PROVIDING EQUAL OPPORTUNITY TO LEARN SCIENCE FOR ENGLISH LANGUAGE LEARNERS: THE ROLE OF SIMULATED LANGUAGE LEARNER EXPERIENCES IN TEACHER PREPARATION

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Abstract

English language learners (ELLs) are the fastest growing student population in our nation’s public school systems; yet, preservice and inservice teachers are commonly underprepared to teach science effectively to this group of students. Though obviously inequitable, providing ELLs with poor or subpar science instruction denies them their civil right to equal opportunity to learn science. In this paper, we discuss simulation as a promising way to prepare preservice elementary teachers to plan and deliver quality science instruction and robust opportunities to learn to ELLs.
Responsive and Equitable Education

The primary focus of education is to improve students’ lives by providing means to overcome the inequities of school and society, and it is the responsibility of teachers to see that this happens for every learner (Adams, Bell, & Griffin, 1997; Cochran-Smith et al., 2009; Darling-Hammond, French, & Garcia-Lopez, 2002; Michelli & Keiser, 2005). However, this is often not the case in many of the schools across America. Instead, schools tend to have a mainstream agenda founded on European-American cultural norms with little allowance for differences or diversity (Gay, 2002; Heward & Cavanaugh, 2001). And although this is challenging for the numerous minority groups of students being underserved, this unresponsive climate is especially difficult for those immigrant students who do not speak English or those children/students of immigrants with limited English-speaking ability.

In addition to the educational system not supporting the linguistic needs of English language learners (ELLs), their cultural identities tend to go unacknowledged. This divisive approach usually occurs through programmatic assimilation and alienation. Valenzuela (1999) spoke specifically about this in her research and warned that

marginality evolves when children are socialized away from their communities and families of origin…. While youth indeed enter school with these divisions among them, schooling exacerbates and legitimates these differences through the structure of the academic program. (p. 264)

These objectifications of minority students, and in particular ELLs, create serious academic barriers and obstacles to authentic learning and academic success, thus limiting opportunities. In fact, “The educational needs of our minority students have always required much attention, yet they often receive the least and this is certainly the case when it comes to teaching students whose first language is not English” (Barrera, 2016); yet, the learning needs of this group of students cannot be ignored.

According to current demographic statistics reported by the National Center for Education Statistics, there are an estimated 4.5 million ELLs in the nation’s public school systems (NCES, 2016a). This rapidly growing student group is primarily concentrated in the urban school setting where they represent approximately 14% of the student population found in large to midsize cities (NCES, 2016a). With respect to enrollment among grade levels, ELLs can be found across elementary, middle, and secondary levels, although 67% of the nation’s ELLs are concentrated in the elementary grades (K-5; NCES, 2016b). “As ELLs are the fastest growing student population in the nation, their academic success in both content and language is critical for their participation in college, careers, and citizenship in U.S. society and the global community” (Llosa et al., 2016, p. 420), making their education in general, and science education specifically, a civil right (Tate, 2001). Given this, it is imperative to not only prepare teachers to teach science in rigorous and socially just ways that provide quality opportunities for all students, but to also prepare them to be responsive to cultural and linguistic diversity of ELLs.

When considering science education, it is opportunity to learn that is a civil right, overshadowing the chance to share the same learning spaces with non-marginalized peers as a social justice construct (emphasis added, Tate, 2001, p. 1018). Focused on quality science education for all, opportunity to learn encompasses three related constructs: time on task (i.e., engaged time, time allocated to science instruction), quality of instruction (relative to concepts assessed), and technology (including science equipment). For instance, if we consider elementary science, the level at which a majority of ELLs are concentrated (NCES, 2016b), we see (a) limited time engaged in science, as science instruction is commonly preempted for mathematics and English language arts or test preparation, (b) curricular or ability tracking that limits exposure to quality science instruction, and (c) little opportunity for students to interact with the tools and technologies of science via hands-on investigations and inquiries (Tate, 2001). Taken together, it should be no surprise that the “science achievement gaps between ELLs and non-ELLs have remained largely consistent and wide based on recent NCES statistics (Llosa et al, 2016, p. 396).
Given these challenges, current research is now recommending a stronger partnering of science and language learning that transforms hands-on activities and second language acquisition techniques into engaging opportunities to learn in science (Lee & Buxton, 2013; Lee, Quinn, & Valdés, 2013). This approach not only calls for the integration of best practices from both fields, but also draws upon ELLs’ funds of knowledge (González, Moll, & Amanti, 2005) and culturally-rich linguistic experiences as the catalyst for engagement. Yet lists of current best practices for teaching science effectively to ELLs found in the literature often include “many unexplained and unexplored meanings” for which preservice teachers are under-prepared to unpack so early in their careers (Buck, Mast, Ehlers, & Franklin, 2005, p. 1028). Therefore, simply presenting this information to preservice teachers during their preparation program is insufficient to affect their practice. To this end, although a majority of the nation’s elementary teachers (82%) feel well prepared to teach science (Banilower et al., 2013), relatively few (17%) feel well prepared to teach science to ELLs (Banilower, Trygstad, & Smith, 2015).

We must also consider that preservice elementary teachers may have limited personal knowledge of being language learners themselves or lack personal or professional experience engaging with non-native English speakers and as a result might feel anxious and unprepared to teach science to ELLs. How, then, can we as teacher educators foster in our preservice elementary teachers an understanding of the learning experiences of ELLs—who must learn content and develop English language proficiency concurrently (Lee et al., 2013)—while instructing them on appropriate teaching practices for ELLs in science (Lee & Buxton, 2013)? This guiding question drove the development of a simulated language learner experience and our subsequent research.

The Simulated Language Learner Experience

Angela (first author), a science teacher educator, collaborated with a foreign language educator to develop a simulated language learner experience for preservice elementary teachers enrolled in the science methods course. Borrowed from medical education, simulation is “a technique that enables the learning and training of individuals and teams through the re-creation of some aspect of the real clinical situation” (Bradley, 2006, p. 261). Given this, our simulated language learner experience put preservice elementary teachers in the role of language learners while providing them with a safe learning context; specific experiences, and attainment of particular knowledge and skills through those experiences related to teaching science to ELLs; and opportunities for reflection to encourage application of knowledge and skills for teaching ELLs to their planning and instruction (Bradley, 2006; Hill, Davidson, McAllister, Wright, & Theodoros, 2014).

The two lessons described below comprised the simulated language learner experience. Both taught in French, these lessons were developed in response to preservice elementary teachers’ limited understanding and application of strategies for teaching science to ELLs. Although the preservice elementary teachers could recall and list instruction and assessment strategies for teaching ELLs in science, there was little evidence of these practices in their fieldwork. Through this simulation, we endeavored to not only demonstrate and facilitate discussion of specific supports for language learners in science, but also to foster an understanding and appreciation of the unique learning experiences of ELLs in science. To accomplish this, the preservice teachers were put—unbeknownst to them at the onset—into the role of language learners during two brief, back-to-back science lessons on series and parallel circuits. The foreign language educator with whom we collaborated to develop the lessons served as the teacher during the simulation, and to date over 200 preservice elementary teachers have participated as students.

As mentioned previously, both lessons in the simulation were taught in French. The first lesson lacked supports for language learners while the second lesson incorporated research-based supports for language learners in science (see Lee & Buxton, 2013). In doing this, the simulation demonstrated and connected to the following constructs related to opportunity to learn: quality of instruction and technology (i.e., science materials; Tate, 2001). Figure 1 contrasts these lessons.
Lesson One was designed to mimic a traditional science class. The teacher spoke quickly as if to native speakers, scribbled a few rough pictures and diagrams of series and parallel circuits on the board, quickly checked for understanding from time to time, and then distributed an assessment with high language demands. Before the start of the lesson, the teacher planted two or three “pleasers” in the class. These students were instructed to respond, oui (yes) each time the teacher asked, Vous comprenez, oui? (You understand, yes?). As might be expected, responses of oui (yes) spread among students with each subsequent question during this fast-paced lesson (Webb, 2016; Webb, Barrera, & Calderon, 2014).

The assessment for Lesson One placed high language demands on the students, asking them to write a paragraph describing series and parallel circuits and to draw one of each. To mimic assessment during a traditional science class, students were given only a few minutes to complete the assessment. The time given would have been sufficient for a native French speaker but posed problems and caused anxiety for the students in this simulated lesson (Webb, 2016; Webb et al., 2014).

Lesson Two taught the same content as Lesson One, but was designed to demonstrate the science learning that could take place if/when language learners are provided appropriate supports. This lesson was slower paced and the teacher used realia (i.e., objects from everyday life used as teaching aids), gestures and demonstrations, and an interactive word wall in her instruction. For instance, when introducing the term pile (battery), the teacher showed a picture of a battery from the interactive word wall as well as an actual C-cell battery. Similarly, when introducing the term allumer (to light), the teacher switched the classroom lights on and off while repeating the term. She also used an interactive word wall to review new vocabulary by having students direct her placement of pictures beside the French words for battery, wire, light bulb, danger, and to light. Then using these materials (two bulbs, six wires, and a C-cell battery), students worked in small groups to construct series and parallel circuits.

The assessment for Lesson Two evaluated students’ understanding of the same science concepts as the first assessment but placed lessened language demands on students. This served to scaffold the academic language demands required of students to demonstrate their understanding while still maintaining content-knowledge expectations. For this assessment, students were asked to draw a series...
and parallel circuit. Images of a battery and two light bulbs were provided to scaffold each drawing. Instead of creating the whole drawing themselves, students were asked for only the accurate arrangements of wires (Webb, 2016; Webb et al., 2014).

**Researching the Simulation**

As mentioned previously, over 200 preservice elementary teachers have participated as students in this simulated language learner experience during their science methods course. Prior to the start of Lesson One, they were asked to answer the following questions: (a) What struggles do you think ELLs face during science class? (b) What instructional strategies do you think are effective for ELLs? Following the simulation (after Lesson Two), the preservice elementary teachers considered the following questions: (a) What were your impressions of the first lesson? (b) What were your impressions of the second lesson? (c) What supports provided during the second lesson facilitated your science learning? (d) What did you gain from participating in these lessons with regard to teaching ELLs?

After the first iteration of the simulation, Stan (second author), a teacher educator with expertise in literacy and English as a second language, joined the team to debrief the simulated lessons and students’ engagement during the lessons as well as emergent themes in students’ responses to the pre- and post-experience questions. In both phases of our research on enhancing preservice elementary teachers’ awareness of the science learning experiences of ELLs, we endeavored to characterize the preservice elementary teachers’ perceptions of and reactions to the lessons in the simulated language learner experience. Extending this, the second phase of our research explored the parallels and disconnects between the preservice teachers’ experiences as language learners in the simulation and their expectations for ELLs’ science learning experiences. Following, we highlight findings from the two phases of our research (Webb et al., 2014). Then, we tie our work back to social justice in science education.

**Concrete Experiences Through Simulated Learning**

In the first phase of our research, we investigated the experiences and perceptions of 180 preservice elementary teachers who participated in the simulated language learner experience in their science methods course. The most common reaction to Lesson One, which lacked supports for language learners, was feeling lost and confused. Some students reported feeling frustrated because they “only comprehended a few words” of the lesson. Still others felt intimidated, discouraged, and even dumb, “shutting down as learners during the lesson and assessment.” Such reactions were due to the preservice teachers’ limited understanding of French, use of insufficient or indiscernible visuals during the lesson, and the fast pace of the lesson. Although some preservice teachers checked out or shut down during this part of the simulation, others utilized coping strategies to make it through the unfamiliar and uncomfortable learning situation. That is, they “picked up on familiar words,” “respond[ed] even if [they] did not know the question or answer,” and “copied answers from the board to please the teacher” to counter feelings of confusion and frustration.

Conversely, Lesson Two, which included research-based supports for language learners, was better received. The preservice teachers were more satisfied with the lesson and surprised they actually understood the science concepts that were taught. They attributed this primarily to the lesson being interactive, including “real-life examples” and “actual objects,” and incorporating a hands-on activity to help “show concepts” and “make connections.” The lessened language demands on the assessment for Lesson Two did not go unnoticed, with preservice teachers commenting, “the activity prepared us for the assessment” and “the assessment mirrored what we did.”

These concrete experiences as language learners, albeit brief, afforded the preservice teachers a unique perspective on the science learning experiences of ELLs. Participating in this simulation fostered empathy for ELLs as concurrent science learners and English learners, and encouraged the preservice teachers to make instructional considerations when teaching science to ELLs (Webb et al., 2014).
Real Emotions Through Simulated Learning

We found it noteworthy that preservice teachers’ experiences of the simulation ignited empathy for the unique challenges ELLs face as science learners. This led us to further explore the preservice teachers’ emotional reactions during the simulation. In the second phase of the research, we investigated the emotional reactions of 37 preservice elementary teachers to the simulation.

Prior to the simulation, preservice teachers were asked to anticipate ELLs’ struggles during science class. Unsurprisingly, 32% of the preservice teachers thought ELLs would struggle with science-specific vocabulary, a challenge even for native English-speaking students. Similarly, 46% of preservice teachers expected ELLs to struggle with communication, namely reading, speaking, and listening. Just one preservice teacher (2.7%) anticipated ELLs would have an emotional reaction to learning science, specifically a struggle with “motivation to succeed” (Webb, 2016).

These predictions stood in stark contrast to the preservice teachers’ own reactions to being positioned as language learners during the simulation. Notably, 35% of preservice teachers declared an emotional reaction to Lesson One while 16% mentioned an emotional reaction to Lesson Two, demonstrating that the preservice teachers had less of an emotional response to learning when they received research-based language supports in the simulation. Whereas the preservice teachers’ own brief experiences as language learners during the simulation were laden with emotions, they failed to consider the emotional responses ELLs might have during science class. Although our sample of 37 preservice teachers is small, it seemed evident they were unaware of the emotional aspects of learning, especially for ELLs (see Darling-Hammond, 1997), highlighting one of the ways in which “meeting the needs of ELLs in the mainstream classroom was even more complex than expected” (Buck et al., 2005, p. 1026).

Across these two phases of our research, the simulation was successful in offering a contextualized learning experience through which preservice teachers came to acknowledge the need to provide ELLs equal opportunity to learn science. Not only did preservice teachers experience how to use research-based supports for language learners in their science teaching, the simulation also fostered empathy for the unique positions of ELLs as science and English learners in the science classroom. The simulation prompted them, if only momentarily, to experience emotions and reactions similar to ELLs in science, drawing attention to supports and the quality of instruction necessary to provide ELLs meaningful opportunity to learn science.

Social Justice in Science Education for ELLs

Science education can and should be viewed as a civil right for all students; yet, ensuring this right for non-mainstream students, such as ELLs, takes special care and attention. To afford ELLs meaningful opportunities to learn science they should be provided sufficient time to learn a quality science curriculum that incorporates the tools and technologies of science (Tate, 2001). Preparing teachers to accomplish this starts in their preservice teacher education program.

The simulated language learner experiences discussed here provide a meaningful and authentic, yet safe, context in which preservice elementary teachers can acknowledge and start to act on the important and necessary work of supporting ELLs in their mainstream classrooms. Our research has shown that this simulation is effective in increasing preservice elementary teachers’ empathy to the experiences of ELLs during science class. It is one thing to read about ELLs’ learning experiences and the teaching practices that can support ELLs in the science classroom; it is another thing entirely to experience feelings of frustration or support based on whether teachers incorporate supports for language learning into their science lessons. In considering the quality of instruction they provide ELLs in science, it is imperative for preservice teachers to understand this gatekeeping role of emotions (Krashen, 1982, 2003). That is, the negative emotional responses to science instruction that lacks language supports can block learning; conversely, lowered emotional responses can result in greater investment in learning when supports are present.
Although preservice elementary teachers are not fully prepared for the realities of teaching science to ELLs in the mainstream elementary classroom (Banilower et al., 2013, 2015; Buck et al., 2005), the simulation discussed here provides one tool or stepping stone to enhance preservice teachers’ preparation in this area. This, however, cannot and should not be done in isolation. Our future work in preparing preservice teachers to provide quality instruction, as an opportunity-to-learn construct, focuses on the ways in which preservice teachers teach science to ELLs in their student teaching placement and beyond. That is, how are they structuring learning for ELLs to provide equal opportunity to learn science? More broadly, such a commitment to equality and social justice should become a more integral aspect of the elementary teacher education program in order for our preservice teachers to develop a philosophy and frame of mind around social justice and education, particularly science education, as a civil right (Tate, 2001).

References
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