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Collaborating with K-12 Partners: Improving Preservice Teachers' Self-efficacy in Teaching Rural English Learners Science through a Guided Experiential Learning Opportunity

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The demographics of the United States are rapidly changing, especially in the Southwest (U.S. Department of Education, 2017). In Texas, the need for English as a Second Language-certified teachers is no longer an option; it is a necessity. As a result, educator preparation programs (EPPs) need to emphasize the importance of providing opportunities for preservice teachers to learn and practice ESL strategies and skills in authentic learning environments, such as outdoor learning within the content areas, including science (Coady et al., 2015; Cuevas et al., 2005). To address this, preservice teachers should be knowledgeable in the content areas and have a greater sense of self-efficacy to better provide adequate linguistic support for English learners (ELs) and improve students' communicative competence. This can be done, for example, through Content-Based Instruction (CBI), which focuses on the introduction and frequent use of a small set of academic vocabulary throughout the lesson cycle in addition to the utilization of multiple supports and resources to increase students' language abilities (August et al., 2009; Stoddart et al., 2002). However, current research suggests the application of the content knowledge may be inaccurate or inconsistent due to low self-efficacy in teaching areas such as science (Cervetti et al., 2015; Dorph et al., 2011; Leader-Janssen & Rankin-Erickson, 2013; Zwiep & Straits, 2013).

Research Question

The purpose of this quasi-experimental research design (Campbell & Stanley, 2011) with purposive sampling (Lincoln & Guba, 1985) was to determine if adding a cross-course experiential learning activity to preservice teachers' course of instruction could improve their self-efficacy in teaching science and in teaching non-native speakers of English.

Review of Literature

Self-Efficacy

Bandura (1997) coined the term self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Teachers who have high efficacy in teaching science are more likely to believe in the effectiveness of inquiry-based teaching and utilize this method in their classroom (Johnson, 2006; Marshall et al., 2009; Riggs & Enochs, 1990). Further, studies related to preservice teacher self-efficacy in working with ELs have identified similar results in that preservice teachers often feel unprepared to work with ELs (Durgunoğlu & Hughes, 2010; Gandar et al., 2005).

Science Learning & Teaching

It is imperative, therefore, that preservice teachers acquire the content knowledge essential to teaching science effectively, particularly when working with ELs. For example, many EPPs do not provide preservice teachers with science content or science methods other than the general science courses required for all university students (Tessier, 2010). This creates a gap in their understanding and in the depth of their knowledge since the intent of foundational science courses are to serve as a general knowledge base for non-major undergraduates and are not for use in the professions. Further, the topics covered in these courses do not align directly to concepts necessary for state-specific teacher licensing.

Notwithstanding the best practices of science instruction and strategies for working with ELs, EPPs need to identify or create opportunities often for preservice teachers to take theory into practice with the support of more capable peers, which should include guidance on the incorporation of family involvement in the student's learning. While many professors in EPPs may assert that this generally occurs during a preservice teacher's field placement experiences, it is often not the reality for a number of reasons. For example, if the preservice teacher's placement does not include science instruction (i.e., science is taught on a day the preservice teacher is not in the classroom), the opportunity for guided support during science instruction development and delivery is missing. Alternatively, if science instruction is provided while the preservice teacher is in attendance and the mentor teacher is not confident in his or her own science teaching abilities, neither the students nor the preservice teacher receive the benefit of quality instruction as outlined in the Next Generation Science Standards ([NGSS]; NGSS Lead States, 2013). Specifically, the NGSS require elementary students to examine cross-cutting concepts throughout all fields of science, apply this knowledge to disciplinary core concepts, and use their overall scientific knowledge to practice as scientists in the classroom and in their world (NGSS Lead States, 2013).

To meet these standards, our teachers—including preservice teachers—must be competent and confident in structuring, delivering, and assessing those standards-based lessons that include the three dimensions of cross-cutting concepts, science and engineering practices, and disciplinary core ideas. Compounding this problem is the lack of opportunity to practice teaching science to ELs because there is a limited group of ELs on the campus or in the mentor classroom, or the mentor teacher is not certified to teach ESL. Classroom teachers with a strong science background typically use the 5E lesson plan model during which the teacher acts as a facilitator for inquiry-based learning. This model is similar in content to the Sheltered Instruction Observation Protocol (SIOP) approach (Echevarria et al., 2017) designed specifically to support content area learning by ELs. However, even with the best of intentions, research suggests that family involvement is critical for school success, especially when it comes to understanding and independently applying science skills and knowledge beyond the classroom.

Outdoor Learning Experiences

Outdoor learning experiences have shown to improve outcomes for both students and teachers. Specifically, students demonstrate a greater understanding of scientific concepts and processes when inquiry-based learning is used (Cervetti et al., 2007; Lee et al., 2008; Ovando & Combs, 2012; Rivet & Krajcik, 2008), and more so when an outdoor environment is utilized (Carrier et al., 2014).

Purpose of the Study

The purpose of this research was to determine if adding a cross-course experiential learning activity to preservice teachers' course of instruction could improve their self-efficacy in teaching science and teaching non-native speakers of English. Specifically, the researchers sought to determine whether the incorporation of a highly structured experiential learning activity across three teacher preparation courses could improve preservice teachers' self-efficacy in teaching science and teaching ELs from a rural school district.

Background

To address these gaps, one EPP sought to develop a unit of instruction that transcended three courses during the preservice teachers' final semester before participating in the state required clinical teaching experience. By incorporating a partnership with a local school district to include an outdoor experiential learning opportunity, this EPP provided a unique learning environment for elementary students while providing preservice teachers an opportunity to engage with ELs in a more authentic atmosphere suited for teaching science.

Significance

Quantitative results of this study could have implications for the curriculum and its design in EPPs. The intentional backwards design of the university courses in addition to requiring preservice teachers to adopt the 5E science lesson model that has been adapted for use with ELs may provide insight to improving preservice teachers' self-efficacy in science content and when working with ELs.

Methodology

Participants

Participants in this study included preservice teachers enrolled in a Foundations of Bilingual and English as a Second Language course and Early Childhood Environments course during the spring semester of 2019 (*N*=30). Twenty-seven of these same students were also enrolled in a Curriculum, Assessment, and Instruction course during the same semester.

Data Collection

Preservice teachers were provided a pre-and post-test survey of the Science Teaching Efficacy Belief Instrument- B (Riggs & Enochs, 1990) and a modified version of Tschannen-Moran and Woolfolk Hoy's Teacher Sense of Self-Efficacy Scale (2001) that incorporated questions specifically related to working with ELs. Researchers obtained permission from authors of both surveys to utilize them in this project.

University Instructional Unit Design. Instructors for the university's courses in Foundations of Bilingual and English as a Second Language Education, Early Childhood Environments, and Curriculum, Assessment, and Instruction developed a unit building upon existing individual course assignments to create an additional experiential learning opportunity for preservice teachers seeking initial state licensure with an ESL endorsement. Course assignments were developed using research-based best practices in science and English learner education with a few adjustments from semester to semester. This learning opportunity was in addition to state-mandated field placement hours and sought to expand the preservice teachers' existing knowledge regarding science instruction and best practices for content area instruction when working with ELs and their families.

Collaborators. Other project collaborators included the cooperating school district's Chief Academic Officer, science department coordinators, certified bilingual classroom teachers, elementary students, the university's biology department, and representatives from the university's biological field station and agricultural facility.

Lessons Developed by Preservice Teachers. For semester one, preservice teachers designed and developed their instructional units at a biological field station maintained by the university. The lessons were then delivered to elementary students at the university's agricultural facility. For semester two, the preservice teachers developed their lessons at the agricultural facility but delivered them on the university campus due to weather restrictions.

Science Lesson Design: Required Elements. The initial assignments for semester one included SIOP lesson planning, developing an appropriate and effective 5E science lesson, creating and delivering pre-and post-assessments of elementary students' learning, and using Flipgrid (Microsoft, 2018) to record elementary students' responses for later use and practice in determining each student's oral proficiency level. For semester two, preservice teachers were also required to develop and distribute two lab-in-a-bag activities in addition to the semester one prerequisites. One lab-in-a-bag was provided to the elementary students prior to the experiential learning opportunity, and the second was provided at the conclusion of the activity for the classroom teacher's use to check for understanding. Both lab-in-a-bag activities included specific questions and tasks designed to engage the elementary student's family and community in their learning both prior to and following the experiential learning activity. Further, for semester two, the pre- and post-test assessments were not required due to district time constraints.

Lesson Elements: Science. The first step required the preservice teachers to design a lesson that incorporated the NGSS dimensions for delivery using a centers-based approach for the following topics: water cycle, food chains, plant adaptations, animal adaptations, landforms, inherited traits, and environment. The NGSS crosscutting concepts of patterns, cause and effect, energy and matter, structure and function, systems and system models, and stability and change were apparent throughout the student-created centers. In addition, many of the centers elicited science and engineering practices, specifically defining problems, developing and using models, carrying out investigations, analyzing and interpreting data, constructing explanations, and communicating information.

With the focus on science instruction and ELs, the next step was to prepare a "lab-in-a-bag" to introduce their lessons to the elementary students prior to their participation in the experiential learning activity. The purpose of the lab-in-a-bag was two-fold. Specifically, they were designed to activate prior knowledge and encourage family and parental involvement in learning. Best practice research suggests that ELs receive the most benefit from experiential learning activities if the content is introduced prior to the experience, with the focus specifically on vocabulary (Robertson, n.d.). Based on a plethora of research, the preservice teachers also included step-by-step instructions in both the English and Spanish languages, a list of key vocabulary, and all items and strategies necessary to complete the activity (Baker et al., 2014; Echevarria et al., 2017; Rodriguez et al., 2013; Wright, 2015).

Lesson Element: Intentional Family Engagement. By sending home a single lab-in-a-bag with a purposeful structure for engagement, parents and families can better understand the content provided to their learners while at school and actively participate in their learning at home. This school-to-home connection with families is a best practice for working with ELs, especially when teachers consider the factors that influence parent participation with school-related activities, such as educational background, socioeconomic status, English proficiency, stereotypes, and ultimately, cultural bias (Lee & Bowen, 2006; Rodriguez et al., 2013). Additionally, when the “lab-in-a-bag” is designed by the teacher to incorporate activities that emphasize the authentic and real-world benefits of science knowledge in their own life and culture, parental involvement increases and student outcomes improve (Yilmaz et al., 2018). Ultimately, the completed “lab-in-a-bag” also provides the classroom teacher with an informal assessment of the students’ prior knowledge as related to the NGSS topics that would be addressed in the upcoming experiential learning activity.

Lesson Element: Intentional Opportunity for ELs to Write & Speak using FlipGrid. The initial “lab-in-a-bag” included a sentence frame for the student to use to practice their written responses. Using the sentence frame, the student then had the opportunity to share their understanding of the introductory activity by recording a Flipgrid video, which was accessible by the university instructor and the classroom teacher. Importantly, if ELs have the opportunity to prepare a written response before speaking, as done with the Flipgrid video activity, they are more confident in their English language abilities, particularly in the content areas (Echevarría & Graves, 2014; Lee & Bowen, 2006).

Experiential Learning Opportunity for Preservice Teachers & ELs. In the next step of the learning cycle, ELs from the participating elementary schools traveled to the university’s agricultural facility to experience outdoor learning in a rural, outdoor environment. By design, the students completed four out of eight rotations through science centers designed and delivered by the preservice teachers using a modified 5E/SIOP lesson plan template to ensure best practices were provided for ELs throughout this abbreviated lesson plan cycle. The centers were placed throughout this authentic outdoor learning environment that included streams, natural habitats, and wildlife.

The preservice teachers began each rotation with a written pre-test on the topic addressed in each center. Lessons were delivered using a variety of strategies that extended beyond traditional classroom approaches and included content-based instructional strategies, the use of Total Physical Response (TPR), realia (including artifacts provided by the biology department, such as animal bones), and other Specially Designed Academic Instruction in English (SDAIE) strategies selected by the preservice teachers (see Vogt et al., 2015; Wright, 2015). New topics for the lessons were purposely selected based on the scope and sequence of the school district. For instance, the preservice teachers that selected the water cycle had students create their own water cycle using cotton balls and the on-site pond. Each rotation was scheduled in 30-minute increments to allow for a tour through the agricultural facility that included learning about livestock and milking cows and a lunch break. At the conclusion of each lesson, the ELs were provided a post-test that included a sentence frame, and one student was selected by the preservice teachers to respond to the same prompt using Flipgrid. The elementary student responses were shared with their district and later used to evaluate and estimate the speaker's level of English language proficiency.

As a final extension of the experiential learning and to further engage the ELs' family in their learning, a second lab-in-a-bag was provided to the students following the experiential learning activity. This second lab-in-a-bag provided students an opportunity to build upon the initial experiential learning activity by again engaging their families in their learning. Specifically, the elementary students were asked to record themselves describing the experiential learning experience to their family members while highlighting at least one particular center, and explaining how that content or topic impacted their family at home and in the community.

Results

Data analysis revealed significant gains in preservice teachers' self-efficacy in teaching ELs (n=30); however, no significant difference occurred in their self-efficacy in teaching science (n= 27). The difference in number of students occurred due to degree plan scheduling with three additional students enrolled in the ESL class during the semester of the study.

Data Analysis

Descriptive statistics and paired t-tests were used to show differences in the data before and after the experiential learning experience. As shown in Tables 1 and 2, participants' self-efficacy in teaching ELs significantly increased after the experience (p<0.0001, t= 4.8531). The mean score of the survey increased 24.067 points.

Table 1

Descriptive Statistics of the Results from the Teacher Sense of Self- Efficacy Scale (Modified for EL Instruction)

Survey Phase	*N*	*M*	*SD*	Minimum	Maximum
Pre-	30	155.4	27.07	118	235
Post-	30	179.467	24.36	142	234

Table 2

Paired t*-tests Results from the Teacher Sense of Self- Efficacy Scale (Modified for EL Instruction)*

	Diff *M*	Diff *SD*	*t*	*df*	*p*-value
Pre– Post	24.067	2.71	4.8531	29	0.0001

As displayed in Tables 3 and 4, the results of the Science Teaching Efficacy Belief Instrument- B surveys did not show a significant difference (p= 0.2284, t= 1.2337). The mean score of the survey increased 1.33 points.

Table 3

Descriptive Statistics of the Results from the Science Teaching Efficacy Belief Instrument- B

Survey Phase	*N*	*M*	*SD*	Minimum	Maximum
Pre-	27	74.63	5.74	60	88
Post-	27	75.96	6.22	66	87

Table 4

Paired t-tests Results from the Science Teaching Efficacy Belief Instrument- B

	Diff *M*	Diff *SD*	*t*	*df*	*p*-value
Pre– Post	1.33	0.48	1.2337	26	0.2284

Discussion

During the first semester of this project, the cooperating district participants were 65 students in the fifth grade, all of whom were ELs. Approximately half had participated in the district's traditional bilingual program while the other half used the support of the district's ESL program. While many preservice teachers did not recognize a difference in student participation or work product, one student did recognize and discuss a disparity in work performance of a learner when compared with the others in the group. Specifically, the elementary student demonstrated a strong oral use of the English language, but when it came to writing, demonstrated significant difficulties in constructing sentences using appropriate content and academic language. The benefit of this partnership with a local district with the on-site support of teachers and district administrators, allowed for a Socratic form of learning, often missing from educator preparation methods courses. District administrators were able to discuss, in general terms, traits and abilities that may be more apparent in students who had progressed through a traditional bilingual program compared with students who had used only ESL support services. This type of experiential learning is simply not possible within the confines of a traditional educator preparation classroom.

Following this experience, preservice teachers expressed a greater empathy and awareness for the diverse needs of ELs in the elementary classroom. For example, when responding to the prompt of how their perceptions of working with ELs may have changed following this experience, one student wrote, "At first I was nervous about how effective I would be…I was surprised how well it went. The students just need different ways and strategies to show their knowledge." Another student echoed this sentiment, stating, "I used to think that it would be a great challenge on me, as well as my students, but it was just the same as other students with a little more explaining and visuals." Specifically, one student wrote, "It opened my eyes more to what they need and what they know. It shows me what I can do as a teacher to provide information to them."

With regard to teaching science to ELs during the experiential learning opportunity, the preservice teachers' responses were positive. For example, one student wrote, "It can be more fun and actually apply to ELLs if done correctly." Another student who was already passionate about teaching science expressed the use of the experiential learning approach, stating, "I knew [sic] hands-on approach was the way to go, especially with ELLs. It showed me science isn't always lab experiments." Similarly, another student highlighted the importance of instructional decision-making in the classroom, which highlighted the notion that there are "so many different ways to teach one lesson and so many variations that you have to choose from and make appropriate for the audience."

Although the changes from the STEBI-B pre- and post- surveys did not yield a significant result, this experience demonstrated the need for additional, intentionally targeted science instruction in the form of a science methods course. In addition, one possible reason that the preservice teachers' self-efficacy in teaching science did not change significantly could be the self-realization of lack of science content knowledge. This need for additional science instruction within the EPP coursework was recognized by the preservice teachers and by collaborators from the biology department, professors, and district administrators. Another important reason was the lack of familiarity with the 5E lesson plan and expectations. Until this experience, the preservice teachers only had knowledge of the EPP's approved lesson plan, which was similar to the Hunter Instructional Model (Hunter, 1971). The transferability from the Hunter style was very difficult for the preservice teachers and served as further evidence for the need to provide preservice teachers with a variety of lesson plan formats including the 5E model and SIOP.

Feedback from the cooperating district was equally positive. For example, the district had received several communications from families asking why their child was selected to participate in this event. Typically, the EL is not able to attend off-campus events such as this since he or she needs to remain on campus to receive language support. The administrator further suggested that parents were appreciative for the opportunity provided to their students to receive this instruction and to participate in an event that was designed to improve the quality of instruction they could receive from future teachers participating in this program. One administrator suggested that this approach, which targeted the development of preservice teachers' skills in teaching science to ELs, also benefitted community relationships in that it demonstrated equity toward the EL student and their families. That alone cannot be taught during a traditional EPPs as it is an element of experiential learning.

Flipgrid was incorporated during instruction in both the fall and spring semesters. It is an important tool for accountability purposes and serves as a way for preservice teachers to check for understanding as each group progressed through their lesson. It was also beneficial in allowing the preservice teachers an opportunity to view all of the elementary participants' responses and as a class, identify the learners' oral language proficiency levels using the Texas English Language Proficiency Assessment System, or TELPAS, guidelines (TEA, 2019). This activity also provided an opportunity for preservice teachers to identify instructional approaches that may have led to the learners' responses. This reflection piece gave preservice teachers a chance to calibrate their TELPAS ratings with each other using the Flipgrid recording. This is a much-needed skill for any teacher who holds an ESL endorsement who may later be called to evaluate a student's proficiency level on their assigned campus.

An area for improvement would be to provide additional supports to preservice teachers in identifying specific approaches their elementary students could use to further incorporate family participation into their video-responses, which aligns with the National Science Teachers

Association's position statement on parental involvement in science learning as these students have "greater success" as learners regardless of their background (NSTA, 2009). Further, Teachers of English to Speakers of Other Languages (TESOL) standards for educator preparation stress that teachers need to demonstrate an understanding about how to "collaborate with other educators, school personnel, and families," to support an EL's content area learning (TESOL, 2019, p. 9).

Another area of improvement is preservice teacher science content knowledge. This need was apparent to the professors, biology students, district coordinators, and the preservice teachers themselves. As much as this project encouraged a deeper understanding of science content in the EC-6 classroom, the district's coordinators found several content and instructional errors in lab-in-a-bag activities. This will require a greater review of the content sent home prior to distribution.

The use of Flipgrid as part of the lab-in-a-bag activities also needs to be revisited. Only two elementary students responded. This could be explained by the late delivery of the bags to the district and scheduling conflicts in that the district utilized two of its bad weather days just prior to the experiential activity, and the fact that the coordinator needed to revise some of the bags prior to distribution to the teachers and students. With earlier delivery to the district, classroom teachers will be better positioned to send the bags home and address misconceptions before and after the experiential learning activity.

Conclusion

This experiential learning activity was the result of an EPP identifying a need to consider the rural science classroom and ELs into the development of university coursework. When faculty intentionally seek and incorporate input from current schoolteachers and administrators to develop assignments for preservice teachers, every stakeholder stands the chance of learning. The preservice teacher is provided an opportunity to work independently in a controlled environment that is not a mentor teacher's classroom. The rules and procedures established by the mentor teacher do not apply in the outdoor or experiential learning environment, and the preservice teacher must quickly establish classroom management in a non-traditional environment with students whom they have had no previous interaction. This experience alone is transferable and relatable to any classroom or instructional setting. The preservice teacher also had to be prepared to teach and adjust plans in an unfamiliar environment. Further, the outdoor experiential learning activity could not incorporate technology due to the remote location of the site. Therefore, the preservice teachers had to develop and deliver engaging, hands-on lessons without the use of technology. This organic learning experience lessened their reliance on technology and required them to act and improvise on the spot when changes were necessary.

The elementary ELs were provided an opportunity to engage with science content in an authentic environment during the first semester. For semester two, the weather kept the students in or near the college, but their lessons were provided in a non-traditional setting. Being on a college campus allowed the idea of attending a university to become a possible reality for the ELs, many of whom had never seen a college campus. In addition, the uniqueness of this opportunity provided engagement not always observed in the elementary classroom on science days. The EL elementary students also provided a much-needed authentic resource for preservice teachers seeking initial EC-6 with ESL certification. Much like learning to drive a car, you cannot improve your skills without the opportunity to practice. The cooperating learners provided this opportunity for the preservice teachers who clearly benefitted from such an experience.

This mutually beneficial opportunity met the needs of both the ELs and preservice teachers to enhance their overall knowledge of science content. For the ELs, college became a reality, and they learned new science content through non-traditional means. The preservice teachers learned about flexibility in teaching, enhanced their science content knowledge, and were able to practice ESL instructional strategies they learned throughout the semester with actual students. This partnership will continue to evolve and improve because both partners realize this opportunity is what is best for students at all levels of education.

Future Research

Due to the global health crisis, future research should include an online opportunity to engage preservice teachers with ELs using other methods of instruction, such as digital field trips. Collaboration could be in the synchronous and asynchronous environments as long as support for the continued use of the blended 5E/SIOP lesson plans were emphasized. Future research should compare results from this localized study to include online teaching approaches and hybrid approaches.

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