogical and methodological components of a theoretical framework. *Journal of Research in Science Teaching*, *44*(3), 424–447.

Md Zain, A., Samsudin, M., Rohandi, R., & Jusoh, A. (2010). Improving students' attitudes toward science using instructional congruence. *Journal of Science and Mathematics Education in Southeast Asia*, *33*(1), 39–64.

Merino, B., & Hammond, L. (2001). How do teachers facilitate writing for bilingual learners in "sheltered constructivist" science? *Electronic Journal in Science and Literacy, 1*(1), Retrieved from http://ejlts.ucdavis.edu/sites/ejlts.ucdavis.edu/files/articles/merino.pdf

Miles, M., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage.

Morojele, P., & Muthukrishna, N. (2013). 'My journey to school': Photovoice accounts of rural children's everyday experiences in Lesotho. *Gender & Behaviour*, *11*(2), 5362–5377.

National Center for Education Statistics. (2011). *The nation's report card: Science 2009* (Report No. NCES 2011–451). Washington, DC: U.S. Department of Education, Institute of Education Sciences.

National Center for Education Statistics. (2013). *English language learners*. Retrieved from: http://nces.ed.gov/programs/coe/indicator_cgf.asp.

National Council of Teachers of English (NCTE; 2008). English language learners: A policy research brief. Retrieved from www.ncte.org.

New Teacher Center of the University of California at Santa Cruz. (2005). *Six key strategies for teachers of English-language learners*. Retrieved from http://www.all4ed.org/files/archive/publications/SixKeyStrategies.pdf

Nieto, S. (2000). Placing equity front and center: Some thoughts on transforming teacher education for a new century. *Journal of Teacher Education*, *51*, 180–187.

Nutta, J., Bautista, N., & Butler, M. (2011). *Teaching science to English language learners*. New York, NY: Routledge.

Peregoy, S. F., & Boyle, O. F. (2005). *Reading, writing, and learning in ESL: A resource book for K-12 teachers* (4th ed.). Boston, MA: Pearson.

Phillips, D. K. & Carr, K. (2010). *Becoming a teacher through action research: Process, context, and self-study*. New York, NY: Routledge.

River, A., & Krajcik, J. (2008). Conceptualizing instruction: Leveraging students' prior knowledge and experiences to foster understanding of middle school science. *Journal of Research in Science Teaching*, *45*, 79–100.

Rojas, V. P. (2007). *Strategies for success with English language learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Short, D., & Echevarria, J. (2005). Teacher skills to support English language learners. *Educational Leadership*, *62*, 8–13.

Short, D., Vogt, M. E., & Echevarria, J. (2011). *The SIOP model for teaching science to English learners*. Boston, MA: Pearson.

Sibold, C. (2011). Building English language learners' academic vocabulary: Strategies & tips. *Multicultural Education*, *18*(2), 24–28.

Smaldino, S., Lowther, D., & Russell, J. (2012). *Instructional technology and media for learning*. Boston, MA: Pearson.

Stoddart, T., Pinal, A., Latzke, M., & Canaday, D. (2002). Integrating inquiry science and language development for English language learners. *Journal of Research in Science Teaching*, *39*, 664–687.

Strack, R. W., Magill, C., & McDonagh, K. (2004). Engaging youth through photovoice. *Health Promotion Practice*, *5*(1), 49–58.

Téllez, K., & Waxman, H. (2005). *Preparing quality educators for English language learners: Research, policies and practices*. New York, NY: Routledge.

Thomas, W., & Collier, V. P. (2002). *A national study of school effectiveness for language minority students' long-term academic achievement*. Santa Cruz, CA: Center for Research on Education, Diversity, & Excellence.

Tissington, L., & LaCour, M. (2010). Strategies and content areas for teaching English language learners. *Reading Improvement*, *47*(3), 166–172.

Tobin, K., & McRobbie, C. (1996). Significance of limited English proficiency and cultural capital to the performance in science of Chinese-Australians. *Journal of Research in Science Teaching*, *33*(3), 265–282.

Tricomi, E. (1986). Krashen's second-language acquisition theory and the teaching of edited American English. *Journal of Basic Writing*, *5*(2), 59–69.

Villegas, A. M. (2008). Diversity and teacher education. In M. Cochran-Smith, S. Feiman-Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education: Enduring questions in changing contexts* (pp. 551–558). New York, NY: Routledge.

Villegas, A., & Lucas, T. (2002). *Preparing culturally responsive teachers: A coherent approach*. Albany, NY: State University of New York Press.

Wang, C. (1999). Photovoice: A participatory action research strategy applied to women's health. *Journal of Women's Health*, *8*, 185–192.

Wang, C., & Burris, M. (1997). Photovoice: Concept, methodology and use for participatory needs assessment. *Health Education Quarterly*, *24*(3), 369–387.

Young, L., & Barrett, H. (2001). Adapting visual methods: action research with Kampala street children. *Area*, *33*, 141–152.

Charlease Kelly-Jackson is an assistant professor of elementary science education at Kennesaw State University. Her research areas include diversity issues in science education and teacher preparation.

Stacy Delacruz is an assistant professor of elementary literacy education at Kennesaw State University. Her research areas include balanced literacy, digital literacy, and literacy among English language learners.