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Maximizing Student Engagement in an Online Setting

Sean Preston, Purdue Global University

Abstract

Maximizing online student engagement is an aspect of learning that is esoteric to virtual learning platforms. The article will attempt to illustrate the benefits of student engagement in a virtual setting. Instructors must replicate in-person engagement among students who live in separate geographic regions. Without proper engagement strategies, virtual learning can become nothing more than an independent study course as students work in silos and fail to connect with one another. Furthermore, learner to learner engagement is a highly valued component of virtual learning that is sometimes not achieved.

Key Words: online, student engagement, virtual learning

Introduction

Student engagement is often an elusive specter. Teachers continually hone their classroom management and lesson planning approaches to effectively engage their students in an academic setting. Student engagement is certainly a contributing factor to student success. Student engagement assumes many forms depending on the grade level, school setting, and subject matter. Teachers are quantitatively and qualitatively evaluated based on student engagement as a measure of classroom management and academic success (Kimball, 2009).

Dixson (2015) suggests an operational definition of student engagement as "the time and energy students devote to educationally sound activities". Buck (2016) goes on to state that the components of engagement are: skills, performance, participation, and emotional connection. Using Buck's research, these four components should be present for a student to feel engaged with a classroom lesson or activity. Students should be taught necessary skills such as active listening, note taking, and summarizing. Performance is often measured when the student completes an assessment demonstrating skills or content mastery. Student participation is evident when a student answers questions during a teacher-directed lesson, makes a presentation to the class, or is actively reading or taking notes. The emotional connection is often the more challenging of the four components to achieve as students possess a wide array of interests and finding a common theme for the entire class is difficult.

With the rise of online education, student engagement has taken on a new definition and is often measured differently. Students do not have the benefit of face-to-face or in-person education where the energy and enthusiasm for the subject may be contagious among students. Students are often left to plan their own approach to lesson completion and the prioritization of activities (Hu & Li, 2017). Online student engagement may be measured using the following anecdotal metrics: (1) the frequency a student responds to the required discussion activity; (2) the substantive nature of their discussion responses; (3) student acknowledgement of instructor posted messages and announcements; (4) student participation in seminars; and (5) student response to grading feedback.

The Early Days

The distance learning model was first used by the U.S. military to provide an education to those soldiers serving overseas or in areas devoid of a college or university campus. Distance

learning, also referred to as correspondence courses, gained popularity during the Vietnam Conflict. This was largely due to the emergence of a college education as a vehicle for a more enriching and prosperous life. The momentum was also enhanced with the conscription age 18-20 for most soldiers and the U.S. government did not want to forestall the educational arc of these college-age men.

In these early days, before the use of computers, students would complete assignments absent interaction with other students. The lessons were self-contained and the typical humanities assignment included a reading, a list of questions to answer, or an essay prompt. The completed assignment was mailed to the institution for grading and feedback was mailed back to the student. This practice created a silo of learning, where the student, for all intents and purposes, existed in the class alone with their instructor as the only source of interaction (Singh & Thurmond, 2019).

In the 1980's, the University of Phoenix pioneered the concept of distance learning via the computer. The University created a bulletin board type approach to what we consider learning platforms today. The instructor would post messages and information about the readings and assignments. Then the students would complete the assignments, much like the correspondence courses of the Vietnam Era. However, instead of using the mail system, the students would email the completed assignments to the instructor for grading. It is important to note that the discussion forum/board we see in modern online courses was still not utilized in the early days of distance education.

Current Approaches to Online Engagement

Since the early pioneer days by the University of Phoenix, many institutions of higher learning have created online and virtual programs and, in some cases, like Purdue University, they have created a separate institution such as Purdue Global. Traditional colleges and universities understand that working professionals want to pursue a degree without leaving full-time employment (Kahu, 2018). As a result, these institutions have developed or adopted various learning platforms such as Blackboard, Canvas, and Brightspace. And each of these platforms maintain commonalities such as discussion forums, an announcement thread, virtual office hours with the instructor, the ability to submit assignments electronically, and 24/7 access to the gradebook.

Programs differ in their position on synchronous versus asynchronous learning. Asynchronous learning are activities that students complete in their own time, such as responding to discussion questions or submitting assignments. Synchronous learning is designed for students to participate in an instructor-led seminar or a group activity at a preselected day and time. These are often conducted using a video-conferencing service such as Zoom or Microsoft Teams and can be referred to as face-to-face sessions.

The most popular form of online education is the use of the interactive discussion forum (Hoi, 2021). Typically, the instructor posts a question on a specific topic and requires students to respond to the discussion prompt and, additionally, to their classmates. Some universities maintain discussion requirements not only in frequency, but in response length and the substantive nature of the post. Posts such as "I agree" are typically not appropriate and would not count towards this requirement. Many institutions hold students accountable with professional code of conduct and suggestions for online etiquette and decorum.

Instructors, sometimes referred to as facilitators, interact with their students in a variety of ways. As with the students, it is most typical for instructors to enter dialogue with their

students via the discussion forum. Questions are posted weekly or in alignment with the units of study. This allows the instructor to maintain "regular" communication with their students by both responding to their posts and asking probing questions, often emulating the Socratic Method of learning. Instructors will hold virtual office hours where students can expect the professor to be available via email, a separate discussion thread labeled "virtual office," or using a variety of direct messaging options.

One of the final methods of online student engagement is the use of virtual team activities or assignments. However, it is important to note that most online students do not like this approach due to the asynchronous setting of most online programs, which does not foster the idea of students scheduling time to work together. Nonetheless, when used properly, this is an effective tool to encourage online engagement. Facilitators will divide the class into groups of three or four and often create a separate discussion thread for them to communicate outside of the weekly or unit discussion threads. The students will be asked to complete a reading or conduct light research and share a critique of the material. Once the critiques are posted for the team to review, the team members will hold a discussion about the results throughout the week. Then, the student will individually write a paper or craft a visual presentation based on the material the team used in their discussion.

New Approaches to Online Engagement

Over the past decade, online education has improved, making it more user-friendly, technologically-engaging, and supportive of differentiated learners (Farrell & Brunton, 2020). As the arc of online education continues to move forward, instructors are continually looking for ways to engage their students more deeply. The discussion forum continues to be the mainstay of online student engagement as it replicates in-person classroom discussion in a traditional setting. Also, completing assignments asynchronously using an online submission of "digital drop box" of sorts is a common practice with most online programs. However, there are three online engagement innovations on the horizon that will likely increase student connectivity and a sense of belonging with the instructor, classmates, and course material.

Instructors may consider adding a robust seminar or other face-to-face component, such as a synchronous class session. This will reduce the feeling of isolation and increase the sense of collaboration and connectivity. Online seminars are not necessarily new to virtual programs, but there is certainly latitude to formalize the activity and create a more meaningful reason to attend the seminar. As mentioned previously, students generally relish the asynchronous setting of most online programs. They value being free to complete the discussion and other assignments at a time that works for their schedule. Nonetheless, seminars bring an element of traditional education to an otherwise digital existence. Instructors may consider sharing the seminar agenda in advance, which will set the expectations for the students. While seminars are instructor-led, the activity should allow for student interaction. And lastly, students are likely to value the seminar if it has a direct connection to the course material or an upcoming assignment. In other words, those who attend will have some bit of "insider knowledge" about how to approach a difficult assignment.

Recently, online programs have shifted their marketing efforts to working professionals who have a desire to increase their current skill set and set their sights on upward mobility. These schools value the industry knowledge these students bring to their degree pursuit and consider awarding credits based on their work experiences. In support of this, online instructors often create assignments that require students to interact in the outside world. Most commonly,

students will interview professionals, using the information gathered to complete a project or prepare for a presentation. This assignment often reaches the top of Bloom's Taxonomy and demands a high level of engagement.

Doris (2018) shares the notion that stand-alone units of study are now being converted to modular design. The researcher believes this will allow the student to connect more deeply with the subject matter and foster small group interaction. Modules are a collection of 2-3 units of study that are grouped together to allow for skills and content mastery. Within the module, students are often asked to complete 2-3 discussion questions, a quiz, a learning activity, and a major assignment. The learning activity is an ideal place to insert a small group activity that does not carry a large grading value, saving that for the major assignment. In turn, this creates a safe place for students to interact within small, collaborative learning groups.

Conclusion

Student engagement is often one of the major goals for online instructors who look to continually improve their approach to establishing and maintaining a high-level student participation. As we look through the early days of online education, we see that student engagement was largely based on the intrinsic motivation of the student to complete their assignments in route to earning a degree. Now, student engagement takes many forms, including opportunities for students to interact via seminars, small group learning, or venturing outside of the virtual classroom and connecting with other professionals in the field. AI may have the ability to enhance online engagement as we enter the dawn of the next era of online education.

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Preservice Teacher and Action Research with Virtual Reality

Heather Stefanski, Arkansas Tech University

Abstract

Through engaging in the process of action research, Arkansas Tech University's middle-level pre-service teachers (PSTs) studied an authentic problem of practice within their field placements, reviewed literature to seek solutions, and utilized technology in a way that supports educational outcomes. They also honed their understanding of technological pedagogical content knowledge (TPACK) with the use of virtual reality sets while also building the capacity to evaluate the practicality and merit of any current and future technology in the classroom.

Keywords: Action Research, virtual reality, pre-service teachers

Introduction

With ever-changing mandates and laws, education becomes a scapegoat for what ails the country. Nationwide, scripted curricula has become pervasive with the onslaught of legislation such as Race to the Top (2009) and Every Student Succeeds Act (2015) as schools are challenged with the pressure of equalizing the academic disparity between students (Hagevik, Aydeniz, & Rowell, 2012; Vaugh, Parsons, & Gallagher, 2021). Unfortunately, one-size-fits-all scripted curriculum creates further inequity because teachers can not adapt to their students' needs and respond to problems of practice in meaningful ways. Teachers do not have the leeway to truly help those who fall behind the pacing guide. Thus, the picture of education that current pre-service educators have is one of textbooks, worksheets, and coverage of topics. When asked to create a robust lesson plan with interesting resources, challenging assignments, and deeper connections, pre-service teachers flail about, requesting teacher editions of textbooks and premade guides. They want to know what to say and how to say it during instruction. They make copious copies of worksheets and fill-in-the-blank slideshows. Technology is used to display the information they want students to regurgitate and higher-order thinking is nowhere in sight.

Pre-service teachers need to learn how to reflect, inquire, investigate, and adapt. They need to prepare themselves and their students for future technological advancements and to become innovators. Therefore, in my undergraduate research class with middle-level pre-service teachers, I created a semester-long endeavor where my students would learn about and use action research in the field with middle school students. My pre-service teachers were tasked with using technology, specifically virtual reality, to solve a real problem of practice in their context. The goals of the course were to bridge research and practice with the use of action research, build pre-service teachers' capacity for real-life problem solving with resources beyond a scripted text, and to encourage the use of technology in a pedagogically sound way (building Technological Pedagogical Content Knowledge).

Review of the Literature

What is TPACK and why does it matter?

Technological Pedagogical Content Knowledge (TPACK) is when the primary forms of knowledge (content, pedagogy, and technology) combine so that the knowledge of how to use technology merges with sound pedagogical and content underpinnings (Redmond & Lock, 2019). TPACK is important because simply granting access to current, ever-changing technology is not enough to ensure students are benefitting. "TPACK emphasizes the importance of preparing pre-service teachers to make sensible choices in their uses of technology when teaching particular content to a specific target group" (Tondeur et al., 2017, p. 46).

Teachers must evaluate, justify the value of, and adapt to emerging technology in the learning process. Yet, pre-service teachers have difficulty blending technology with sound pedagogy and content instruction (TPACK), often using technology to create activity-driven lessons rather than standards-based lessons (Wang, Schmidt-Crawford, & Jin, 2018). While research indicates that pre-service teachers have a positive attitude toward technology, they have a very narrow idea of what actually constitutes appropriate use of technology in the classroom (Redmond & Lock, 2019). Understanding the appropriate use of technology to support content impacts the success of their teaching. It is critical that future educators develop confidence in evaluating and leveraging emerging technology to support content instruction. This call to action is aligned with the National Educational Technology Plan which stresses teacher exploration of emergent technologies to increase student motivation and promote access and equity (King & South, 2017).

These future teachers must be able to evaluate the educational merit of not only what is currently available to classroom teachers, but also what could be possible in the near future. In the book, *Where Good Ideas Come From,* Steven Johnson presents the future in what he calls the ***"adjacent possible"*** – things that we are just about to be able to do. The fundamental idea of the ***adjacent possible*** is that prior learning and innovation create the opportunity for new ideas and further innovation. One particular avenue for considering the adjacent possible is through virtual reality technology.

Because pre-service teachers (PSTs) have a limited vision of what educational technology is, capitalizing on emerging tools can help broaden their perspectives. The novelty of virtual reality (VR) in education creates inherent engagement, making it an optimal platform for PST exploration. The use of VR technology creates a motivational foundation and immersive environment for learning. In particular, the use of VR allows K-12 students access to experiences they normally could not have and gives them unique perspectives, for example: inside the vascular system of the human body (Lege & Bonner, 2020). VR applications can help students improve conceptualization of abstract concepts, heighten spatial awareness, and experience highly visual tasks (Pellas, Mystakidis, & Christopoulos, 2021). Also, as believed by constructivists such as Piaget, "learners actively build their own knowledge by extracting

meaning from the sensorial experiences they have in the world and, therefore, they are not just passive receivers" (Di Natale, et al, 2020, p.2006).

Why Action Research?

Like all things in life, the field of education is constantly changing because children, society, technology, careers, and politics are not stagnant. Therefore, teachers must become lifelong learners; a degree is not the end of scholarship (Cochran-Smith & Lytle, 1999). Action research is a mechanism in which teachers can improve upon their own work while also sharing their knowledge with others in the field, disseminating rich, practical knowledge that is personally constructed (Smith & Sela, 2005). The process of action research begins with identifying a problem of practice. Next practitioners research possible solutions and create a plan. Finally, the plan is implemented and the results are evaluated for the effectiveness of the solution (Dana & Yendol-Hoppey, 2014).

Pre-service teachers have negative attitudes towards research, citing it as a waste of time, a burden on their already overwhelmed mental and emotional states, and too tied to assessment which is stressed enough (Van Katwijk, Jansen, & Van Veen, 2021). To combat the negative perception of research, teacher educators should emphasize its benefits and teach PSTs how to implement action research in a way that does not add to the never-ending duties of an educator. The benefits of action research are that it bridges the gap between theory and practice, empowers teachers to make their own informed decisions, promotes reflective thinking, expands pedagogical repertoires, fosters an openness to new ideas, provides opportunities for professional growth and development, and gives novice teachers a voice (Hine, 2013; Hine & Lavery, 2014). Crawford-Garrett, Anderson, Grayson, and Suter (2015) suggest that PSTs, particularly when in the field, should be taught how to perform action research and that there may be a need to reconceptualize student-teaching so that research is not such an insurmountable task, but one that is ingrained. Also, by arming novice teachers with an systematic way to problem solve real-life classroom issues, they feel more prepared for and aware of the potential pitfalls that educators face, they feel more able to effect change, and often stay in their chosen career for the long haul (Miskovic, Efron, & Ravid, 2012).

Methods, Purpose, and Research Questions

The participants in this study were twelve pre-service middle level teachers in a university undergraduate program. All participants were in a Foundations of Research class for one semester during the spring of their junior year.

During the class, the PSTs were introduced to action research, designed and implemented their own projects utilizing action research, and presented their findings at the university level. The goals of the project were for the PSTs to connect evidence-based practices in their content areas with technology, namely virtual reality sets, and to solve field-based problems of practice. The objectives of the class include applying the methods and processes of inquiry, locating and interpreting literature relevant to a research project, evaluating and interpreting multiple

perspectives, and reporting research findings. As future educators, they must be able to identify problems of practice, investigate possible solutions, implement a plan, and reflect on the outcomes to improve instruction and maximize learning.

Through this project, the hope was that the PSTs would gain a better understanding of using technology to focus instruction on content, highlighting standards, instead of creating lessons that use technology as an add-on just for the sake of using technology.

This research article centers around two distinct research questions:

1. Through participating in action research in an undergraduate class, would pre-service teachers be more open to using action research in their future careers?
2. Would the use of virtual reality technology in their action research projects enhance their technological pedagogical content knowledge?

Research Process

To gauge the PSTs' initial understanding of TPACK, they answered the TPACK.xs questionnaire (28 items) created by Schmid, Brianza, and Petko (2020), which has been tested for validity and reliability for pre-service and in-service teachers who teach in only one subject concentration. The TPACK survey is a self-assessment of the various combinations of TPACK (PK, CK, TK, PCK, TCK. TPK, TPACK).

Due to restrictions outside the course instructor's sphere of influence, the PSTs were not in classroom settings. As such, the participants pivoted to using a local Boys and Girls Club as the venue for their research. The Boys and Girls club offers an after school program from 3:00-6:00 PM Monday-Friday for school-age children in our area. The directors of the Boys and Girls club spoke to the participants about their environment and typical middle school students who participate after school. Once they met with the PSTs, the directors had the middle school students voluntarily sign up to participate and parent permission slips were sent home. The Boys and Girls club middle school students reflected on their own areas of weakness as a means to determine problems of practice.

The PSTs were assigned to two middle school students based on those self-assessed areas of weakness and the pre-service teachers' content area focus in our program (Math, English Language Arts, History, or Science).

Before meeting with students, the PSTs trained on the VR devices in class, using the *First Steps* app. They explored possible apps and interactive YouTube videos that could help them address problems of practice. They also discussed how technology should support content and when technology is pedagogically appropriate in a lesson.

Once the PSTs felt comfortable on the VR devices and they met with their assigned students, they determined a more specific problem of practice by interviewing the students, looking at work samples, or giving a pre-assessment. The PSTs worked to find relevant literature on best practices for the content area and for using virtual reality. After they reviewed the literature, the PSTs created a lesson plan that incorporated the virtual reality devices and applications they chose.

The funding for the technology came from a grant. Due to the nature of the grant, there was difficulty accessing funds for applications, therefore, the PSTs were asked to find free applications if possible.

Before implementing their lesson, the pre-service teachers participated in two peer reviews of their plans and a conference with the course instructor using a rubric (see Appendix A) to help them evaluate their instructional choices.The rubric measured adherence to state standards, selection of VR materials, validity of assessment instruments created to middle-level student growth, adequacy of VR use (best practices and teaching strategies), the relationship to the problem of practice, and justification of choices. Throughout the semester the PSTs met in professional learning communities (PLCs) to discuss the literature, application selection, data collection and results, making adjustments where needed. The PLCs were formed based on content area. The PLC structure was used in this course because studies have found that when teachers participate in a PLC, their teaching practices improve due to collaboration, exploration, discussion, and content focus (Vescio, Ross, & Adams, 2008).

After finalizing their plans, the PSTs implemented their lesson and administered a post assessment with their two assigned students. They collected and analyzed data, drew conclusions, wrote a paper on their action research, and completed a reflection activity.

Once the PSTs' research concluded, they answered the TPACK.xs questionnaire again as a post-test. The PSTs also answered an open response questionnaire about the process of action research (Appendix B).

Results

The data from the TPACK pre and post surveys were compared and disaggregated via subject area to see if the subject impacted the pre-service teachers' self-reporting after the implementation of the action research project.

When comparing the pre and post TPACK surveys particular attention was paid to those combinations that included technology. Technological Knowledge (TK) seemed to improve in the areas of keeping up with new technologies and self-efficacy in their technical skills. Technological Pedagogical Knowledge (TPK) increased in all areas as did Technological Content Knowledge (TCK) and Technological Pedagogical Content Knowledge (TPCK) (Tables 1-4 below).

Table 1
Technological Knowledge

Statement Number	Description	Pre	Post
Statement 1 I keep up with important new technologies.	Strongly Agree	1	0
	Agree	3	4
	Neutral	4	5
	Disagree	2	3
	Strongly Disagree	0	0
Statement 2 I frequently play around with technology.	Strongly Agree	0	2
	Agree	5	1
	Neutral	2	8
	Disagree	2	1
	Strongly Disagree	1	0
Statement 3 I know about a lot of different technologies.	Strongly Agree	1	2
	Agree	6	1
	Neutral	2	6
	Disagree	1	3
	Strongly Disagree	0	0
Statement 4 I have the technical skills I need to use technology.	Strongly Agree	0	3
	Agree	6	7
	Neutral	2	2
	Disagree	1	0
	Strongly Disagree	0	0

Table 2
Technological Pedagogical Knowledge

Statement Number	Description	Pre	Post
Statement 1 I can choose technologies that enhance the teaching approaches for a lesson.	Strongly Agree	1	2
	Agree	5	7
	Neutral	4	2
	Disagree	0	1
	Strongly Disagree	0	0
Statement 2 I can choose technologies that enhance students' learning for a lesson.	Strongly Agree	2	2
	Agree	3	7
	Neutral	5	2
	Disagree	0	1
	Strongly Disagree	0	0
Statement 3 I can adapt the use of the technologies that I am learning about to different teaching activities.	Strongly Agree	0	3
	Agree	6	8
	Neutral	4	1
	Disagree	0	0
	Strongly Disagree	0	0
Statement 4 I am thinking critically about how to use technology in my classroom.	Strongly Agree	2	4
	Agree	7	6
	Neutral	1	2
	Disagree	0	0
	Strongly Disagree	0	0

Table 3
Technological Content Knowledge

Statement Number	Description	Pre	Post
Statement 1	Strongly Agree	0	1
I know how technological developments have changed the field of my subject.	Agree	2	9
	Neutral	5	0
	Disagree	2	2
	Strongly Disagree	0	0
Statement 2	Strongly Agree	0	0
I can explain which technologies have been used in research in my field.	Agree	1	4
	Neutral	3	5
	Disagree	5	3
	Strongly Disagree	1	0
Statement 3	Strongly Agree	0	0
I know which new technologies are currently being developed in the field of my subject.	Agree	0	4
	Neutral	2	3
	Disagree	6	5
	Strongly Disagree	2	0
Statement 4	Strongly Agree	0	3
	Agree	0	3

I know how to use technologies to participate in scientific discourse in my field.	Neutral	4	4
	Disagree	5	2
	Strongly Disagree	1	0

Table 4

Technological Pedagogical Content Knowledge

Statement Number	Description	Pre	Post
Statement 1	Strongly Agree	0	4
I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom.	Agree	8	6
	Neutral	1	2
	Disagree	1	0
	Strongly Disagree	0	0
Statement 2	Strongly Agree	1	4
I can choose technologies that enhance the content for a lesson.	Agree	5	7
	Neutral	4	1
	Disagree	0	0
	Strongly Disagree	0	0
Statement 3	Strongly Agree	0	3
	Agree	4	6

I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.	Neutral	6	3
	Disagree	0	0
	Strongly Disagree	0	0
Statement 4 I can teach lessons that appropriately combine my teaching subject, technologies, and teaching approaches.	Strongly Agree	1	2
	Agree	3	6
	Neutral	6	4
	Disagree	0	0
	Strongly Disagree	0	0

When disaggregating the data by subject area, Science TK, TPK, and TPCK increased, while TCK decreased. Math TK, TCK, and TPCK increased while TPK remained the same. English Language Arts TK, TPK decreased while TCK and TPCK increased. History TK, TPK, TCK increased and TPCK remained the same.

Table 5
Subject Areas

Subject Area	TK	TPK	TCK	TPCK
Science	Increased	Increased	Decreased	Increased
Math	Increased	Same	Increased	Increased
English	Decreased	Decreased	Increased	Increased
History	Increased	Increased	Increased	Same

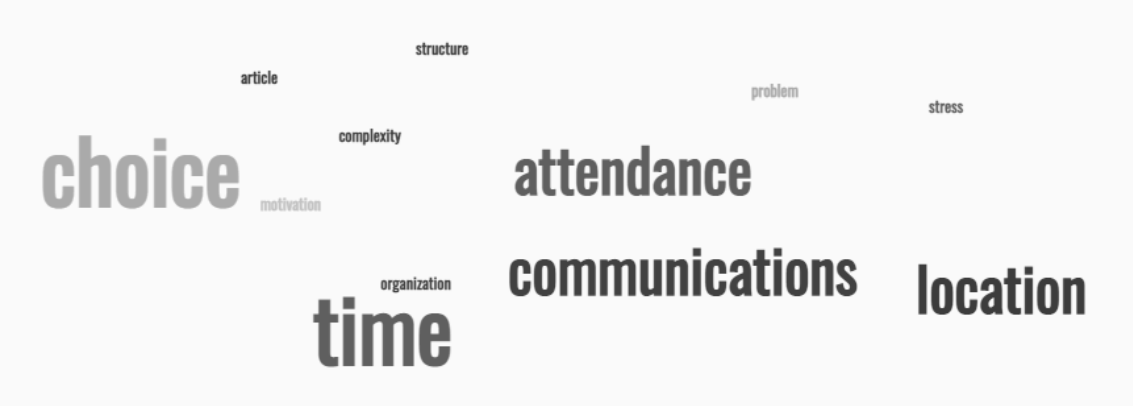
In the open response questionnaire, all students were able to articulate the purpose of action research, as well as the process. As to whether or not the students believe they would use action research when they are in-service teachers, eight said they would, three said they might, and one said no. From those who would engage in action research, reasons included “I want to

advocate and promote educational reform," "I will always want to make learning more attractive and fun for everyone involved," "I now have the tools to figure out solutions for challenges in my classroom." The participants who indicated that they might use action research all cited their fear of being overwhelmed by all the tasks that teachers already do. The participant who said no explained that "the formal process of action research is stressful."

After the PSTs submitted their anonymous reflections, they were coded by looking for emerging themes. "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language based or visual data" (Saldana, 2016, p. 4). The themes were typed into a word cloud generator, highlighting the most prominent themes (Figure 1). The themes were: stressful, time, complexity, organization, structure, writing articles, communication, problems, attendance, choice, location, useful, motivation, and ongoing.

Figure 1

Themes



Discussion

Through this project, the hope was that the PSTs would gain a better understanding of using technology to focus instruction on content, highlighting standards, instead of creating lessons that use technology as an add-on just for the sake of using technology.

This research article centers around two distinct research questions:

1. Through participating in action research in an undergraduate class, would pre-service teachers be more open to using action research in their future careers?
2. Would the use of virtual reality technology in their action research projects enhance their technological pedagogical content knowledge?

According to the questionnaire, the majority of the participants would use action research in their future classrooms and they do understand the process. They highlighted the need to canvas current research to inform their practice. The post-project TPACK survey indicated that most of the PSTs claimed their ability to use technology to support their pedagogy and content instruction increased. The ELA pre-service teachers reported some decline; their reflections

suggested that the decrease in TK and TPK was due to the inability to locate free applications to suit the needs of their students. Finally, all students were able to think about VR as a possible instructional resource and began to think about how to use a myriad of applications in new ways, demonstrating that learning can happen without a textbook or worksheets.

There were several limitations to this study which impacted the results. First, this was a small class; there are only twelve middle-level pre-service teachers in this class. Therefore, the participant group was small; thus conclusions beyond these participants cannot be accurately predicted.

In addition, the venue and circumstances around the pre-service teachers' research created a restrictive environment. At the Boys and Girls Club, middle school students were grouped and rotated to different centers during their three hours at the facility. They began with a snack and then moved around with those predetermined groups every 30 minutes. This impacted the PSTs' ability to work with students as some preferred to go to their center rather than work with the pre-service teachers. There was also a great deal of distraction as the students moved amongst the centers. Another issue was that the middle school students would leave at different times, which meant that the PSTs didn't always have full access to the students. Further, the areas of weakness that the students first self-described weren't necessarily accurate, causing the pre-service teachers to struggle when trying to nail down a problem of practice. Conversely, using the Boys and Girls Club venue was somewhat less restrictive in terms of using the devices. Access to Wifi at the Boys and Girls Club was easily available, while access to Wifi in the school district requires a great deal of permissions and caveats.

In the pre-service teachers' reflections, they noted that due to time and attendance barriers at the venue, they felt an inordinate amount of stress about this research project and indicated that the stress might have impaired their judgment of action research. They also wanted to explore other topics than virtual reality and felt that being able to choose topics should be a component to this project since action research typically begins with an authentic problem of practice. In this case, the problems were given to them and they were asked to use the virtual reality devices with free applications to solve their problems of practice. Finally, the restriction of using free apps was a challenge because most free applications are geared toward recreational play and did not lend themselves to educational goals; however, this also forced the pre-service teachers to think about the available applications in new ways, finding educational merit in atypical resources. The limited number of free applications also caused some of the pre-service teachers to focus on motivation and interest as opposed to direct standards-driven content problems, which created an opportunity for the pre-service teachers to look at other aspects of and influences on student learning.

In future course offerings, action research projects should be embedded in classroom field experience. PSTs should use data to identify a problem of practice and VR technology should be an option for use but not a requirement. These changes may bring the goal of connecting research to practice to the forefront, but, admittedly, may also hinder their development of technological pedagogical content knowledge depending on their choice of solutions.

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Appendix A

Research Project Formative Rubric

Grows	Description	Glows
	Problem of practice: Problem is identified. The lesson addresses the problem.	
	State standards: Appropriate standards are identified and align with the problem of practice.	
	Objectives: Objectives are well-written, address the standards, and align with the problem of practice.	
	Selection of VR materials: Materials address the problem of practice, meet the needs of the students, and are appropriate for middle-level students.	
	Best Practices with use of VR: Based on research (literature review), the lesson uses best practices.	
	Assessment: The assessments (pre and post) align with the activities and assess the standard.	
	Justification: Choices are justified and literature has been consulted.	

Appendix B

1. What is the purpose of action research?

2. What is the general process for conducting action research?

3. What is the general format of a research article?

4. Do you think you would conduct action research as an in-service teacher and ***why/why not***?

The Importance of Administrator Support in Improved Job Satisfaction Among Teachers

Camille Wheeler, University of Arkansas at Fort Smith

Abstract

The purpose of this study was to provide evidence and recommendations to increase administrative support to improve job satisfaction among teachers. The problem was that 45% of teachers reported job dissatisfaction. The rationale for this study was that it is critical to improve teacher job satisfaction since it may lead to greater performance and retention while reducing burnout. Teachers are leaving both their districts and the profession at the highest rates ever seen. The central research question was, "How can administrator support be increased to improve job satisfaction among teachers?" Three forms of data were collected for this applied research, including interviews, a focus group, and a survey to determine the contributing factors affecting job satisfaction. Participants were employees of a small, suburban school in Arkansas; the identities of participants were protected and remained anonymous. After discussing the research findings, three recommendations were made: increase administrative team presence, implement a teacher recognition program, and establish an employee wellness committee which were supported by data.

Keywords: job satisfaction, burnout, administrative support, administrative presence, communication, and teacher recognition.

Overview

The purpose of this study was to provide recommendations to administrative leadership to increase administrative support to improve job satisfaction among teachers in the district. The problem was that 45% of district teachers reported job dissatisfaction on the Staff Satisfaction Survey (Wheeler, 2021). The educational site for this study was a suburban school in Arkansas. The district is composed of 743 students in grades Kindergarten through 12th grade, with an average class size of 14 students per class (Arkansas Department of Education, 2021). The district had 73% of students who qualified for free or reduced meals, and 2% were English language learners. Additionally, 18% of all students in the district receive special education services. Teachers were found to have an average of 10 years of teaching experience, with a 93.8% graduation rate. Administrators within the district included the superintendent, three principals, two district instructional facilitators, and a district testing coordinator. The central research question for this study was "How can administrative support be increased to improve job satisfaction among teachers?"

The Problem

Over the past five years, turnover rates in the district have ranged from 9% to 13%, but the focus has not been on teacher job satisfaction. Job satisfaction comprises many factors, including burnout, administrator supervision, student behavior, personal accomplishment, and other areas (Simoes & Calheiros, 2019). Glickman and Burns (2021) looked at the effect of administration supervision on teacher wellness, including remaining humble, giving praise, encouraging teacher inquiry, offering concrete suggestions, and advice to struggling teachers, energizing them intellectually, and developing them as leaders. It was noted that staff well-being is directly related to student well-being. Devaki et al. (2019) noted that failing to address

teachers' mental health and wellness directly affects their abilities to address critical needs within their classrooms and with their students. A monthly recognition program for one outstanding teacher from each building has been implemented inconsistently and a retention bonus program has been implemented with no significant impact. Nothing notable has been implemented to address teachers' health and mental well-being.

The decline in teacher job satisfaction is a growing issue affecting teachers in the district daily. Improving job satisfaction may potentially benefit teachers, students, and administrators, through improved job satisfaction with greater autonomy, a stronger sense of accomplishment, and loyalty to the district. Increased job satisfaction may also result in greater student achievement. Zamarro et al. (2021) noted that nearly 25% of teachers employed at Arkansas public school districts in January of 2021 indicated a desire to leave their positions compared to a national average of 16%. Before COVID-19, less than 8% of teachers were leaving the field, but that has increased to 19% and 30% (Pressley, 2021). This is significant for school districts also facing teachers leaving the field due to burnout. Districts must develop and implement programs to ensure that the current teachers on staff have the well-being to remain in the educational field, which would benefit students and the community by having experienced teachers. Educators need to have a sense of autonomy, efficacy, a supportive school culture, supportive administration, a reasonable workload, and job satisfaction (Kaynak, 2020). Poor work conditions, bullying behavior from students toward teachers (Buskila & Chen-Levi, 2021), and teacher shortages can have detrimental effects on a teacher's emotional and mental state (Woudstra et al., 2018).

Literature Review

Job Satisfaction and Teacher Turnover

The impact that job satisfaction has on the field of education can be significant. Wright and Bonett (2007) have shown that overall job satisfaction is the most significant predictor of turnover, even more so than individual factors. Each year an average of 8% of teachers leave the field of education, while another 8% shift schools (Cormier et al., 2021). With a turnover rate of 16%, these impacts can be felt across districts. Ingersoll et al. (2021) showed that teaching forces have become older, less experienced, more female, more diverse, and unstable in recent years. Turnover increases the number of teachers with less than three years of experience, teachers with alternative or provisional licenses, and class sizes (Sorensen & Ladd, 2020). One way to mitigate teacher turnover is to increase job satisfaction among educators.

When considering how to improve job satisfaction, districts must consider internal and external factors in determining the needs of staff related to job satisfaction and retention. Districts should consider previous research to help understand the factors that impact teacher job satisfaction and programs that have improved job satisfaction. However, they cannot solely depend on what districts around them are doing, as districts within the state vary so much (Holmes et al., 2019). More recent research found that there are both internal and external factors that affect burnout and retention. External factors include occupational stress, school environment, and learners' disruptive behavior, while internal factors include the teachers' creativity, personality, emotional intelligence, empathy, and self-efficacy (Zabihi & Khodabakhsh, 2019). All these factors can positively or negatively impact job satisfaction among educators.

Young (2018) found that teachers leave the profession due to various reasons that diminish job satisfaction. Young also found that higher-poverty schools, higher crime rates, and poor leadership had higher impacts on teacher turnover rates and lower student achievement.

Over the past three years, the impact of the COVID-19 pandemic has increased the rates of teachers leaving the profession (Pressley, 2021). Before COVID-19, only 8% of experienced teachers were leaving the profession each year, with new teachers (less than five years) leaving at rates of 19% to 30%. Since COVID-19, rates have increased to 22% of experienced teachers and 27% to 43% of new teachers leaving the profession. Similarly, the Arkansas Department of Education (2021) found that nearly one-fourth of teachers indicated a desire to leave the profession since the COVID-19 pandemic. This is especially impactful with the impending retirement of the baby boom generation of educators, which results in a need to increase graduating teacher rates by at least 30% over current rates to meet school needs in the coming years (Carver, 2021).

The teacher turnover rate has also been shown to have an economic effect on the district. In the U.S., seven billion dollars is spent annually on teacher turnover, and the cost to replace one teacher can be anywhere from $13,000 to $24,000, not including salary (Reitman & Karge, 2019). The Arkansas Department of Education has been studying teacher retention for several years. In 2018 they found shortages in 15 out of 18 teaching areas (Arkansas Department of Education, 2018), with the greatest shortages being in the areas of special education, math, science, foreign languages, art, and library sciences. Since then, additional studies have been conducted to determine factors that impact retention and how to slow the turnover rate among teachers leaving the profession.

Teachers leaving rural districts due to job dissatisfaction have a more significant impact on smaller districts. Studies have shown that turnover in rural districts reinforces the community's poverty level and leads to lower student achievement rates (Frahm & Cianca, 2021). Poor work conditions, bullying behavior from students toward teachers (Woudstra et al., 2018), and teacher shortages (Buskila & Chen-Levi, 2021) can have detrimental effects on a teacher's emotional and mental state. The research has clearly shown that to prevent burnout, educators need a supportive administration, favorable working conditions, a reasonable workload with adequate pay, a positive school culture promoting strong interpersonal relationships, and mental well-being (Kaynak, 2020).

One of the greatest issues today's educators face is burnout and mental health issues with high demands from working conditions coupled with limited support and resources (Cormier et al., 2021). Given the high cost of training and replacing teachers, it is in the district's best interest to try and retain qualified teachers, in which administrators play an essential role. Administrators must provide the support needed so that the retention rate of teachers can be increased. Additionally, principals who regularly engage in culture building, visioning for the school, budgeting, and improving instructional practices can increase teacher satisfaction (Frahm & Cianca, 2021). Each has been shown to have a positive impact on reducing burnout and improving job satisfaction.

Administration & Characteristics

Administrators play a crucial role in the educational system. Administrators, which include the district's superintendent, principals, curriculum directors, instructional specialists, and other staff leadership, can affect all aspects of a school. As Frahm and Cianca (2021) stated, administrator support can increase job satisfaction and decrease educator turnover within the

district. The review of the current literature primarily focused on the role of the principal within the school as Van der Vyver et al. (2020) determined that principals have the most significant impact on the climate and culture of the school and district. The principal is uniquely positioned to support and encourage staff and students, ensure educators have the needed resources, partner with parents and community members, and advocate for teacher and student needs (Redding et al., 2019).

The Bureau of Legislative Research (2018), Harris et al. (2019), and Ingersoll et al. (2021) all looked specifically at the factors identified above to determine their effects on teacher well-being. One key area that was researched was the role of school administrators on educator well-being. Berkovich and Eyal (2018) found that fostering an emotionally healthy climate where teachers can express emotions within the school helped to improve the school's atmosphere. Glickman and Burns (2021) looked at the effect of administration supervision on teacher wellness and made recommendations for how administrators interacted with staff including remaining humble, giving praise and affirmation, encouraging teacher inquiry, offering concrete suggestions and advice to struggling teachers, energizing them intellectually, and developing them as leaders.

As previously discussed, administrators play a significant role in the climate of their building and in helping educators to manage stress levels. Skaalvik and Skaalvik (2021) have shown that understanding what burnout and emotional exhaustion look like can help administrators counteract negative effects. Emotional exhaustion can often appear as low energy, chronic fatigue, restlessness, and frustration due to high academic demands (Thuruthel & Tungol, 2021). Watching for these signs and initiating conversations with educators about coping strategies that can help will benefit both educators and students. Helping teachers focus on their mental health and avoid burnout can positively impact job satisfaction and retention. In much of the previous research, teachers have reported that they experience lower job satisfaction and well-being levels when principals are viewed as apathetic, uncaring, and or presenting conflicting expectations (Van der Vyver et al., 2020).

Administrators have a strong influence over teachers through building supportive relationships, prioritizing classroom visits, helping teachers use data, acknowledging teachers' work, providing for professional improvement, working collaboratively with teachers, and distributing leadership to teachers. These things have been proven to support a positive school climate and the educators therein. Sowell (2018) has shown that administrators can increase job satisfaction and teacher retention through the culture and climate of a building. Berkovich and Eyal (2018) determined that principal support is said to mitigate teachers' negative emotions about themselves and their work and can help reduce stress. Teachers who feel supported by administrators report a greater level of job satisfaction and lower levels of burnout. Ebersold et al. (2019) found that administrators who support teacher autonomy are more likely to facilitate competence and satisfaction among their staff. Autonomy is confidence in one's ability to act effectively and be competent in their word and can play an impactful role in education.

Working Conditions

When researching job satisfaction among teachers, one area that can impact satisfaction levels is the working conditions within the building and the district. Kaynak (2020) identified working conditions as just one of many factors impacting job satisfaction. Working conditions in schools are essential for teacher motivation, effectiveness, job satisfaction, and student learning opportunities (Toropova et al., 2021). Working conditions include a trusting and supportive

environment, reasonable expectations, well-behaved students, adequate resources, and respect from the community. During their research, Harris et al. (2019) found that 92% of principals felt like the working environment was trusting and supportive when questioned about conditions, while only 53% of teachers held this viewpoint. Similarly, 83% of principals felt the resources available were adequate, yet only 19% of teachers agreed. These results show a substantial disconnect between the administration and teachers about the working conditions in the school.

Many teachers have reported experiencing stressful workplace dynamics like unequal workload distribution, favoritism, or lack of opportunity for input (Schlieber et al., 2019). These issues can cause conflict and work overload, leading to emotional exhaustion and dissatisfaction with the job (Yang et al., 2018). While these are areas that teachers have identified, administrations do not often recognize these areas of job dissatisfaction. This shows a clear misconception between administrators' and teachers' views regarding workload distribution, emotional exhaustion, and opportunity for input. Teachers see their working conditions turning in a negative direction with a lack of financial resources, greater demands on teachers, and a lack of work/life balance, making it difficult for teachers to experience satisfaction and accomplishment in their work (Rasanen et al., 2020).

High Demands

Over the past several years, the demands on teachers have increased. The number of tasks teachers are asked to complete has increased, yet their workday and compensation have not increased. This often results in teachers taking work home and completing tasks on personal, unpaid time. Teachers have reported that administrators who expect work to be done from home cause conflict between work demands and family demands, leading to exhaustion (Buskila & Chen-Levi, 2021). As teachers reach a state of emotional exhaustion, they begin to feel burnout, and job dissatisfaction increases. This is especially true in rural districts with a smaller population and tax base to support the school. Conversely, administrators who provide adequate time for teachers to complete tasks and who do not expect work to be completed outside of school hours can positively impact exhaustion and burnout in teachers. Additionally, increased burnout can be attributed to a lack of available resources (Montoya & Summers, 2021) and strained workplace atmospheres resulting from internal consistency issues and staff conflict (Financz et al., 2020). While there will always be some level of teacher turnover, improving the workplace climate and ensuring teachers have the resources needed will help to improve job satisfaction, leading to less turnover (Shirrell & Reininger, 2017).

Mental Well-Being

There is an upward trend in teachers who are reporting mental health issues and who are taking antidepressants. This trend has increased from less than 1% of teachers in 2000 to 5% in 2018 (Jerrim et al., 2021). Teachers have recently reported higher levels of depression, anxiety, and burnout. “Burnout is more than emotional exhaustion, it is more than chronic tiredness and fatigue, it is discouragement, alienation, a crisis of meaning and values, and the disconnection with one’s work life” (Maior et al., 2020. p. 136). This issue negatively affects multiple aspects of educator job satisfaction. Increased stress and mental health problems impact students, co-workers, administrators, parents, and the classroom climate. It increases the negative effect on teachers’ mental and physical health and decreases motivation and efficiency (Bi & Ye, 2021). Teaching has been ranked as one of the most stressful jobs out of 26 occupations among helping/service professions (Saloviita & Pakarinen, 2021). One factor that can play a role in this

stress is the feeling of personal accomplishment each teacher has. Research has also shown a positive correlation between teacher emotional support, a sense of personal accomplishment, and student academic achievement, all of which can lead to greater job satisfaction (Jensen et al., 2019).

Stoloff et al. (2020) have identified five key components of well-being. These components are positive emotions, engagement, relationships, meaning, and accomplishment. Each component is necessary for a teacher to achieve a strong sense of well-being. To counteract the impact on teachers' emotional, physical, and mental well-being teachers must take time for self-care and stay positive.

While many schools focus on the psychological needs of the students, it is essential to remember that educators also have psychological needs. Including educators in the conversational process can increase their levels of emotional engagement and commitment, whereas teachers who feel burned out are emotionally exhausted, have a sense of unaccomplishment, and feel depersonalized (Ford et al., 2019). "Teaching is a disempowering profession with frustrations coming from not having a voice in the environment, which reflects into the classroom" (Rumschlag, 2017. p. 22).

Teachers leave a school for many reasons, including a lack of principal effectiveness, weak administrative structures, student behaviors, uncompromising practices, and poor compensation rates (Holmes et al., 2019). Factors such as the school and classroom climate, peer relationships, teacher/student relationships, high demands, and working conditions can all negatively impact job satisfaction and retention rates. Nevertheless, teachers stay because they are committed to their students, have opportunities for leadership and collaboration, connect to the community, and find significance in their personal and professional lives (Seelig & McCabe, 2021). It will be crucial for districts to address the needs of the teachers by assessing their workloads, evaluation programs, compensation rates, and demands on the teachers' time.

Procedures

Three methods of data collection were utilized throughout this study. These methods included interviews, a focus group, and a survey. The first method of data collection was semi-structured interviews of nine participants including six certified teachers and three paraprofessionals. The interview questions were based on specific topics relevant to the research allowing baseline data to be obtained. Participants were selected from all levels of the grade-level spectrum in the district's elementary, middle, and high schools. Participants were selected from volunteers contacted through email. The sampling of participants was representative of the district population.

The second approach used to collect data during this research was a single focus group with 12 questions. This approach explored how administrators in the district describe the culture, the expectations from the administration, the level of support received, and the desired changes. The focus group was conducted face-to-face and comprised two principals, two curriculum support specialists, the assistant superintendent, and the district superintendent. This focus group was representative of all administrative areas in the district.

The final approach used to collect data in this study was a quantitative survey. The survey explored how staff perceive job satisfaction, support, and requirements made on them. Data collected also identified areas that harm teacher mental wellness, negatively impact job satisfaction, and factors that have a positive impact on teacher mental wellness. To collect data, a closed-ended Likert-type survey was administered electronically using Google Forms and

emailed to all staff in the district. The survey consisted of five demographic questions and 19 questions developed from the literature review. The scale consisted of five possible answers from Always, Often, Sometimes, and Rarely to Never. A quantitative survey was chosen because it will provide participants with only one answer to each question, ensuring the completion of all questions. Participants were given a two-week time frame to complete the survey. The results were analyzed by calculating the frequency of each number reported on the survey for each question and were validated through test reliability and consistency.

Findings

Interview Results

Interviews were conducted with three elementary, middle level, and high school teachers, as well as three paraprofessionals, to find themes related to low job satisfaction among teachers in the district. Various themes were identified and reported in Table 1.

Table 1

Code and Themes from the Interview Data

Themes	Codes	Participants' Quotes
Working Conditions	Improving	"Students are adjusting, and behavior is starting to get better, but it is hard to get our students to buy into what we are doing. It is just going to take more time."
	Disconnected	"Staff is not close, and there is no time together as a building to connect."
	Isolated	"Grade levels tend to stick together, and everyone is in their own little group. There is not a lot of communication from administration or teachers".
	Excessive Workload	"We do not have enough time to get everything done during the school day, and the expectation from the administration is that we will do what needs to be done, even if it means spending hours working at home. It is too much to do, especially for newer teachers".
Administration	Support	"Administration needs to support all the teachers, not just the general education teachers. If you don't know what my job is, then come and talk to me. Don't just ignore me".
	Presence	"Administration needs to be in the classrooms more and have a greater presence for the students to see. The administrative team does not really know or understand what is going on in the classroom".

Themes	Codes	Participants' Quotes
	Behavioral Support	"Behavioral support is the only thing I see my principal doing on a regular basis. Behavior is getting better with students".
	Trust	"I do not feel like I am trusted to do my job by the administrative team".
	Access	"I have to seek out my principal if I need something. Check-ins are few and very quick when they do happen".
	Communication	"There is a lack of communication from the administrative team. We don't get the information we need to be able to do our jobs the way they need to be done, and then we get in trouble for not knowing things. There is a lack of communication between teachers as well".
	Voice	"Allow us to have a say in what we teach. The curriculum we have now is too hard for our students and doesn't meet their needs. Administration does not listen to us and needs to stop putting so much emphasis on test scores".
Awareness	Unappreciated	"Morale is way down this year with teachers. The administration tells us to take care of ourselves but then restricts our days off and takes our lunch break or planning time for meetings. I rarely get an uninterrupted lunch break or planning time to get my work done".
	Undervalued	"I don't feel recognized or valued for the job I do. I need to hear more positives from administration, and I don't want to wait until the end of the year to be told what I am doing wrong. I want to see more recognition for the things we are doing as teachers".
	Student Recognition	"Only the highest performing students are recognized. We don't recognize the small successes or progress that our students make. There is no recognition at all for our special education students".
	Teacher recognition	"I want to hear more positives that I am doing from admin. I need to hear that I am doing a good job." "I don't want to wait until the end of the year for my principal to sit down and tell me

Themes	Codes	Participants' Quotes
		what I need to do better on. Give me a chance during the year to make changes."

Focus Group Findings

The second data collection approach for this study was a single focus group. A semi-structured interview was conducted with the administrative team of the district. Two principals, one instructional specialist, the assistant superintendent, and the superintendent were all part of the focus group interview.

Focus Group Results

A single focus group was conducted with the administrative team to find themes related to low job satisfaction among teachers in the district. Themes were identified based on similarity and reduced into smaller sections for analysis. Various themes were identified and reported in Table 2.

Table 2

Codes and Themes from the Focus Group Data

Themes	Codes	Participant Quotes
Growth	Improving	"Data is showing student growth and teachers are reaching out for help and support as needed."
	Data	"Looking at data is time-consuming for teachers and takes up a majority of their time."
Support	Connection	"We work to connect teachers with needed resources and training. It is encouraging to see teachers interacting with each other and the level of camaraderie that they have."
	Accountability	"The evaluation system is to help facilitate the adult learner and to let them pick what they are good at and focus on that, as well as areas they need to grow in."
	Communication	"One of our greatest challenges is combating misinformation, both with the community, as well as with the teachers and staff."

Survey Description of Participants

Participants included teachers and staff from across all three levels within the district. 45 responses were collected from across the district. Six participants were between the ages of 20 to

29, ten participants were between the ages of 30 and 39, 14 participants were between the ages of 40 to 49, nine participants were between the ages of 50 to 59, and six participants were 60 or older. Of the survey respondents, 11 of the respondents had been teaching for five or fewer years, twelve respondents had six to ten years of experience, three respondents had 11 to 15 years of experience, 11 respondents had 16 to 20 years of experience, and eight respondents had 21 or more years in the educational field. Of the respondents, two held an associate degree, 19 held a bachelor's degree, 18 held a master's degree, and the remaining six respondents had a high school diploma. Respondents were from all grade levels and specialties in Pre-K through 12th grade, including classified and certified staff. All respondents voluntarily participated in the survey; no identifying data was collected.

Survey Results

Surveys were collected from 45 faculty and staff members of the district to solve the problem of low job satisfaction. First, surveys were accessed through Google Forms for data analysis. Then, a frequency and mean table was created to display the frequencies and means of the Likert scale responses, as reported in Table 3.

Table 3

Frequency and Average of Survey Responses

Question	Frequency					Mean
	5	4	3	2	1	
1. My interactions with my colleagues are positive.	8	30	7	0	0	4.02
2. I have faith in the integrity of my principal.	16	16	11	2	0	4.02
3. I feel valued by the administration.	4	16	14	7	4	3.2
4. Communication from the principal meets my needs within the district.	8	14	16	5	2	3.47
5. At the end of the day, I feel burned out.	4	16	14	11	0	3.29
6. I am satisfied with my job	6	13	22	4	0	3.47
7. Student behavior affects my classroom negatively.	8	13	16	7	1	3.44
8. My principal provides support to deal with student behavior.	9	23	9	3	1	3.8
9. I have a good relationship with the parents/guardians of my students.	6	25	14	0	0	3.82
10. Principals encourage innovation with teachers.	9	14	18	3	1	3.6
11. My voice is heard by my principal.	9	16	15	3	2	3.6
12. I feel as if I am part of a team.	8	20	9	5	3	3.56

Question	Frequency					Mean
	5	**4**	**3**	**2**	**1**	
13. I feel strong loyalty to this school.	12	19	9	4	1	3.82
14. I feel frustrated with my job.	4	8	19	11	3	2.98
15. I am thinking about leaving this school.	5	6	11	13	10	2.62
16. I am thinking about leaving the field of education.	3	4	7	19	12	2.27
17. I believe the administration appreciates my efforts in the classroom.	5	14	15	6	5	3.18
18. My efforts in the classroom are appreciated by the parents/guardians of my students.	5	17	15	6	2	3.38
19. I worry that I will be unable to meet/provide for my family's needs financially.	16	11	15	2	1	3.87

***Note*:** Means for each question were calculated by summing the results for each question and dividing the results by the total number of participant responses.

Discussion of the Findings

Complete data analysis of the interview, focus group, and survey results identified three significant factors that negatively impact job satisfaction: lack of administrative presence, lack of recognition, and a need for increased collegial relationships.

From the interviews, three overall themes were identified from participant interview responses. The first was working conditions, the second was administration, and the third was awareness. The first theme that became evident during the data analysis was working conditions within the district. Working conditions impact teacher motivation, effectiveness, job satisfaction, and student learning opportunities (Toropova et al., 2021). One participant described the working conditions by saying, "Last year was total chaos, but this year it is improving. Everyone is still adjusting to the new programs." Another participant stated "The culture feels more disconnected this year. We never have time together as a staff outside of our grade levels. We don't see each other or communicate anymore." While some participants felt the district's working conditions were improving, most participants stated that the current working conditions fostered a feeling of isolation or disconnect compared to the previous year. Participants new to the field of education stated that they felt like they were left to learn new skills by themselves and had little to no support and stated, "I am overwhelmed with everything that must be done. It is too much, and I don't have any help." According to Yang et al. (2018), a sense of isolation contributes to a stressful dynamic of work overload, emotional exhaustion, and dissatisfaction. Every participant interviewed stated a desire for more time together as a staff to communicate, plan, and support each other and the students.

The second theme evident during the interview process focused on the level of support given and received from the administrative team. Van der Vyver et al. (2020) determined that the administrative team has the most significant impact on the culture and climate of a district. The

identified keywords were “presence” with nine mentions, “behavioral support” with six mentions, “trust” with five mentions, “access” with nine mentions, “communication” with six mentions, and “voice” with seven mentions. To give an example of presence, one participant stated, “Administration needs to be in the classrooms more and have a greater presence for the students to see. The administrative team does not really know or understand what is going on in the classroom.” When asked if the teachers received support for behavioral issues, nine out of twelve participants indicated that they got the support they needed if they sought it out but that the principals did not come and see what teachers needed stating, “If I call the office or go find him, he will help, but he never checks in with me.” During the interview, five out of twelve participants stated that they do not feel like the administrative team trusts them to do their jobs, and they are micromanaged and not given the freedom to do the things their students need to be the most successful. Berkovich and Eyal (2018) found that supportive principals could mitigate teachers' negative emotions about their jobs. Seven out of twelve participants made similar statements. In addition, all interview participants discussed the perceived lack of communication from the administrative team. One participant stated, “We don’t get the communication we need from our principals and often find out about things the same time that parents do, which makes it difficult to answer parents’ questions.”

The third theme that emerged from the interviews was awareness, noted by the phrases “unappreciated” and “undervalued,” mentioned 11 and seven times, respectively. Many participants shared this feeling of being undervalued, which can significantly impact teachers' and students' perceptions of support. In their research, Frahm and Cianca (2021) demonstrated a direct correlation between administrator support and teacher job satisfaction. This research directly supports this study in which participants stated they felt undervalued and under-supported by the administrative team. One participant stated, “I don’t feel valued or trusted by the administration for the job that I do.” While another participant mentioned, “We do not have enough time in the day to get everything done that is required of us, and so we have to take it home. I don’t get paid to work at home, and it is affecting my family.” The other shared sentiment from several teachers was that they felt the administrative team was not in the classrooms as frequently as needed and was unaware of what was occurring.

Analysis of the interviews showed that participants identified additional keywords of “student recognition” and “teacher recognition,” mentioned 14 and 11 times, respectively. When asked how the district recognizes student achievement, one participant stated, "Only the highest performing students are recognized. They don’t do anything for the struggling students to work towards, which makes it harder for me to motivate my students.” When asked how teachers/staff were recognized for their efforts, all participants stated there was no recognition for what they do and that their work is not publicly appreciated. However, research has indicated that effective teachers collaborate with others and have higher student achievement, which should be recognized by the administrative team (Young, 2018). Eight of the twelve participants voiced similar statements about the need for positive encouragement, with one stating, “It would be helpful to hear what I am doing well and get those positive statements.” Ten out of twelve interview respondents stated they feel more isolated and disconnected than in previous years. This sense of disconnect can have a significant negative impact on job satisfaction.

Focus group data revealed two themes: growth and support. Within the theme of growth, the keywords identified were “improving” and “data,” mentioned five and six times, respectively. Like interview data, the administrative team felt that the district was growing and improving. Participant Three reported seeing his teachers reaching out for help and seeking

support to improve their practices and stated, “I see teachers collaborating together all the time.” Likewise, Participant Five reported that daily walk-throughs were helping the administrative team identify needs and areas of improvement and stated, “When I walk in the classes every day it helps me see what is going well and what we need to work on in just a few minutes.” Participant Four noted that the evaluation system gives teachers a focused growth area stating, “We set goals at the beginning of every year that my teachers are working on all year long.”

As Redding et al. (2019) found, a negative school climate can be counteracted by principals advocating for the needs of teachers and students and fostering an environment of growth. However, data collected from the focus group and interview data illustrated a disconnect between the perceptions of the teachers/staff and the administrative team. For example, focus group participants stated they completed daily classroom walk-throughs, yet four interview participants stated that the principals never came into their classroom. Another example of the disconnect between the administrative team and teachers was in the area of recognition. Participants in the focus group stated they recognize teachers frequently, yet eight of the twelve participants expressed a desire for more positive recognition. Interview data also revealed that while the culture is growing and improving, teachers and staff do not feel like the district is improving as much as the administrative team reported.

The other keyword identified in the focus group was “data.” The focus group noted that data are used to determine student growth, and teacher needs, and keep track of what teachers do during the instructional day. The administrative team collectively noted that teachers spend significant time looking at data. As previously identified, burnout can play a significant role in the intention of a teacher to remain in the field of education (Maslach, 1998). Knowing that data is time-consuming for teachers, the administrative team must be mindful of actions that can lower stress levels, prevent burnout, and help teachers manage their needs (Bi & Ye, 2021).

The next theme identified by the focus group was support. Identified keywords included “connection” with six mentions, “accountability” with four mentions, and “communication” with eight mentions. The administrative team reported connecting with teachers and staff through daily walk-throughs, Professional Learning Communities (PLCs), and teacher visits. Participant One recognized the Pirate Pride award given monthly to outstanding teachers and said that “more effort is being made to highlight teachers' work on social media.” Participant Three reported that “I give little celebrations and notes/emails to my teachers” to recognize their work, and Participant Four stated, "I give shout-outs and have a monthly meal for the staff.”

Despite the administrative team’s efforts to recognize and support the work in the district, interview data from teachers and paraprofessionals indicated that support from the administration was lacking. They reported they must seek out support and did not feel the administrative team had enough presence in the classrooms and buildings, stating that “the principal has a few places they always stand, and the kids know to avoid those areas. They need to be moving around more.” The interview process also noted that staff morale had decreased over the past year, and the excessive workload negatively impacted job satisfaction.

The next keyword identified within support was “accountability.” The administrative team reported that the evaluation process kept the teachers accountable for growth and area needs. However, eight out of 12 interview participants reported that they did not know the evaluation process or what was expected of them, indicating a significant disconnect between the actions of the administrative team and the teachers/staff. One participant stated, “My principal doesn’t have an evaluation system, so I don’t know what his expectations are.” Another participant noted, "I haven’t been evaluated in six years.” These statements support that there is a

disconnect between the principals and the teachers. As Ingersoll et al. (2021) reported, for evaluations to be effective, there must be meaningful interaction between the teachers and evaluators.

The final keyword identified in the focus group was “communication.” Communication was also an identified keyword in the interview process by the teachers and paraprofessionals. The administrative team noted that they communicate with the teachers through notes, emails, and pop-ins and reported that teachers are given information promptly. The administrative team also reported that combating misinformation was an ongoing issue. Participant One stated, “One of my biggest issues is combating misinformation and rumors with staff members.” Participant Three also stated, “misinformation makes it harder to fight the negativity in the district, but we work hard to make sure they have all the information needed.”

In comparison, the interview responses noted that communication from the administrative team was often lacking and did not meet the needs of staff in the buildings. Teachers reported that information was often published on social media before they were informed, making it difficult for them to answer questions from parents and stakeholders. Seven out of 12 participants reported a lack of communication from the administration in the interview process, again highlighting a disconnect between the administrative team and the teachers. Where the administrators feel they have adequate communication, teachers felt a need for more communication from the administrative team.

Three themes emerged from the survey: frustration or burnout, a lack of appreciation, and financial concerns. Question 16 of the survey had the lowest mean score of 2.27, indicating that only a small number of respondents were considering leaving the field of education. Conversely, questions one and two had the highest mean score of 4.02, indicating that more respondents have faith in the integrity of their principal and have positive interactions with their colleagues. While 23 out of 45 respondents were not considering leaving the school district, 11 out of 45 were considering leaving, and 11 others were neutral. Based on these results, a significant impact on job satisfaction was the feelings of burnout felt by teachers. Twenty out of 45 respondents reported feeling burned out at the end of every day based on question five of the survey, which had a mean score of 3.29.

Question 17 of the survey looked at feeling appreciated and valued by the administrative team. Twenty out of 45 respondents reported feeling valued by the administration. However, 14 respondents were neutral, and 11 respondents reported they did not feel valued by the administration, which gave a mean of 3.18.

On question 19, 27 out of 45 respondents, with a mean score of 3.87, indicated that they were worried about being able to financially meet their families' needs. Financial insecurity aligns with the research done by Schlieber et al. (2019), which found that 75% of teachers worry about having enough money to pay their bills. Educators in the district report greater stress and concerns about the financial impact on their families. Sixty percent of the respondents reported financial concerns about paying their bills, negatively impacting job satisfaction.

Recommendations

After analysis of the data collected in this study, three possible solutions are recommended. The most effective solutions recommended to solve the central research question are:

1. Increase administrative team presence by:
    a. Administrative Substitutes

   b. Administrative Team Walk-Throughs
2. Increase Teacher Recognition by:
   a. Monthly Peer-Nominated Award
   b. Communication Platform
3. Increase Collegial Relationships through:
   a. Wellness Committee
   b. Virtual Collaboration
   c. All Faculty Staff Meetings

Recommendation to Increase Administrative Team Presence

Administrator presence is a crucial element within the role of the leader. Principals and administrators should be prominently seen, consistent, and authentic. Hall (2021) tells us that the administrator's presence can set the tone for the entire school. Teachers and staff need active supervision based on their individual needs and centered around their improvement. As the data in this research study has shown, employees of the district feel the need for a more significant administrator presence in the classrooms and buildings. Increased administrative presence through the use of the administrative team as substitutes and administrative walk-throughs, will help increase the district's job satisfaction. One of the most effective ways to bridge the gap between administration and staff is for the administrator to return to the classroom as a substitute (Joseph, 2022). Administrators can use this time to model instructional practices, connect with students, and support teachers. Substituting also allows administrators to engage with the teacher as they discuss the lessons and student learning. Leaders should also visit the classrooms early and often to see all aspects of the classroom, including teacher interactions with students, student interactions with classmates, and teacher-to-teacher interactions. Administrative walk-throughs can help foster trust with staff and improve teaching and learning.

Recommendation to Increase Teacher Recognition

Employee recognition refers to how an organization shows appreciation for employees' contributions. Jones (2019) states that employee recognition assists in the following:

- Retaining top talent
- Increasing employee engagement
- Encouraging high performance

The data collected in the interviews and surveys demonstrate the need for increased teacher recognition. Seven out of 12 interview participants expressed a need for more positive affirmation and question 17 of the survey showed that greater administrative appreciation is needed. On question 17 of the survey, five of 45 respondents stated that the administration did not appreciate their work, another 14 respondents *rarely* felt appreciated, and another 15 *sometimes* felt appreciated. This question had a mean of 3.18 and demonstrates the lack of appreciation staff felt. These recommendations will help increase a sense of appreciation and job satisfaction.

A monthly employee recognition award is recommended to increase peer-to-peer recognition within the district. The employee of the month would not be chosen by the administration but by team members and colleagues. The following recommendations can help to establish a communication platform that all staff members can use:

1. Create a dedicated hashtag to celebrate employees.

2. Develop the platform, so everyone gets notified when something is posted that is easily accessible, fun and collaborative, and offers valuable insight.

A communication platform can help meet the needs of staff for more positive recognition and support.

Recommendation to Increase Collegial Relationships

Glickman and Burns (2021) show a connection between the positive interactions between teachers and administrators and increased job satisfaction. In his research, Young (2018) demonstrated that peer/colleague support could directly increase job satisfaction. The annual teacher turnover rate is currently at 16%, with almost half of that coming from new teachers with less than five years in the field (Cormier et al., 2021). Although collegial relationships are one of the most prevalent types of interpersonal relationships, they have not been the subject of much philosophical study (Betzler & Löschke, 2021). Research has shown that teachers who get along well with each other are more likely to remain in their current position, feel more committed to teaching as a profession, and are better able to cope with stress and burnout. Furthermore, positive collegial relationships increase teachers' commitment to and satisfaction with their jobs.

Summary

The purpose of this study was to provide recommendations to the administrative leadership to solve the problem of low job satisfaction among teachers in the district. The problem was that 45% of district teachers reported job dissatisfaction on the Staff Satisfaction Survey (Wheeler, 2021). Three recommendations were made: increase administrative team presence, implement a teacher recognition program, and establish an employee wellness committee which were supported by data. Districts must look at supporting teachers' needs to decrease burnout and increase job retention.

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ESL Preservice Teachers' Perceptions of Using Artificial Intelligence in Language Education

Mohamed Ibrahim, Arkansas Tech University
Brett Stone, Arkansas Tech University

Abstract

This study aims to investigate variables affecting ESL preservice teachers' opinions on the use of AI in English education. The variables include participants' previous experience with AI, their beliefs about its value for language learning and their English proficiency level. The results of the first question regarding AI showed that beginner level students have less confidence in the ability of AI models to help improve their English skills compared to intermediate and advanced students. The results of the second question indicate that prior hands-on experience with AI leads preservice teachers to more positive views on incorporating them into language education, compared to no experience. Finally, results of the third question suggest that students' belief that AI language models can help them learn English better is associated with greater belief that AI could replace human teachers. The findings also showed that factors such as ESL preservice teachers' English proficiency level, their hands-on experience with AI, and their AI beliefs influence their opinions on AI adoption in their own classrooms. These findings align with previous research indicating that perceived usefulness strongly influences adoption intentions (Davis et al., 1989). The interpretations of these findings, recommendations, and the research limitations were also discussed.

Keywords: English as a Second Language, AI, Artificial Intelligence, English

Introduction

Many scholars attested that the use of artificial intelligence (AI) technologies is affecting many fields of society, including the field of education. Specifically, the wide use of AI in language education prompted many debates between educators and researchers. For example, supporters of the use of AI in education emphasize many positive possibilities that AI tools can create such as the ability to personalize students' learning. However, the critics of AI in education argue that using AI undermines real human interaction and emotional connection in the learning process (McStay, 2020; Vinuesa et al., 2020; Yang et al., 2021). These conflicting opinions prompt us to investigate the perceptions of the users within language education regarding the possible use of AI in teaching and learning.

One of the next generations of educators who will be impacted using AI in teaching and learning are preservice teachers. Although these preservice teachers have grown up surrounded by technology in their daily lives as digital natives, many of their views regarding integrating technology like AI specifically within education are critical and complex (Antonenko & Abramowitz, 2023; Istenic et al., 2021). As preservice teachers complete their training and enter the workforce, they will find themselves in an era when schools are increasingly adopting AI applications, from automated essay scoring to virtual tutors (Alam & Mohanty, 2022; Hahn et al., 2021; Hemachandran et al., 2022; Ramesh & Sanampudi, 2022). Therefore, the purpose of this study is to investigate the factors affecting ESL preservice teachers' perceptions of AI integration in English language education and its value for enhancing language learning.

Recent Research in AI

Teachers have used personalized learning approaches in face-to-face and online education for many years. In this teaching strategy, teachers first identify each student's learning styles, strengths, and weaknesses. The next step is developing different learning experiences that match each student's needs and abilities. Traditionally, this learner-centered teaching approach was found to improve students' engagement, motivation, and learning outcomes. Recently, many educators started utilizing AI to personalize instruction. The shift in using AI prompted many educators to investigate the pros and cons of the use of AI in instruction. Although the preliminary results of these studies were generally positive, there were a few concerns associated with the use of these new AI technology tools. Several studies show that one of the main pros of using AI in education is the AI ability to support students' learning through creating different personalized learning experiences (e.g., Murtaza et al., 2022; Tapalova & Zhiyenbayeva, 2022; Tavakoli et al., 2022). For example, recent studies between 2020-2023 examined the use of tutoring systems powered by AI helped students to personalize their learning, and consequently, improved their learning and motivations (Bhardwaj et al., 2021; 2020; Huang et al., 2023).

Another area of research related to the use of AI in education was the use of AI to help teachers with daily administrative tasks. In general, these research found that the use of AI tools assisted teachers with tasks such as identifying students' learning performances and early warning of at-risk students (e.g., Bhutoria, 2022; Chan & Hu, 2023; Nabizadeh et al., 2020; Timotheou et al., 2023). In recent years, many educational institutions implemented AI-powered data analytics in their online learning systems. These institutions added AI tools to their learning management systems (LMS), such as Blackboard, CANVAS or Moodle. The impact of the use of these AI tools were also investigated in the context of LMS and found it helped instructors to identify online low-performing students and provide personalized content matching their academic levels (Delgado et al., 2020; Foster & Siddle, 2020; Jagannath & Banerji, 2023; Murtaza et al., 2022; Rane et al., 2023; Yu et al., 2022). In the context of the current study, ESL research investigated the use of AI in language education and found similar positive results. Moreover, in recent studies investigating the use of AI in language education found that it helped ESL students improve their speaking skills, pronunciation and fluency (Chen et al., 2021; Cope et al., 2021; Kim, 2019; Kuddus, 2022; Liu et al., 2023; Makhlouf, 2021; Ouyang & Jiao, 2021; Pennington et al., 2019; Rogerson-Revell, 2021; Zou et al., 2023).

The positive experiences that many educators found while using AI confound the opinions of other educators who voiced their concerns regarding the use of AI in instruction. Much research has addressed these concerns associated with the use of AI in education. For example, recent research found that there are many educators who have expressed their concerns regarding some of the negative issues related to using AI including a lack of clear measurements to protect students' information and privacy, the absence of AI emotional intelligence, and the fear that teachers could lose their jobs as a result of over relying on AI in teaching (e.g., Ahmad et al., 2023; Chan & Tsi, 2023; Kamalov et al., 2023). Teachers also voiced other concerns such as the lack of suitable training and professional development in how to integrate AI effectively in teaching.

Another theme discussed in the literature is teachers' perception regarding the use of AI in teaching and learning. Many studies found that the participants' early use of AI correlates with their positive views of using AI in learning. For example, few studies examined teachers' view regarding the use of AI and found that teachers' prior experience with AI affect their adoption of AI as well as their positive views about its use (Antonenko & Abramowitz, 2023; Choi et al.,

2023; Ibrahim & Ibrahim, 2023; Rusmiyanto et al., 2023). Furthermore, research found that positive experiences with AI tools can lead to favorable opinions on AI's potential, while negative experiences can result in skepticism about AI's reliability and pedagogical value (Kim et al., 2020). These findings suggest that ESL preservice teachers' beliefs about AI's effectiveness in language learning are crucial in shaping their perceptions of AI's role in education (Sumakul et al., 2022).

Students' opinion towards the use of AI in education was also discussed in the literature. Generally, students are supportive of the use of AI in learning and expressed a positive view on the use of AI particularly the value of immediate feedback and personalized learning, (Chai et al., 2021; Chocarro et al., 2023). In more recent research ESL students favored the use of AI in language education as a supporting tool to enhance their language skills. However, students were extremely concerned about issues related to the use of AI such as their privacy, data security, and the potential loss of human interaction in learning (Ibrahim & Ibrahim, 2023).

Key Research Questions

Based on prior research, this study will be guided by the following research questions:

1. How does the use of AI in language education affect the perceptions of ESL preservice teachers with different levels of English proficiency?
2. How does prior experience using AI language models affect the perceptions of ESL preservice teachers regarding the value of AI in language education?
3. What factors best influence the perceptions of ESL preservice teachers regarding the replacement of human teachers with AI in language models?

Research Question 1: How does the use of AI in language education affect the perceptions of ESL preservice teachers with different levels of English proficiency?

The focus of the first question is to examine how the use of AI in language education can affect the perceptions of ESL preservice teachers with different levels of English proficiency. The investigators hypothesized that the use of AI in language education can impact ESL preservice teachers' perceptions differently based on their English proficiency. Through a one-way ANOVA analysis, the study surveyed 419 participants to assess differences in perceptions of using AI for language education based on English proficiency levels.

Research Question 2: How does prior experience using AI language models affect the perceptions of ESL preservice teachers regarding the value of AI in language education?

The second research question focused on the effect of preservice ESL teachers' prior experience with AI language models on their perceptions regarding the value of AI in language education. To address this question, the investigators conducted group statistics and independent sample t-tests to analyze the responses of the 419 participants based on their prior experience with AI in their learning to examine whether individuals with prior experience using AI language models hold different perceptions regarding the AI value in language education.

Research Question 3: What factors best influence the perceptions of ESL preservice teachers regarding the replacement of human teachers with AI in language models?

This question was proposed to identify factors that could predict ESL preservice teachers' beliefs regarding the possible replacement of human teachers by AI language models. The

investigators included variables such as English proficiency, prior experience with AI models, and positive views on AI usage in education. Recent research discussed the extent to which AI can replace humans and found that the human teacher's role remains unique in encouraging students' critical thinking, adopting social-emotional skills, and providing personalized guidance (Kim et al., 2020; Pratama et al., 2023; Yang et al., 2021).

Method

Research Design

The investigators used a within-subject design to investigate the perceptions of ESL preservice teachers regarding the use of AI in language education. The present study has two independent variables: ESL preservice teachers' English proficiency level and prior experience using AI models. Dependent variables: ESL preservice teachers' Perception regarding the use of AI models in language education, perception regarding AI in replacing human teachers and perception that AI could improve English learning.

Sampling and Participants

The investigators utilized a convenience sampling technique to recruit the participants included in this study. Participants were preservice teachers attending a four-year university during the spring semester 2023 in Turkiye. Investigators solicited students' participation via electronic mail to take part in the study. Participants were 419 undergraduate preservice teachers, 122 male, 297 female, and their ages were between 18-22. Participants identified that their level of English proficiency was the following: 219 students with intermediate and 198 advanced in their English language proficiency.

Data Collection and IRB

Before the data collection, investigators obtained the approvals from the university institutional review boards and then collected the anonymous data. After the data collection via the online survey instrument, the records were housed on the university's secure server.

Materials

Demographics: The demographic survey was deployed to participants on Google Classroom. Participants were asked about their age, gender, and their English proficiency level (e.g., intermediate, or advanced).

Research instruments: For this study, the investigators used a 5-point Likert scale to ask about students' opinion on using AI in teaching and learning.

The questionnaire was discussed with other faculty members teaching in the college of education to assess the content and construct validity prior to conducting the study. The questionnaire was also used with other college students in different courses and applied the inputs of the faculty members to improve clarity, comprehensiveness, and relevance, as well as to check for content validity.

The questionnaire includes 5-questions with 5-level Likert scale to assess students' opinion in using AI in learning and has been validated. Reliability has been measured using Alfa Cronbach with the point of reliability being 0.89. Students were asked to respond to the following example statement: "AI language models, such as CHAT GPT, could help you learn

English better than traditional methods". Students had the choice to select one of 5 choices: "1- Strongly disagree" to "5- Strongly agree".

Intervention: Investigators created assignments and encouraged students to use AI in their activities. Students who completed their weekly posts received credit and these posts were accessible and viewed by the instructor and other students.

Procedure

The online remote learning activities utilized through Google Classroom. To help students with their time management and self-regulated learning, investigators added a discussion forum to the learning activities and students completed one module every week at their own pace and received module credit for completing the module assessments and the discussion forums. Students completed the questionnaire during the last week of the semester and investigators collected all learning assessments and questionnaire responses for analyses.

Results

Statistical Analyses: Prior to the main analyses, the investigators screened students' responses for systematic patterns of missing data (e.g., when no value was stored for the variable within variable sets). However, the investigators did not observe any patterns of missing data.

Question 1: How does the use of AI in language education affect the perceptions of ESL preservice teachers with different levels of English proficiency?

The first question investigated the difference between the ESL preservice teachers' perceptions of AI language model in relation to their English proficiency level. To answer this question, investigators conducted a one-way ANOVA. Participants were divided into three groups based on their self-reported English proficiency - beginner ($n = 2$), intermediate ($n = 219$), and advanced ($n = 198$).

Before running the one-way ANOVA, the investigators first checked for its assumption of homogeneity of variances and found that it was violated for both ANOVA tests as indicated by significant Levene's tests ($p < .05$). However, ANOVA is considered robust to violations of this assumption when group sizes are approximately equal (largest/smallest ≈ 1.5), which was true in this study. Second, the normality assumption can be assumed based on the large sample size per group. Finally, there was no evidence of outliers based on the range of scores.

The ANOVA results showed no significant difference between proficiency groups on perceptions of AI models being a good idea for language education, $F(2, 416) = 1.01$, $p = .364$. However, there was a significant difference between groups on beliefs about AI helping learn English better than traditional methods, $F(2, 416) = 4.52$, $p = .011$.

Post-hoc Tukey HSD tests revealed beginner level students ($M = 1.00$, $SD = 0.00$) significantly differed from intermediate ($M = 3.10$, $SD = .967$, $p = .016$) and advanced students ($M = 2.96$, $SD = 1.17$, $p = .027$) in thinking AI could help learn English better. Beginners had less confidence in AI for language learning. No other group differences were significant.

The results suggest that beginner level students have less confidence in the ability of AI models to help improve their English skills compared to intermediate and advanced students. Students with lower proficiency appear more skeptical, while those with higher proficiency are more open to AI tools supplementing traditional teaching methods. Tables 1 and 2 summarize the ANOVA results.

Table 1

The descriptives of one-way ANOVA to assess differences in perceptions of using AI for language education based on English proficiency levels of ESL preservice teachers.

			N	Mean	Std. Deviation	Std. Error
Using AI language models in language education is a good idea.			N	Mean	Std. Deviation	Std. Error
			0	2	3.00	.000
Using AI language models in language education is a good idea.	Intermediate		219	3.84	.784	.053
	Advanced		198	3.86	.929	.066
	Total		419	3.84	.855	.042
AI language models could help you learn English better than traditional methods.	Model		Fixed Effects			.855
	Model	Random Effects				.042
	0	2	1.00	.000	.000	1.00
AI language models could help you learn English better than traditional methods.	Intermediate		219	3.10	.967	.065
	Advanced		198	2.96	1.170	.083
	Total		419	3.02	1.076	.053
	Model		Fixed Effects			1.067
	Model	Random Effects				.147

Table 2

The result of one-way ANOVA to assess ESL preservice teachers' differences in perceptions of using AI for language education based on English proficiency levels.

		Sum of Squares	df	Mean Square	F	Sig.
Using AI language models in language education is a good idea.	Between Groups	1.481	2	.741	1.013	.364
	Within Groups	304.123	416	.731		
	Total	305.604	418			
AI language models could help you learn English better than traditional methods.	Between Groups	10.295	2	5.147	4.523	.011
	Within Groups	473.467	416	1.138		
	Total	483.761	418			

Note: Significant at $p < 0.001$ level

Question 2: How does prior experience using AI language models affect the perceptions of ESL preservice teachers regarding the value of AI in language education?

This research question explores whether individuals with prior experience using AI language models, such as CHAT GPT, hold different perceptions regarding their value in language education. Participants were categorized into two groups based on their responses to

the question, "Have you ever used AI language models, such as CHAT GPT?" Group statistics and independent samples t-tests were conducted to compare the mean responses of participants with prior experience to those without, on statements related to the value of AI language models in language education.

The results of the independent samples t-test showed that there were 268 participants who had used AI models (M = 3.95, SD = .871) and 151 who had not (M = 3.65, SD = .793).

Before running the independent samples t-test, the investigators checked Levene's test for equality of variances and found that there was no significant difference across the perception variables ($p > .05$), indicating the assumption of homogeneity of variances was met.

The t-test results showed a significant difference between groups for views on AI models as a good idea for language education, $t(417) = 3.52$, $p < .001$. Those with experience had more positive views (mean difference = .30). However, there were no significant differences between groups for perceptions of AI helping learn English better than traditional methods ($p = .748$) or AI replacing human teachers ($p = .521$).

The results indicate that prior hands-on experience with AI models leads to more positive views on incorporating them into language education, compared to no experience. However, experience did not impact preservice teachers' beliefs about AI replacing human teachers or improving English skills relative to traditional methods. Tables 3 and 4 summarize the independent samples t-test results.

Table 3

Shows the independent samples t-test group statistics results, including mean scores and standard deviations of differences in perceptions of AI language models between preservice ESL teachers

	Have you ever used AI language models?	N	Mean	Std. Deviation	Std. Error Mean
Using AI language models in language education is a good idea.	Yes	268	3.95	.871	.053
	No	151	3.65	.793	.065
AI language models could help you learn English better than traditional methods.	Yes	268	3.01	1.083	.066
	No	151	3.05	1.067	.087
AI language models could replace human teachers in language education.	Yes	268	2.20	1.037	.063
	No	151	2.27	1.131	.092

Table 4

Shows the independent samples t-test to examine differences in perceptions of AI language models between preservice ESL teachers who had prior experience using them and those with no experience

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Using AI language models in education is a good idea.	Equal variances assumed	.106	.745	3.524	417	.000	.302	.086
	Equal variances not assumed			3.616	335.783	.000	.302	.084
AI language models could help you learn English better than traditional methods.	Equal variances assumed	.479	.489	-.321	417	.748	-.035	.110
	Equal variances not assumed			-.322	315.037	.747	-.035	.109
AI language models could replace human teachers in language education.	Equal variances assumed	.621	.431	-.642	417	.521	-.070	.109
	Equal variances not assumed			-.627	289.293	.531	-.070	.112

Note: Significant at $p < 0.001$ level

Question 3: What factors best influence the perceptions of ESL preservice teachers regarding the replacement of human teachers with AI in language models?

Regression Assumptions

The investigators conducted regression analysis to identify factors that can predict ESL preservice teachers' beliefs regarding the potential replacement of human teachers by AI language models. The investigators utilized descriptive statistics, correlation matrices, and regression coefficients to analyze responses from 419 participants to identify the most significant predictors.

The regression model includes the dependent variable the responses of ESL preservice teachers' perception regarding whether AI could replace human teachers in language education. The regression model includes four independent variables: English proficiency, AI experience, belief that AI is good for education, and AI helps students learn English better.

Before interpreting the regression results, the investigators checked the regression analysis assumptions and found that the assumption of no multicollinearity was met, as evidenced by tolerance values greater than 0.1 and VIF values less than 10 for all predictors. The assumption of independent errors was met, as the Durbin-Watson value was close to 2. The assumption of normally distributed errors was satisfied, as assessed by a histogram and P-P plot of the residuals. The assumption of homoscedasticity was met, as assessed by a scatterplot of the

residuals against the predicted values. No significant outliers were detected, as assessed by casewise diagnostics.

The multiple regression model as a whole with four predictors, significantly predicted belief that AI could replace teachers, $F(4, 414) = 16.920$, $p < .001$, $R2 = .141$, indicating that approximately 14.1% of the variance in the dependent variable was explained by the model. According to the coefficients, belief that AI helps learn English better ($\beta = .311$, $p < .001$) significantly and positively predicted belief that AI could replace teachers, while the other predictors did not contribute significantly to the model.

The results suggest that students' belief that AI language models can help them learn English better is associated with greater belief that AI could replace human teachers. This aligns with previous research indicating that perceived usefulness strongly influences adoption intentions (Davis, 1989). So, as AI capabilities in language learning improve, students may view AI as a substitute rather than just a supplement. Tables 5, 6 and 7 summarize the regression analysis.

Table 5

Regression analysis descriptive statistics to identify factors that significantly predict ESL preservice teachers' beliefs regarding the potential replacement of human teachers by AI language models.

	Mean	Std. Deviation	N
AI language models could replace human teachers in language education.	2.23	1.071	419
What is your level of English proficiency?	2.46	.527	419
Have you ever used AI language models?	1.36	.481	419
Using AI language models in language education is a good idea.	3.84	.855	419
AI language models could help you learn English better than traditional methods.	3.02	1.076	419

Table 6

Multiple Linear Regression model summary of factors that predict ESL preservice teachers' beliefs regarding the potential replacement of human teachers by AI language models, (n=419)

				Std. Error	Change Statistics				
Model	R	R Square	Adjusted R Square	of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.375[a]	.141	.132	.998	.141	16.920	4	414	.000

Note: a. Predictors: (Constant), AI language models could help you learn English better than traditional methods., Have you ever used AI language models? What is your level of English proficiency? Using AI language models in language education is a good idea. b. Dependent Variable: AI language models could replace human teachers in language education.

Table 7

Shows standard multiple linear regression coefficients to identify factors that significantly predict ESL preservice teachers' beliefs regarding the potential replacement of human teachers by AI language models, (n=419)

	Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	.969	.373		2.598	.010					
What is your level of English proficiency?	-.136	.093	-.067	-1.460	.145	-.072	-.072	-.067	.993	1.007
Have you ever used AI language models?	.090	.104	.040	.869	.385	.031	.043	.040	.959	1.042
Using AI language models, in language education is a good idea.	.139	.063	.111	2.212	.028	.219	.108	.101	.825	1.212
AI language models could help you learn English better than traditional methods.	.309	.049	.311	6.281	.000	.355	.295	.286	.849	1.177

Note: a. Dependent Variable: AI language models could replace human teachers in language education.

Discussion

The focus of this study was to investigate ESL preservice teachers' perceptions regarding the use of AI in language education. The investigators used the responses from 419 ESL students to answer the three main questions of this study. The results of these questions addressed the relationship between ESL preservice teachers' English proficiency, prior experience with AI language models, and perceptions of AI in language education.

The first research question intends to investigate how the English proficiency levels of ESL preservice teachers influence their perceptions regarding the use of AI language models in language education. The results of the first question indicate that ESL preservice teachers with higher English proficiency levels tend to have more positive views on the use of AI language models in language education. Additionally, those with beginner level have less confidence in the ability of AI models to help improve their English skills compared to intermediate and advanced preservice teachers. This finding was demonstrated by the significant difference between groups on beliefs about AI helping learn English better than traditional methods. This finding confirms other findings of prior research suggesting that students with lower language proficiency levels may have concerns about over-reliance on technology or feel less self-efficacy with using digital tools (Makeleni et al., 2023). In contrast, more proficient preservice teachers

are likely to feel greater confidence in their capability to integrate AI effectively into instruction. These findings show that English proficiency may play a role in shaping perceptions of ESL preservice teachers regarding the use of AI in language learning and suggests that preservice teachers across proficiency levels recognize potential benefits of AI, despite some reservations (Yang, 2022). Therefore, designing training focused on AI integration strategies set apart by proficiency level may help utilize these views while also addressing beginner student concerns.

A possible interpretation of these findings is that ESL preservice teachers with higher proficiency levels may have a better grasp of the English language, allowing them more effectively utilize and understand the benefits of AI models in language education, while beginners may lack the confidence or knowledge to fully utilize these tools, leading to less positive views. Additionally, preservice teachers with higher proficiency levels might have had more exposure to different learning tools and methodologies, including AI language models and this understanding could contribute to their positive perceptions. Further, although this study did not collect information about students' preferred learning style, it is possible that advanced learners might prefer self-directed and technology-aided learning methods, which AI models can support, while beginners might benefit more from traditional, teacher-led methods. Finally, it is possible that higher proficiency learners might have experienced the benefits of personalized, immediate feedback that many AI models provide, leading them to rate these tools as more effective. These interpretations could be explored in future research deploying learning theory models such as either the Knowledge-Attitude-Behavior (KAB) model or Theory of Planned Behavior (TPB).

The second research question aims to explore how prior experience with AI language models influences preservice ESL teachers' perceptions of the value of AI in language education. The results of the second question indicate that preservice teachers with prior experience using AI language models exhibited more positive views regarding the general idea of incorporating AI in language education and their prior experience with AI language models influences their attitudes toward the AI value in language education. Additionally, there were no significant differences between groups for perceptions of AI helping learn English better than traditional methods or that AI replacing human teachers. These findings were demonstrated by the significant difference between groups for views on AI models as a good idea for language education, where those with experience had more positive views. These findings confirm findings from prior research suggesting that the use of AI in language education positively affected advanced students’ language confidence, and boosted their interest in language learning more than beginner students (Pokrivcakova, 2019).

A possible interpretation of these findings is that preservice teachers with prior experience using AI language models may have a better understanding of the potential benefits and practical applications of these tools in language education. This understanding could contribute to their positive views on the general idea of incorporating AI in language education. Additionally, the lack of significant differences between groups for perceptions of AI helping learn English better than traditional methods or AI replacing human teachers could suggest that while preservice teachers see the value in AI, they may also recognize the importance of human interaction and traditional teaching methods in language education. Finally, AI models may be particularly effective for students who already have a certain level of proficiency in the language due to the personalized and immediate feedback that AI models can provide.

The final research question attempted to identify factors that predict ESL preservice teachers' beliefs regarding the replacement of human teachers by AI language models. The

results of the final question indicated that positive perceptions about the efficacy of AI language models in learning English emerged as a significant predictor for the belief in AI replacing human teachers. Surprisingly, factors like English proficiency and prior experience with AI did not significantly contribute to predicting this perception. The findings suggest that having used AI models and viewing them favorably for language education increase belief in their capability of replacing human instructors. However, the more preservice teachers believe AI can enhance English skills relative to traditional methods, the less they tend to think AI could substitute for human teaching. Hands-on experience and overall value judgments shape views on AI replacing teachers but recognizing limitations in AI's teaching capabilities lowers belief they can fully replicate human instruction. These findings were demonstrated by the significance of the proposed regression model in predicting the ESL preservice teachers' belief that AI could replace teachers and that AI helps learn English better is significantly and positively predicted their beliefs. No other predictors contribute significantly to the model.

A possible interpretation of this result is that the perceived effectiveness of these tools plays a crucial role in shaping their beliefs and teachers who have seen the benefits of AI models in language learning may be more likely to believe in their potential to replace human teachers. Additionally, the lack of significant contribution from factors like English proficiency and prior experience with AI to predicting this perception could suggest that these factors are less influential in shaping ESL preservice teachers' beliefs about AI's potential to replace human teachers due to a variety of reasons, such as the perceived limitations of AI models or the value placed on human interaction in teaching. Another possible interpretation of this result is that ESL preservice teachers make a clear distinction between enhancement instruction and replacement of teachers. Further, while ESL preservice teachers see AI models as valuable tools for enhancing language learning, they may not view AI models as capable of fully replicating the human element of teaching.

Finally, the results of this study emphasize that preservice teacher perceptions of AI in language learning are multifaceted and shaped by interrelated factors such as English proficiency, hands-on experience, and beliefs about AI utility influence opinions, but not always in a straight line. This highlights the importance of utilizing individualized strategies for integrating AI technologies into teacher training and professional development.

Limitations and Future Directions

Despite different findings presented in this study, the investigators recognize several limitations. One of these limitations is the lack of qualitative data to discover the reasoning behind ESL preservice teachers' perceptions. Therefore, future mixed-methods research could build on these findings regarding ESL preservice teachers' own views on AI in language learning through follow-up interviews or focus groups that could help elaborate on survey findings. Additionally, the sampling method of this study focused exclusively on preservice teachers in one university. Therefore, expanding the participation pool to several universities and other populations could strengthen our study findings generalizability. Therefore, we recommend future research that may explore these findings with diverse participant groups and a broader range of AI technologies. Future research can advance our understanding of these findings by predicting the extent to which knowledge gains in instructional strategies among ESL preservice teachers influences attitudes, and consequently, shapes behaviors regarding ethical applications of AI in ESL instruction. Important in future investigations is understanding the strength in the association of the subjects' attitude and resulting behavior in all ESL AI instructional activities.

Implications

Despite the above-mentioned limitations, this study showed the importance of considering different factors before AI integration in language education such as students' language proficiency, prior experience with AI, and their beliefs about the effectiveness of using AI in learning. As we are adjusting to AI integration in instruction, addressing these factors is crucial for successful AI implementation. Therefore, it is important to tailor AI interventions based on students' English proficiency levels, their beliefs about AI effectiveness, and their prior experience of AI in learning. Furthermore, it was clear that most of the ESL students do not believe that AI would replace human teachers because human pedagogy is irreplaceable in preparing future educators for language teaching.

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Using Instructional Models in Synchronous Online Mathematics Lessons: Reflections of Pre-service Teachers

Julie Mills, Texas A&M Commerce

Abstract

In this qualitative study, pre-service teachers (PSTs) reflected on their use of specific models of instruction when teaching synchronous online mathematics lessons. PSTs found the models of instruction helpful when planning and facilitating student-centered discovery lessons. Some participants found the online format of teaching a challenge, but overall PSTs confidence improved in developing and teaching online lessons. The models of instruction served as a scaffold for PSTs when designing and delivering mathematics lessons in a synchronous online setting.

Key Words: Pre-service Teachers, Synchronous, Math Lessons

Pre-service teachers (PSTs) write and deliver various lessons during their undergraduate course work and student teaching, but do not always have experience with different models of instruction. As a mathematics methods instructor, I wanted PSTs to be exposed to a variety of student-centered instructional models, so they did not rely solely on direct instruction. Due to the COVID-19 pandemic, teachers quickly pivoted to delivering online instruction despite being unprepared (Hodges et al., 2020). To prepare PSTs to teach in an online format, PSTs were required to create and deliver a synchronous online mathematics lesson using a specific model of instruction. Therefore, this study focuses on the beliefs held by and reflections of PSTs after they taught a synchronous online mathematics lesson using an assigned model of instruction. This study was guided by the following research questions:

1. According to pre-service teachers, what are the benefits of using specific instructional models when planning for and teaching synchronous online mathematics lessons?
2. According to pre-service teachers, what are the challenges faced when using specific instructional models for mathematics lessons taught synchronously online?
3. How prepared do pre-service teachers feel they are to teach synchronously online?

Theoretical Framework

The National Council of Teachers of Mathematics (NCTM, 2000) promotes constructivist principles through conceptual understanding, use of manipulatives, and integrating real-world scenarios in mathematics instruction. As a constructivist, Bruner (1960) emphasized that learners should be motivated by integrating their own interests and by promoting curiosity in lessons. Bruner's approach to learning encourages students to develop mathematical understanding through exploration and experience or by "discovery." His "discovery approach" offers a vastly different approach to traditional teacher centered models like lectures.

Regardless if a lesson is taught face-to-face or online, mathematics is best learned by discovering concepts, collaborating with peers, and connecting to the real-world. In this study, student-centered models of instruction are used to promote a constructivist approach to teaching mathematics in an online setting. Instructional models are defined as, "a step-by-step procedure that leads to specific learning outcomes (Estes et al., 2016)." Due to the student-centered nature

of the models of instruction used and the promotion of discovery learning, constructivism serves as the theoretical lens for this study.

Literature Review

Teachers transitioned quickly to online teaching due to the COVID-19 pandemic in the Spring of 2020. During this pivot, many K-12 teachers felt unprepared to teach in an online setting (Eadens et al., 2022; Hathaway et al., 2023). Even among those that felt prepared, only a few felt very prepared to teach remotely (Hathaway et al., 2023). Eadens and colleagues (2022) found more experienced classroom teachers felt less prepared to teach in online settings, and that elementary teachers felt less prepared for the pivot than middle school teachers. However, teachers who had recently completed a graduate degree that involved taking online courses, seemed to be more confident in teaching online (Hathaway et al., 2023).

When switching to online remote instruction, teachers reported using a variety of technology tools including various learning management systems, video conferencing tools, multiple apps, and electronic devices (Dixon et al., 2022; Hathaway et al., 2023). According to Dixon and colleagues (2022), elementary teachers relied more on technology tools used in an asynchronous environment due to student computer access and time constraints. While participants seemed familiar with many different tools, some teachers reported school districts providing professional development on technology tool use rather than providing online pedagogical support (Hathaway et al., 2023).

Like classroom teachers, Kim (2020) found many PSTs were not ready for the quick shift to online instruction. While many universities offer online coursework, at the time, Grazianos and Bryan-Bongey (2018) found very few had an entire course dedicated to preparing teachers to teach online. However, almost half of programs represented allowed PSTs to lead online discussions and/or required PSTs to create online content during coursework (Grazianos & Bryan-Bongey, 2018). Researchers agree that PSTs should have more opportunities to integrate technology and teaching in a variety of delivery methods including online and blended (Dixon et al., 2022; Hathaway et al., 2023). In addition, educator preparation programs (EPPs) should include curriculum emphasizing best teaching practices and online pedagogy (Dixon et al., 2022; Eadens et al., 2022).

Very few articles highlighted the implementation of instructional models when teaching in an online format. However, Sengul (2021) and Ohn-Sabatello (2020) both described the use of the 4E/5E instructional model when school districts pivoted to remote instruction in 2020. A structured model like 5E can provide a much-needed routine for remote learners (Ohn-Sabatello, 2020) and promotes student-centered instruction in virtual environments just like face-to-face instruction (Ohn-Sabatello, 2020; Sengul, 2021). The research focused on instructional models in online settings is limited, and therefore the study described in this paper helps contribute to the existing literature by examining the implementation of instructional models in synchronous online mathematics lessons created and delivered by PSTs.

Methods

This study began as a classroom assignment meant to encourage PSTs to use student-centered instructional models when teaching mathematics in an online format. In this qualitative study, the researcher investigated the benefits and challenges of pre-service teachers' use of models of instructions. Specifically, the researcher examined how pre-service teachers perceived their implementation of those models when teaching in a synchronous online format.

This study was conducted at a small liberal arts college in a southern state. Participants were enrolled in an undergraduate senior level elementary/middle level mathematics methods course typically taken the semester prior to clinical teaching. Prior to their methods semester, PSTs had the most experience with the direct instruction or gradual release model of instruction but had also been introduced to inquiry-based models. The 41 participants were enrolled in a mathematics methods course that was taught in a hybrid format. Of the participants, about 88% identified as women (n=36) and 12% identified as men (n=5). Approximately 75% of the participants (n=31) were seeking elementary certification and the rest were seeking middle level certification (n=10).

PSTs completed a reflection survey after writing and teaching a K-8 mathematics lesson to their peers in a synchronous online format. The participants worked in small collaborative groups to develop a lesson using their assigned model of instruction. Groups were assigned one of the following instructional models: concept attainment, concept development, integrative, problem-based learning, inquiry (Estes et al., 2016), and BSCS 5E (Bybee et al., 2006). Groups had class time to develop their lessons and opportunities for conferencing with the course instructor. While participants were familiar with some of the instructional models, they were unfamiliar with most. Participants were provided overviews of each model including all the steps of the instructional model, and during conferencing with the professor they were able to learn more details about the model of instruction. Groups taught their 20 minute lessons during their elementary/middle level mathematics course to their peers via a synchronous Zoom session. After teaching their lesson, each PST completed an online reflection questionnaire that included multiple prompts regarding their lesson. These prompts included both open-ended and likert scale items. This study was part of a larger study that also investigated PSTs' implementation of the NCTM mathematical practices when teaching synchronously online and face-to-face (Williams Mills et al., 2023). For this analysis, only the prompts related to instructional models and confidence in teaching online were used.

The open-ended survey items were qualitatively analyzed using descriptive coding (Saldaña, 2021). The initial round of coding resulted in four themes - planning, student engagement, teacher implementation, and future use. The Likert scale data was analyzed using means for each item.

Findings

This study included both open-ended and Likert scale items from a questionnaire administered after the PSTs taught their synchronous online mathematics lessons to their peers. This section is organized by the findings from the open-ended items and then the likert scale items. The qualitative coding of the open-ended responses resulted in four themes - planning, student engagement, implementation, and future use. This section is organized by the themes, highlighting both the benefits and challenges in each theme. The final part of this findings section outlines the results from the Likert scale items regarding confidence in planning and teaching online lessons.

Planning

Participants described both benefits and challenges during the lesson planning process when using a specific model of instruction, and this theme was coded twenty-seven times. When planning, several PSTs found the instructional models templates served as a guide, helping them "break down" their lessons. One elementary education major shared, "It helped by giving a very structured step-by-step organization." Several participants emphasized the ease of using the model templates, for example, "it made setting up a lesson plan easier/more efficient in my opinion."

The models and collaborative planning process helped some participants create stronger lessons. According to one PST, the model "helped me think deeper about the activities and information I was trying to include in the lesson." Valuing the group assignment, one participant explained, "I did not realize how difficult it was to come up with questions, but sitting with a group of aspiring teachers creating a lesson was fun and I feel like it helped me learn a lot."

Most of the PSTs argued the models were useful when planning instruction, but some found integrating the models challenging, restrictive, time-consuming, and difficult to fully implement. One PST reported, "I felt more constricted. I felt like I did not have the freedom to incorporate other ideas into the lesson because I was so worried about hitting every step of the model." Another participant argued using a model "was a bit of a hindrance since it was so detailed, it required a lot more thoroughness than some lesson plan formats I have used."

Some participants emphasized the challenges of implementing a model of instruction, but ultimately praised the experience. Initially worried about using a specific model of instruction for the lesson, one PST described her feelings, "it was a little daunting to begin, but once we got started, we were able to easily make our lesson flow with this model of instruction." Similarly, another participant stated:

> This model of instruction was new to me; so in the beginning, I felt that it hindered my lesson plan writing process. I kept thinking, 'How am I going to find a standard that allows me to group items in a certain way?' I felt stuck. As I kept looking for standards, though, I began to come up with multiple ideas! Once my group decided on grouping decimals, the rest of the steps to the model seemed to fall right into place. It was very easy after I got started, and I truly enjoyed using this model of instruction!

Student Engagement

Many of the PSTs commented on how the instructional models encouraged student-centered, collaborative, and often discovery-based lessons. Student engagement was coded eleven times during data analysis. One PST mentioned, "the students ultimately did most of the work because they had to define the concept using what they learned," while another participant liked the model because, "students [were] doing the 'teaching' and learning with teachers acting as facilitators." Highlighting the student-centeredness of the models, one PST shared, "the steps in the model make it nearly impossible for the teacher to do the majority of the work."

The participants also described their lessons as "more interactive, allowing students to "be creative," and promoting students to "work together to figure out the concept." One PST focused on the discovery approach, "I liked that it allowed students to independently discover different things about the numbers we presented before actually telling the students what they should be looking for."

Implementation

The theme implementation was coded seventeen times throughout the questionnaires. Participants discussed both the successes and challenges of implementing their lessons when using specific instructional models. Successes included discovery learning and implementing valuable activities, while participants stressed time limits, online format, and misunderstanding of models as challenges.

One successful implementation of the model of instruction included, "students became empowered through their discovery of learning and that is and has always been a part of my philosophy of education." Another PST recognized the model allowed them to "fill our lesson with purposeful activities for our students."

A few participants specifically mentioned the struggles of implementation regarding the synchronous online format of the lesson. For example, "this lesson was difficult to approach through [a] remote setting because we cannot supply students with materials or fully monitor and group students at once," and "though it was done virtually, we struggled finding interactive things for them to do like Kahoot or something like that."

Time restrictions on the assignment was also identified as a challenge. Some participants complained of the twenty-minute lesson time limit, like, "it was hard to do a project-based learning for such a short time frame." Others did not fully grasp their assigned model of instruction. Unsure of their implementation, one PST explained, "I'm not sure that the lesson we planned covered every aspect of the model."

Some PSTs found the student-centered nature of the lessons more challenging and different from lessons they had prepared and taught previously. According to one participant, "For concept attainment, I struggled most with not telling the students exactly what the answer was since we had to give examples and non-examples and let students figure out what the answer was." Another participant felt their inquiry model did not have a "natural flow" and stated:

> Instead of focusing [on] making the lesson engaging, it took the majority of my focus to analyze 'is this how this is supposed to go?' The heart of the issue is this model is completely different from every other model I am used to. I do not see where this model is used enough for it to become second nature. Although, I will not discard it.

Future Use

Participants discussed how and if they planned to use the instructional models in the future and this theme was coded twenty-eight times during data analysis. Twenty-six participants identified they would probably use their assigned model of instruction in the future. One participant said they would not use their assigned model again and another participant was on the fence. When discussing their future use, participants discussed the reasons why and how they would use the models.

When sharing about future use of the models, several participants mentioned the models promoted student engagement as the primary reason they would use the instructional model again. According to one PST, "I like that the 5E model encourages active participation from students." Another participant agreed, "I do plan on using this model again because I think that students grasp a concept better when they discover the concept themselves." While most participants had some plans of using the models in the future, two expressed understanding and implementation of the models as challenges. Reflecting on the concept attainment model, one PST stated, "It can be beneficial for the students for some topics, so although it may be challenging for me, as the teacher, to create, if it helps the students, I will try to incorporate it as

much as I can." One participant had no plans of implementing the integrative model again, "the reasoning is because the instructions are not very clear compared to the other models of instruction."

A few participants described when they would implement the models again, specifically using concept attainment and concept development as "pre-assessments" or for new topics. For example, one PST shared, "I would plan on using this model again for an introduction. I think it is a good way to see common misconceptions that students might have."

Several PSTs also planned on using these models in "other content areas." After teaching with the concept attainment model, one PST said, "This particular lesson plan can be used for all subjects, not just math…I felt like once you have this model established within the classroom, students would enjoy following it and trying to define parts of their learning." Additionally, a PST praised the integrative model, "By changing the data set, it can be used across the curriculum to identify the similarities and differences of the subjects being studied. Students are able to see how things are related and what they have in common." However, not all participants agreed on the versatility of the integrative model, "I think that it is mainly usable in math whereas it would be difficult to implement this type of model in other content areas."

Likert Scale Results

Participants in this study completed several Likert scale items in order to report their confidence levels regarding remote teaching. The scales ranged from one to five with one being the least confident and five being the most confident. As shown in Table 1, participants, on average, reported higher levels of confidence after teaching a remote lesson. When asked about preparing mathematics lessons for remote learners, participants responded on average a confidence level of 3.18 prior to teaching the lesson and a 3.93 level after teaching the lesson. In regard to teaching a mathematics lesson for remote learners, participants reported an average 2.88 confidence level prior to teaching the lesson and 3.63 after teaching the lesson.

Table 1
Means and Standard Deviations of Confidence Levels on Mathematics Remote Teaching

Item	Prior to teaching	After teaching
Plan a math lesson for remote learners	3.18 (0.98)	3.93 (0.94)
Teach a lesson for remote learners	2.88 (0.99)	3.63 (1.05)

Note. Standard deviations are presented in parentheses.

Discussion

The purpose of this study was to identify the benefits and challenges of using specific instructional models when planning for and teaching synchronous online mathematics lessons. In addition, we sought out to determine how prepared PSTs felt to plan and teach mathematics lessons to remote learners. In this section, we will respond to each of the three research questions.

Participants found the instructional models were most beneficial in the planning stages of lesson development and creating student-centered constructivist lessons. For many, the steps of

the instructional models provided a scaffolded approach to lesson building. These PSTs were able to use the steps to ensure a well-rounded and engaging lesson design rather than starting from scratch. Several participants valued the structure and felt it served as a guide and pushed them to add more detail to their lesson plans.

Throughout their reflections, PSTs commented on the student-centeredness of their lessons and how the students were discovering mathematics. Participants mentioned the models required students to solve problems rather than the teacher modeling and solving for students. These instructional models helped PSTs ensure they were creating and leading constructivist lessons that allowed for a "discovery" approach to learning mathematics.

When discussing the benefits, PSTs did not specifically mention how it helped them in teaching synchronous online lessons, but instead just focused on the benefits for them and their students. Perhaps, the model served enough as a scaffolding tool to build confidence and understanding that student-centered mathematics instruction is appropriate no matter the delivery method.

The challenges faced by PSTs most often happened during the delivery of the online synchronous mathematics lesson. These challenges included online format, time restrictions, and inauthenticity. While the mention of the online format was obsolete when talking about successes of using the instructional models, several participants highlighted the challenges of teaching a synchronous remote lesson. The struggles of being unable to provide classroom supplies to remote students, monitoring online groups, and keeping students engaged in a remote setting reflected a limited technological pedagogical content knowledge (TPACK) (Schmidt et al., 2009) of the participants because they did not utilize or understand best practices when teaching mathematics in an online format. Some participants also stressed the difficulty of teaching K-8 lessons to their college peers rather than to actual elementary and middle grades students, reflecting that authentic experiences in a K-12 setting were necessary.

Finally, we sought to determine how prepared these PSTs felt to teach synchronous online mathematics lessons. The PSTs did gain confidence in preparing and teaching synchronous online lessons after teaching the mathematics lessons to peers, but still scored themselves on average less than a four on a five-point scale. Perhaps with more practice, participants would continue to grow in their confidence in teaching online mathematics lessons.

Conclusions & Implications

Due to the qualitative nature of this study, generalizations cannot and were not intended to be made. However, some teacher educators, university faculty, and educator preparation program (EPP) coordinators may find the results from this study helpful or "transferable" (Lincoln & Guba, 1985)) when preparing PSTs to teach mathematics in a K-12 setting. Based on the findings from this study, we found three major implications for these stakeholders.

The use of specific instructional models helps PSTs plan student-centered constructivist mathematics lessons. PSTs found the structure of these models helpful in planning discovery-based lessons. By requiring specific models, it can provide a scaffold for students that struggle to create engaging lessons that allow students to do mathematics. The use of models beyond 5E and direct instruction provides PSTs with a better understanding of strong lesson design and allows them to make generalizations about effective models of instruction and how to successfully implement them. These models also transfer to synchronous online settings, preparing PSTs for classroom experiences beyond the traditional classroom.

PSTs need more opportunities to write and deliver lessons using various instructional models and should have opportunities to do so in authentic settings. While participants in this study did feel more confident in teaching online lessons after teaching one lesson, more opportunities would probably continue to increase their confidence. PSTs should have the opportunity to teach specific models in a synchronous online field setting to K-8 students and not just within their EPP coursework. In addition, the time restriction of these lessons made it challenging to implement some of the models like 5E and problem-based inquiry. These models often take more than one day of instruction to complete all the steps of the model (Sengul, 2021) and as these models are frequently used in K-12 mathematics classrooms, PSTs should create lessons that reflect more authentic implementation.

EPPs and teacher educators should implement curricula that enhance technological pedagogical content knowledge (TPACK) (Schmidt et al., 2009). When reflecting, PSTs rarely commented on the online format. This could be because implementing the model seemed more of a challenge then delivering synchronous online instruction. While most participants did not complain about teaching online, they could benefit from more instruction on best practices when teaching online and have additional opportunities to plan and deliver synchronous online lessons to K-12 students (Dixon et al., 2022; Eadens, et al., 2022; Kim, 2020) and in blended formats (Hathaway et al., 2023). With the need to adapt to student learner needs, PSTs should be prepared to teach using various instructional delivery methods (e.g., face-to-face, blended, synchronous online) and have opportunities to do so during field experience.

The participants in this study demonstrated some pedagogical, content, and technological knowledge, but sometimes struggled with specific mathematical pedagogical technological knowledge. For example, some participants still used manipulatives (sometimes digital) and break out rooms for small group discussions but did not always understand best practices to formatively assess students in the online setting. As pointed out by Kim (2020), using hands-on activities can be a challenge when teaching synchronously online. While some instructional models and pedagogy cross over between delivery formats, preservice teachers still need experience creating student-centered lessons that augment the instructional delivery methods used.

While teachers and PSTs need additional instruction, guidance, and experience in teaching in a variety of delivery methods, the use of instructional models can serve as a scaffolding tool to help teachers transfer best practices to different delivery methods. The use of instructional models in various settings (e.g. face-to-face, online, blended) can help promote student-centered instruction while allowing PSTs and teachers the opportunity to explore the most appropriate tools to use for that particular model and delivery method.

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The Outcomes of Elementary Digital Citizenship Curriculum: A Systematic Literature Review

Kristy Bentley, University of Central Arkansas
Jason Trumble, University of Central Arkansas

Abstract

As technology becomes increasingly prevalent in the lives of young students, educators have worked to establish ways to be proactive in how digital safety and ethics are taught. Digital citizenship is an ill-defined term, yet we find implementation of digital citizenship curricula being implemented in schools. While much research has been done about the perceptions of teachers and parents about what is essential to know about digital citizenship, and many articles have been written about the best practices for teaching digital citizenship, less is known about how these elements and practices measure outcomes or impact student behaviors, especially in an elementary setting. This systematic literature review examines empirical articles written about digital citizenship and elementary students to discover what has been learned about how these curriculums measure outcomes and impact the behavior of elementary students.

Keywords: digital citizenship, digital citizenship curriculum

Introduction

Technology plays a significant role in students' lives. Young learners are entering a world where digital devices are ubiquitous and connectivity to the internet through devices and applications is the norm. In order for students to thrive in this digital age, they must develop skills and competencies that increase their awareness and ability to navigate digital and physical spaces (Hava & Gelibolu, 2018). As digital citizenship education continues to evolve, teachers are at the forefront, requiring a solid understanding of digital citizenship to guide students in responsible and ethical technology use. In 2019, an Arkansas task force was established to enhance computer science education, including implementing digital citizenship standards in elementary grades. Digital citizenship, often embedded in classroom character education, extends beyond good character to include safe, ethical, and discerning technology use. Young people must understand how to use digital tools appropriately and be empowered to participate in online communities. Although various digital citizenship curriculums exist in online and physical spaces, there is no consistency in language, focus, or learning outcomes across curriculums. The importance of teaching digital citizenship, including increasing students' abilities to safely engage in digital spaces, navigate the complexities of online life, and be active participants in these contexts, cannot be overstated. Educators must build a strong understanding of digital citizenship to effectively guide students in using technology responsibly and ethically (Ribble, 2017).

Theoretical Framework

Digital Citizenship Definitions

Defining digital citizenship can seem like shooting an arrow at a moving target. The current definitions all include some participatory elements and personal digital protections, but the structure and expectations of being a digital citizen are wide-ranging. The term "digital citizenship" consolidates a variety of attitudes, behaviors, and issues that can create opportunity and vulnerability. Many early definitions of digital citizenship focused on using digital tools to

participate in society (Bennett et al., 2019; Hermes, 2006; Mossberger, 2008; Ribble et al., 2004; Richards, 2010). Digital citizens should go online to be more informed about government and politics and to use the online platform to gather others for a political cause (Mossberger, 2014). Digital citizens should have the means to access and navigate online tools to help strengthen a digital economy (Missingham, 2009). Digital citizenship involves using technology to enhance our lives in society, the community, and politics (Vizenor, 2014).

Mossberger (2009) defined digital citizenship as the expected behavior connected to technology use and contributing to online and offline political citizenship. Missingham (2009) connected digital citizenship to politics by defining it as necessary for democracy today. Bennet, Wells, and Rank (2009) also described digital citizenship as being connected to the political world and preparing for both the good and bad aspects of the digital world and a digital society. Ohler (2011) suggested teaching digital citizenship with character education. He argued that students do not live two lives, one digital and one unplugged, but one life. As teachers, we should prepare our students to be good members of every community we are a part of, whether online or off. Aydin believed that digital citizenship was being aware of the dangers of the digital world (Kansu & Oksuz, 2019).

Although there are many definitions of digital citizenship, the most recognized and referenced is Ribble's from the website digitalcitizenship.net. He defined digital citizenship as "a concept which helps teachers, technology leaders, and parents to understand what students/children/technology users should know to use technology appropriately" (Ribble, 2023, para.1). The website's definition was later to include: "Digital citizenship is the continuously developing norms of appropriate, responsible, and empowered technology use" (Ribble, 2023 para. 1).

The digital world creates tremendous opportunities for learning and socialization for young learners, but it can also have a negative impact on health and safety that could last for a lifetime (Stoilova et al., 202; Abi-Jaoude et al., 2020; Biernesser et al., 2020). Individuals must be empowered to engage with the digital world legally, safely, ethically, and effectively (Hollandsworth et al., 2011). The definition of digital citizenship determines what topics are covered in a curriculum because the definition drives the focus of what digital citizenship should entail. ISTE and Common Sense Education both share widely referenced digital citizenship resources. According to ISTE, digital citizenship consists of things you should do, including improving your community by voicing opinions about public polity, showing tolerance online, and looking at online sources critically. ISTE encourages digital users to see positivity, possibilities, and opportunities in the use of technology (ISTE, 2022). In a video on its website, Common Sense Education describes digital citizenship as thinking, acting, being online using a critical eye, and being safe and responsible in the digital world (Common Sense Education, 2021).

Digital Citizenship Standards and Elements

Ribble's Nine Elements of Digital Citizenship

The Nine Elements of Digital Citizenship were first introduced by Ribble & Bailey in the early 2000s. They gained prominence in 2015 with Ribble's book Digital Citizenship in Schools: Nine Elements All Students Should Know (Ribble, 2020). Ribble's (2017) Nine Elements of Digital Citizenship are currently defined on the website digitalcitizenship.net, where he suggests nine digital citizenship elements or themes. These elements establish a working knowledge of digital citizenship and a framework for curriculum and assessment scales. These

nine elements are vital in deciding what outcomes are essential for digital citizenship. Building on the S3 framework (Ribble, 2017), which uses safety, savvy, and social as the backbone of the nine elements, the nine elements are digital access, digital commerce, digital communication and collaboration, digital etiquette, digital fluency, digital health and welfare, digital law, digital rights and responsibility, and digital security and privacy.

Digital access is being mindful that everyone may need access to the internet at home. Digital commerce is buying, selling, and banking online. Digital communication and collaboration are how information is shared online. Digital etiquette is using digital tools with the feelings of others in mind. Digital fluency is how well someone understands the digital world. Digital fluency includes understanding how media literacy works and distinguishing real vs fake news. Digital health and welfare refers to the time spent online and having a balanced life online and offline. Digital law encompasses using digital tools and resources morally and ethically. Lastly, digital security and privacy cover how to keep devices free from harmful viruses and how to prevent online attacks (Ribble, 2017). The themes covered in these nine elements can be seen throughout many digital citizenship frameworks and curriculums.

ISTE Standards

Originally known as the National Education Technology Standards, the International Society for Technology in Education (ISTE) created multiple standards to support technology education. These standards include frameworks for students, teachers, and educational leaders to successfully learn, teach, lead, and prepare for the digital age. The standards have research-based lesson ideas, suggestions for professional development, and a blueprint for curriculum creation (ISTE, 2022). The NETS standards were developed in 1998, and while there are no national standards, the ISTE standards are still the most accepted and widely used list of standards for technology education (Cooper, 2015). Because of the evolving nature of technological innovation, the ISTE standards are revised every five to ten years to ensure they represent the changes in modern technology and instructional trends. (ISTE, 2022).

The ISTE standards for students are seven standards designed to include many aspects of using technology. Each standard is broken down into indicators that describe behaviors and actions that demonstrate meeting the expectations of the standard. Here, we examine the standard focused on Digital Citizenship. The ISTE Standards for Students, Digital Citizenship indicators concentrate on opportunities, responsibilities, and the safety and legality issues of working in a digital world. This standard highlights digital identity and digital footprints, how to interact safely and positively online, intellectual property, and managing personal data (ISTE, 2016). These standards align with Ribble's (2017) nine elements of digital citizenship but allow for broad contextualization in various educational contexts.

AASL Standards Framework for Learners

The American Association of School Librarians (AASL), a division of the American Library Association (ALA), has created a crosswalk to link its standards and frameworks to the ISTE standards (AASL, 2021). The AASL standards are the basis for many state library standards (Mackley & Barnett, 2021). Because the AASL Standards are closely tied to the ISTE Standards, digital citizenship standards are blended throughout many state library media standards (Abercrombie, 2016). The AASL standards use six foundations: inquire, include, collaborate, curate, explore, and guide school library curricula. Each foundation includes thinking, creating, sharing, and growing domains to provide further guidance (AASL, 2022).

Evolve Framework

This digital citizenship framework developed by Lindsey and Mattson (2021) focuses on digital citizenship, digital age literacy, and learner agency designed to cultivate the skills and habits needed to be successful in the digital age. Lindsey and Mattson (2017), referred to on their website as the DigCit Doctors, provide training for families and organizations and a curricular framework for PK-12 (Edvolve, 2021). The framework, divided into digital safety, media and information literacy, digital well-being, and social responsibility, details grade-level indicators of success, sampling questions, supporting technology skills, and content alignment with ISTE standards. The digital citizenship element of the framework explores how to be a good citizen of a digital society through digital safety, privacy protection, identifying fake online news and sharing accurate information, digital footprints, and positively using a voice to enhance the digital community (Lindsey & Mattson, 2021). Digital citizenship is using digital tools to improve life and interact with a digital community while conscious of the benefits and pitfalls of the digital world.

Digital Citizenship Curriculums

Common Sense Digital Citizenship Curriculum

The Common Sense Digital Citizenship Curriculum is the most commonly referenced in the literature. Launched in 2010 in collaboration with Project Zero, a research group from the Harvard Graduate School of Education, the curriculum is based on academic research and the input of students, teachers, and parents. It is designed to train students how to use technology responsibly. It uses the research about digital life for K-12 students to form the framework for the curriculum (James et al., 2021). Common Sense offers curriculums at each grade level that focus on the needs and behaviors of specific age groups according to research through surveys and interviews. The curriculum covers media balance, online security, digital footprints, cyberbullying, and media literacy (James et al., 2021). Common Sense promotes its materials as a free and comprehensive curriculum that provides lesson ideas, online games, videos, resources, and ways to engage parents. It is designed to create core dispositions and good digital habits while teaching lessons based on young people's issues in a digital environment (James et al., 2021).

ISTE Seal of Alignment Curricula

ISTE reviews student curricula and other digital resources to ensure they align with the skills promoted within the ISTE standards framework. Partnered with the Internet Keep Safe Coalition or iKeepSafe, ConnectSafely, and the Family Online Safety Institute, ISTE recommends programs or websites that align with their standards. While many of these resources only cover digital literacy and technology use, a few specifically include digital citizenship skills (ISTE, 2022). Google provides a free online digital citizenship curriculum that has earned a Seal of Alignment from ISTE (ISTE, 2022).

Google's Be Internet Awesome

Google's Be Internet Awesome curriculum provides lesson plans, premade interactive slides and flashcards, online games, and other resources that cover five fundamental digital citizenship and safety topics. Be Internet Smart: Share with Care provides guidelines about communicating online by explaining what is appropriate and safe. Be Internet Alert: Don't Fall

for Fake promotes being aware that online peers and situations may be fake or unsafe. Be Internet Strong: Secure Your Secrets encourages protecting your privacy online. Be Internet Kind: It's Cool to Be Kind advocates positivity with personal online interactions. Be Internet Brake: When in Doubt, Talk It Out encourages students to seek help from a trusted adult when something online is questionable or upsetting (Google, nd). Learning.com provides a digital literacy curriculum that includes online safety and digital citizenship. One of their EasyTech digital literacy content areas covers online safety and digital citizenship. Learning.com is not a free online course (Learning.com, 2021).

ISAFE Digital Learning Curriculum

ISAFE Enterprises is a company that provides schools with student data safety, cybersecurity, and compliance. ISAFE also has curriculums for both schools and commercial organizations. The digital curriculum has eight themes: citizenship, privacy, identity management, security, safety, ethics, media and information literacy, and technology (ISAFE Enterprises, 2022-2023).

DigCitCommit

While not a framework or curriculum, DigCitCommit examines five digital citizenship competencies: inclusive, informed, engaged, balanced, and alert about issues dealing with the digital world. DigCitCommit, partnered with a coalition of organizations that include Common Sense Education, ISTE, Google for Education, Digital Citizenship Institute, EdTech Team, Los Angeles Unified School District, and Microsoft Education, provides educators with a library of resources, courses, and digital citizenship curricula. This clearinghouse of resources makes it easy for an educator to see what is available and to find needed information and resources to teach digital citizenship to students (DigCitCommit, n.d.).

Digital citizenship is using digital tools and interacting with a digital community while conscious of the benefits and pitfalls of the digital world. The definitions and frameworks of digital citizenship help to decide the expected outcomes of a digital citizenship curriculum in the classroom. Young children are gaining access to a digital environment, so digital citizenship must be taught as early as Kindergarten (Lauricell et al., 2020). The standards and curriculum used to teach digital citizenship across the country are inconsistent, so it is vital to keep our young students, who are global digital citizens already, safe in the digital world.

The Purpose of the Study

Digital citizenship constructs are increasingly becoming part of curricular conversations for K12 teachers, teacher educators, and parents. Literature exists that promotes digital citizenship curriculum, how digital citizenship should be taught, when it should be learned, and who should teach it. As discussed above there is a wide range of digital citizenship curricula and resources available for teachers. However, more research needs to be conducted about the outcomes of digital citizenship training, especially in an elementary school setting. This systematic literature review examines the empirical studies that focus on measuring digital citizenship outcomes and the impact of teaching digital citizenship on student behavior. Our study aims to explore the available research that addresses student outcomes and suggestions for measuring the effectiveness of these curriculums. Additionally, we hope to find gaps in the research about digital citizenship in elementary education and suggest future study areas. The following research questions guide this study.

Research Questions

1. How are digital citizenship outcomes measured in elementary students?
2. Do digital citizenship curriculums impact elementary students' behaviors?

Methods

The Education Resources Information Center Database (ERIC) was chosen as the search database for the literature review because it is dedicated to education research and is sponsored by the United States Department of Education's Institute of Education Sciences (ERIC, nd). Using the detailed database view, Education Full Text H.W. Wilson, Education Research Complete, and Education Source were also used to provide a complete list of empirical studies related to the research questions. The search terms used in ERIC were "digital citizen*" AND "elementary." Using the Boolean operator AND limited the results to studies related to elementary education. Results were also limited to scholarly or peer-reviewed journals available in English and published after 2010. In 2010, the Common Sense Education Curriculum was launched. Additionally this time frame includes when Ribble (2010) first defined digital citizenship, so studies conducted after 2010 could include both a comprehensive curriculum and a specific definition of digital citizenship.

The search, using the search terms and parameters, yielded 43 full text, peer reviewed results. The abstracts were scanned to discover initial relevance, and then a brief scan was conducted to establish the type of article. Of the 43 results, 4 were literature reviews, and 20 were empirical studies. The 19 remaining results included ideas for best practices, curriculum and standard overviews, and a policy statement. Focusing on the empirical studies, the articles were closely examined to establish relevance based on the research questions. Only one article related to both research questions, so the articles were reevaluated to include a wider range of grade levels and articles that related in some way to the research questions. Using the extended range, four articles were related to the research questions.

Results

Each scholarly article that successfully met the initial search criteria was closely examined to explore the participants involved in the study, what research methods were employed, and the findings derived from the research. After a comprehensive review and analysis of the results, specific similarities emerged consistently throughout the body of research, serving as a guiding blueprint for further analysis. With these similarities in mind, each empirical study was further examined to identify varying definitions of digital citizenship, which has evolved significantly in recent years. Next, the specific frameworks of digital citizenship that steered each study were identified to provide insight into the theoretical structures of the research. Along with these elements, the articles were also analyzed to determine the specific digital citizenship curriculum employed and the scales used for the study. This allowed for a deeper understanding of the research tools, providing a more comprehensive view of the study's methodologies. A summary of the initial findings is presented in Table 1.

Table 1

Analysis of Empirical Studies Relating to the Outcomes of Digital Citizenship Curricula

Citation	Participants	Method	Findings	DC Definitions	DC Framework	DC Curriculum	DC Scales
Coklar & Tatli (2020)	550 teachers	Mixed	A significant relationship was found between information literacy and computer internet literacy	Mossberger, 2009 Ribble, 2008 and 2011	ISTE		Digital Citizenship Scale (Isman and Gungoren 2014)
Kansu & Öksüz (2019)	76 preservice teachers	Mixed	Pre-service teachers presented primarily high digital citizenship scores	Missingham, 2009 Bennet, Wells, & Rank, 2009 Aydin, 2015	ISTE		The Digital Citizenship Scale (Kocadağ, 2012)
Ciftci & Aladag (2017)	461 pre-service primary school teachers	Mixed	When a pre-service teacher had high score on digital attitude scale, they scored higher on the digital citizenship scale	Vizenor, 2014 ISTE, 2007 Ribble & Bailey (2007) Mossberter, et al. (2007)			Digital Citizenship Scale (Isman and Gungoren, 2014)
Martin et al. (2019)	K-12 educators pursuing a graduate degree	Mixed	Educators believe that students are aware of some digital citizenship topics, but that a specific digital citizenship curriculum should be taught starting early	ISTE (2019) Ribble & Bailey (2011) Ohler (2011)	ISTE Ribble's 9 Elements	21st Century Competen-cies Common Sense Media iSafe Project Internet Safety Task force	
Hollands-worth et al. (2017)	500 media specialists	Mixed	Most educators are aware of digital citizenship,		Ribble	Common Sense Media GoodPlay Project/	

Citation	Participants	Method	Findings	DC Definitions	DC Framework	DC Curriculum	DC Scales
			less than half had digital citizenship skills as part of state standards			New Media Literacies	
Martin et al. (2021)	113 parents	Mixed	Parents answered that they were aware of what apps their children used online, 40% of parents limited screen time, and almost all of the parents were concerned about online safety		Ribble's 9 Elements	Researchers used a Likert scale based on Ribble's 9 Elements	
Yorulmaz & Can (2016)	126 K-12 school directors	Quant	Competency is high & does not vary in gender or years		ISTE		
McNaug-ton et al. (2021)	9-12 year-old students	Quant	Self regulation and social skills decreased across the age range				Big 5 personality inventory
Chou & Chiu (2020)	442 elementary students	Mixed	Digital Fluency Scale proved to be reliable and valid. Students scored highest in digital citizenship and lowest in research.	ISTE	ISTE		

Citation	Participants	Method	Findings	DC Definitions	DC Framework	DC Curriculum	DC Scales
Lauricella et al. (2020)	K-12 teachers	Mixed	Less than a quarter of K-5 teachers surveyed teach media balance and well-being but teach a lot about privacy, safety, and cyberbullying	Ribble (2017) Mattson (2017)	Ribble's 9 Elements ALA (2007 outdated) ISTE Krueger's 9 key resources	Common Sense Education BrainPop Everfi Be Internet Awesome by Google I keep Safe Netsmartz Media Smarts	Listed scale measures what skills are taught, not the outcomes
Başarmak et al. (2019)	Secondary curricula	Qual	Computer Science and Democracy and Human Rights classes reference digital citizenship have the most. Few others do.	Ribble (2017) Ribble & Bailey (2005)			Digital Citizenship Scale for the Young" developed by Kuş, Güneş, Başarmak and Yakar (2017)
Styron et al. (2016)	120 Teacher and principal prep students	Mixed	The survey indicated that students did not feel prepared to manage cyberbullying occurrences.	Ohler (2011)	ISTE		
Phillips & Lee (2019)	134 school librarians	Mixed	School librarians are heavily responsible to teaching digital citizenship, but believe it should be a collaboration with classroom teachers.	Ribble (2017)	Ribble	Common Sense Education	
Oudewee-tering & Voogt (2018)	Primary and secondary teachers	Mixed	Teachers believe that they have a social		P 21-21st century compent-cies		

Citation	Participants	Method	Findings	DC Definitions	DC Framework	DC Curriculum	DC Scales
			responsibility to teach digital citizenship concepts.				
Misirili & Akbulut (2013)	8th-grade students	Quant	Scale was found to be a reliable indicator or technology literacy	PRI	NETS		Study developed the Technology Standards for Students scale
Zhong (2017)	254 public school teachers	Quant	Principals' digital leadership supports CCSS but they still need to improve technology PD	ISTE	ISTE		
Chou et al. (2012)	9th grade iPad pilot class	Qual	Students were more engaged with Ipads, but teachers needed more time and collaboration to more effectively use the Ipads				
Hollands-worth et al. (2011)	500 library media specialists	Mixed	While subjects like plagiarism and copyright are taught, they are not included in state standards. Many teachers are unaware of the need to teach digital citizenship skills.	Ribble (2010)			

Citation	Participants	Method	Findings	DC Definitions	DC Framework	DC Curriculum	DC Scales
Alkhayat et al. (2020)	288 female early childhood preservice teachers	Qual	Preservice teachers surveyed intended to use Web 2.0 technologies in future classroom instruction.	ISTE	ISTE		
Metcalf & La France (2013)	134 principals from a large metro school	Quant	Principals felt they were most prepared for digital citizenship and least for visionary leadership.	ISTE NETS-A			

Summary of Findings

The articles in the initial search discussed the basics of digital citizenship, including how it is defined, where it fits in the overall curriculum, and who should be teaching it. However, this systematic literature review revealed few empirical studies focused on the impact of teaching a digital citizenship curriculum and even less on teaching elementary students about digital citizenship. It is agreed that digital citizenship education should begin in early childhood, but more is needed about its impact on these students.

McNaughton et al. (2022) investigated students aged 9-12 in low socioeconomic and multicultural schools in Pacific Island communities in New Zealand. The study analyzed a program where all students could use their devices for schoolwork. The devices were provided to each student by a charitable trust. Students were taught curriculum topics designed to develop digital skills such as gathering resources, using those resources to form an informed opinion, and sharing that information with others. The participating schools all had a school-wide commitment to digital citizenship and were taught to be cyber-smart through a set of mutually agreed-upon standards and practices.

McNaughton et al. (2022) measured how digital citizenship lessons contributed to students' ability to self-regulate and use social skills in digital usage both at home and at school. Using a five-point self-rating scale, this quantitative study measured skills like self-regulation, focus, empathy, perspective, and prosocial behavior. The results showed that self-regulation while using digital tools lowered between the ages of 11 and 12 and that students overall had less self-regulation when participating in a digital environment. Also, home digital use showed lower levels of self-regulation than school digital use. The study's findings showed that the older the student, the lower they ranked themselves able to self-regulate. This was explained by the fact that older students have developed more metacognitive skills and can think more critically about

their digital habits. This study demonstrates a definitive example of how a digital citizenship curriculum impacts student behavior in elementary-aged students.

The results revealed two studies by Hollandsworth (2010; 2016). Hollandsworth published an initial study and then revisited it to highlight changes. The first article is a 2010 qualitative study published in 2011. The study provides a baseline on the state of digital citizenship education during its infancy. By surveying and interviewing K-12 media specialists who were members of a state library media and educational technology association in the United States, researchers asked if digital citizenship skills were taught in their schools or included in the state standards. Media specialists were asked what elements of digital citizenship provide the most important outcomes for students. Of the elements of digital citizenship mentioned, most media specialists teach about plagiarism, copyright, evaluating websites, online safety, and cyberbullying, but less than half of the respondents said that these elements were mentioned in state standards. 47% of respondents said they teach these skills throughout several grades and subjects. 35% said they should have taught these skills as part of an established curriculum. Media specialists cover these skills because of their impact on digital behavior and ethics. When the survey was administered, ISTE and the American Association of School Librarians provided a list of standards, but teachers needed help finding a comprehensive curriculum.

The second article (Hollandsworth, 2016) revisits the qualitative study to provide an update on how digital citizenship is taught in K-12 schools. Respondents indicated that there was a shift from teaching about copyright and plagiarism to online safety based on the changing needs of the students. The survey also revealed that while digital citizenship seems to be taught more, there was still a need to be more of an educational focus in the curriculum. These articles provide valuable insight into the evolution of digital citizenship education, the shifts that have taken place, and how the desired outcomes of digital citizenship outcomes influence practice. The priority change will influence how digital citizenship outcomes are measured because the focus will change.

Cou and Chiu (2020) developed a scale for assessing the digital fluency levels of preadolescent students. Students aged 11-12 in an elementary school in Taiwan were used as the sample group to develop the Digital Fluency Scale. The Digital Fluency Scale measures creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem-solving, and decision-making using a 7-point Likert scale. The scale is designed to be a self-reporting tool to inform the learning of both students and teachers. Digital Fluency means how well students solve authentic problems with digital tools. This mixed methods study collected interview questions from a focus group made of teachers and students to help form the questions of the questionnaire to be used as the measurement instrument. The creation of this measurement instrument will allow both teachers and students to evaluate the behavioral impact of a digital citizenship curriculum and define the outcomes.

Discussion

The systematic literature review on digital citizenship education and its impact on students' behavior has revealed a significant need for more empirical research. Despite the various standards and goals proposed for elementary digital citizenship curricula, a noticeable gap exists in the research literature. Given the increasing importance of digital citizenship in our technologically advanced society, this gap is concerning. Understanding how digital citizenship education influences students' behavior is crucial, as this knowledge can guide the development of more effective curricula. Therefore, the need for more empirical research in this area cannot

be overstated. While informative, the current state of research is insufficient to fully comprehend the complexities of digital citizenship education and its effects on students' behavior.

Ribble's (2017) Nine Elements of Digital Citizenship and the ISTE standards are the most frequently mentioned standards and frameworks for curriculum creation in the literature. The ISTE standards, according to their website, have been adopted in every state in the US and many other countries (ISTE, 2021), demonstrating their widespread acceptance and use. The American Association of School Librarians (AASL) provides crosswalks to link their standards to the ISTE standards (AASL, 2021). This crosswalk serves as a valuable tool, showing where the ISTE standards fit into the National Library Standards by providing a side-by-side comparison view of the two sets of standards (AASL, 2021). This comparison allows for a better understanding of how these standards align and differ, which can benefit curriculum development.

The ISTE standards provide a comprehensive list of behaviors for students in the digital age. However, while widely accepted, the digital citizenship portion of the standards is only partially comprehensive. It omits some of Ribble's (2017) nine elements, such as digital access, which advocates for equitable access for all; digital commerce, which focuses specifically on financial online transactions; and digital health and welfare, which emphasizes leading a balanced life between online and offline activities. The ISTE standards are competency-based, which outline a set of skills and knowledge that students should possess to use technology effectively. These standards encapsulate some of the expected outcomes of a digital citizenship curriculum. However, they are not comprehensive or specifically tailored to elementary students, indicating a need for further refinement and specificity in the standards.

RQ1 How are digital citizenship outcomes measured in elementary students?

The initial research question in this study focused on measuring outcomes of digital citizenship. A systematic literature review was conducted to delve into this topic, revealing a variety of digital citizenship scales that could be utilized or adapted to assess the outcomes of a digital citizenship curriculum. This is a critical aspect of the research, as the effectiveness of any curriculum is determined mainly by its measurable outcomes. Therefore, identifying reliable and valid scales for measuring digital citizenship is a significant step in the research process. Furthermore, these scales provide a standardized evaluation method for comparisons across curricula and educational contexts.

Kocadag's (2012) Digital Citizenship Scale is one tool specifically designed to measure the levels of digital citizenship in preservice teachers. This scale employs a seven-point Likert-type scale to evaluate a pre-service teacher's perception of their knowledge of various facets of digital citizenship. These encompass communication, law, access, rights, health, safety, and trading (Kansu & Oksuz, 2019). Using a Likert-type scale gives an informed understanding of the preservice teachers' perceptions, providing valuable insights into their digital citizenship knowledge. This scale's focus on preservice teachers also highlights the importance of digital citizenship education in teacher training programs.

Another scale that measures levels of digital citizenship is the Digital Citizenship Scale developed by Isman & Gungoren (2014). A five-point Likert scale evaluates 34 different elements of digital citizenship. The elements are derived from Ribble and Bailey's key factors for digital citizenship goals, which include student academic learning, student behavior, and student life outside of school. The scale uses nine areas of behavior broken down into 34 different elements to analyze the digital citizenship levels of students (Isman & Gungoren, 2014).

This comprehensive approach ensures a thorough evaluation of student's digital citizenship levels, providing a detailed picture of their digital behaviors and attitudes.

Chou and Chin (2020) developed another scale through a literature review and focus group. This scale measures the digital citizenship fluency of preadolescent students by scoring 25 items using a 7-point Likert scale. The questions concern innovation, research fluency, critical thinking, and digital citizenship. This scale's unique focus on preadolescent students and its inclusion of innovation and critical thinking make it a valuable tool for assessing digital citizenship in younger populations. It also emphasizes the importance of fostering digital citizenship skills from an early age.

Each digital citizenship scale measures different populations, but they all attempt to measure many of the same characteristics and standards of digital citizenship. Kocadag, Isman, and Gongoren developed scales based on Ribble and Bailey's (2007) key digital citizenship goals. Chou and Chin, while measuring some of the same goals, group them into one set of questions, expanding to include questions about innovation, research fluency, and critical thinking. The other two scales do not measure anything other than the digital citizenship goals. Each scale, used for a specific purpose, could easily be adapted for any number of digital users. Each standard, framework, and scale of digital citizenship contains many of the same components and would be suitable for any age and ability level. These scales' adaptability and inclusivity are key strengths, making them valuable tools for digital citizenship research and education.

RQ2 Do digital citizenship curriculums impact elementary students' behaviors?

The second research question focused on whether a digital citizenship curriculum has a tangible impact on student behaviors. This question is of significant importance as it seeks to understand the practical implications of such a curriculum on the day-to-day actions of students. However, a review of the existing literature reveals a significant gap in this area. The scales and assessments found in the literature focus predominantly on perceptions and levels of digital citizenship. They need to adequately address the impact or change in behavior that may result from such a curriculum. This is a significant gap in the research, as understanding the behavioral implications of a digital citizenship curriculum is crucial for assessing its effectiveness and making informed decisions about its implementation in educational settings.

More research is required to explore how a digital citizenship curriculum impacts student behavior. This is not just a matter of academic interest but a necessity for educators and policymakers tasked with designing and implementing these curriculums. One study that has attempted to address this is McNaughton's study (2022), which measured how digital citizenship lessons contributed to students' ability to self-regulate and use social skills in digital usage both at home and at school. This was done using a five-point self-rating scale measuring self-regulation, focus, empathy, perspective, and prosocial behavior. This study is notable as it is the only one that shows the impact of digital citizenship lessons on behavior.

However, this study only measures self-regulation and social skills. It does not focus on any other aspect of digital citizenship, like rights and responsibilities, digital access, currency, communication, or safety. These are the basis of Ribble and Bailey's nine elements of digital citizenship that are often referred to as necessary for developing a good digital citizen. Therefore, while McNaughton's study is a step in the right direction, it is not comprehensive in its approach. More research is needed that not only measures self-regulation and social skills but also includes all the other aspects of digital citizenship. This will provide a more holistic understanding of the

impact of a digital citizenship curriculum on student behavior. This comprehensive approach is essential for creating effective digital citizenship curriculums that truly prepare students for the digital age.

Limitations

This systematic literature review has several limitations that need to be acknowledged. First, the review was conducted using the library database at the researcher's institution. This confines the range of literature accessed to what was available in this particular database. Consequently, pertinent studies and articles may not be included in the review because they were not accessible through this database. Next, the researcher accessed the ERIC database using specific delimiters and boolean language. While this approach can help refine the search and concentrate on the most relevant articles, it can also potentially exclude pertinent studies that do not fit within the specific delimiters. This could result in a review that is not fully representative of the existing literature on the topic. The results of this review may only include some published empirical articles focused on this topic, so significant findings and perspectives may not be included. The review is also limited because it only includes published articles. This means the review did not include unpublished studies, such as dissertations, theses, and conference papers. These sources often provide valuable insights and should not be overlooked in a comprehensive literature review. While the systematic literature review provides useful insights into the topic, these limitations should be considered when interpreting the results.

Conclusion

The current literature review reveals a gap in digital citizenship education research. There is a lack of empirical evidence collected on the outcomes and impacts of digital citizenship curriculums, which is a cause for concern given the increasing importance of digital literacy and the need for active citizenship in the digital age. The scarcity of data is particularly unfortunate as it hinders the ability to gauge the effectiveness of existing digital citizenship curricula. While some curricula are available, more comprehensive data collection and analysis are needed to confirm their efficacy in shaping students' digital citizenship behaviors and habits. This critical issue leaves educators and policymakers in the dark about the best practices for digital citizenship education. Developing and implementing effective strategies that enhance students' digital habits is only possible with more evidence.

This systematic literature review highlights one study that suggests a potential impact of digital citizenship curriculums on student behavior. However, this isolated finding is not sufficient to draw definitive conclusions. The lack of corroborating studies highlights the need for more research to validate these initial findings and provide a more comprehensive understanding of the impact of digital citizenship education. The literature review has made it abundantly clear that there is a pressing need for more research to assess the impact of digital citizenship education on students' digital habits. This is particularly important for elementary students at a formative stage in their digital engagement. Future research should focus on evaluating the effectiveness of digital citizenship education and determining whether it is effective in molding the digital habits of these young learners. The current research on digital citizenship education leaves many questions unanswered. Future research must address these gaps to provide a more comprehensive understanding of digital citizenship education and its impact on students' digital habits.

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A Case Study to Promote Culturally Relevant Teaching with STEM

Punett Gill, Texas A&M International University
Filiz Shine, Texas A&M International University

Abstract

Teacher preparation programs are influenced and impacted by sociocultural factors. National reports show Hispanic students on average have a persistent gap in mathematics and science scores. Student teachers with local cultural knowledge can help close this gap. This study aims to understand the methods utilized by a bilingual female Hispanic science teacher who crosses the border daily and integrates language and innovative science pedagogy in a science learning event named Puerto Educativo. This study suggests ways to incorporate language with STEM education through the following strategies: the STEM toolbox, the inclusion of parents and family, and the utilization of both Spanish and English in instruction.

Key Words: STEM, bilingual, culturally relevant, literacy

Introduction

Teacher actions in border regions are influenced by sociocultural factors such as the larger context of the community and the method in which students learn STEM (science, technology, engineering, and mathematics). In this essay we use the term STEM to refer to the use of scientific inquiry activities including hands-on activities, communicating scientific data through bilingual environments, use of scientific tools, and problem solving skills.

There is an achievement gap between Hispanic students and White students and according to national reports, it underlies a growing Hispanic population and Hispanic students that are English Language Learners. While Hispanic scores have increased, on average White scores remain higher on average on all assessments. In this essay, the authors identify the bilingual teacher as Hispanic because she identifies as being from Mexico and that is the ethnicity she used. Scientific inquiry, as discussed by the National Science Teachers Association (NSTA), refers to the the way students come to understand the natural world, to ask questions and seek the evidence to answer their questions, and through the process of inquiry students learn how to investigate and gather the evidence, to develop explanations, and to defend and communicate their conclusions. Other important components of implementing scientific inquiry is to be able to use tools to understand and collect data, and then to discuss explanations based on this (NSTA Position Statement Scientific Inquiry, 2024). More recently, NSTA has positioned scientific inquiry to mean explaining phenomena and designing solutions, integrating science and engineering practices beginning in the early grades, providing evidence to solutions, and to ensure assessment of students learning, regardless of children's race, class, ethnicity, socioeconomic status, gender, age, and cognitive skills and physical abilities (NSTA Declarations, 2024).

If we delve into the national reports, and more specific academic components of science-like scientific inquiry, a hallmark of the scientific enterprise, we find it has fallen behind. The National Assessment of Educational Progress (NAEP) is one the largest national representative assessments of what students are able to do in mathematics, science, reading and writing and released as the Nation's Report Card. According to NAEP, true scientific inquiry, especially for lower performing groups and children that are Hispanic has been consistently low. The Nation's

Report Card from the 2019 assessed grade four “Student Experiences with Scientific Inquiry ", which included working on a science project, discussing measurements and hands-on activities, talking about problems engineers can solve, and figuring out different ways to solve a science problem. In 2019, 30% of all teachers of fourth grade in the nation reported students’ frequency in participation of these scientific inquiry related activities as never to once or twice a year (NAEP 2019). Even more, lower performing students, at the twenty-fifth percentile or lower, had larger percentages that indicated students never to once or twice a year participated in scientific inquiry related activities: working with other students on projects, discussing measurements and results of hands-on activities, and figuring out various ways to solve science problems (NAEP 2019).

What is more, only 21% of all fourth graders had laboratory facilities for lab instruction (NAEP 2019). The Nation's Report Card from the 2015 Science State Snapshot Report states the scores for Hispanic students were 27 points lower than their White counterparts and were not significantly different from 2019 which was 24 points. English learners had lower score gaps in the 2019 graph report. This is similar to results from the Third International Mathematics and Science Study (TIMSS) in 2019, wherein the average score for US Hispanic 4th grade children was 20-44 points lower than the overall average (NAEP, 2015; TIMSS, 2019).

Despite these reports, children who may be English learners or speak dual languages and are Hispanic students can learn about scientific inquiry in ways that integrate content and can bridge gaps in STEM, especially for elementary grades. Teacher preparation programs can help student teachers reflect on their motivations for teaching, especially concerning language and attitudes (Valdez, 2014). Being proficient in two languages has many benefits. Children who develop bi-literacy skills are less likely to leave school than children who do not develop bi-literacy skills (Rumbaut, 2014). We also know when Hispanic children continue to use their native language and are bi-literate they are more likely to attend college compared to students who are not bi-literate (Santibanez and Zarate, 2014). Needless to say, the ability to speak two languages has many benefits and is associated with increased divergent thinking, problem solving, and pattern recognition (Bialystok, 2011). Specific strategies in science classes such as the use of partners, multi-sensory environments, visuals, and utilizing English and Spanish cognates can enhance science content learning (Garza et al., 2014).

The purpose of this article is to detail a case study of one female bilingual Hispanic student teacher and the strategies that can be used in Hispanic populations especially for children who are learning to speak English or are proficient in two languages. This case study will discuss how she taught academic Spanish language during an informal STEM learning event called Puerto Educativo, located on the border between Nuevo Laredo, Tamaulipas, Mexico and Laredo, Texas in the United States. Some of the main questions which guided this case study analysis were:

1. How did your use of the STEM toolbox activity increase knowledge of science and mathematics tools?
2. How does your background/cultural knowledge affect the way you implement STEM toolbox activities?
3. Has the STEM toolbox activity increased your knowledge and application of STEM in bilingual settings and for future teaching?

Literature Review

Academic knowledge and an understanding of science concepts can be developed with teaching strategies which support dual language instruction. The following examples discuss studies where children were exposed to dual language environments which reduced children's anxiety of academic content in science and/or mathematics. Garza et al. (2014) studied a workshop where sixty-six bilingual and generalist student teachers were exposed to environmental education in a dual language environment. In this workshop, student teachers were paired up and received training in English and Spanish. Collaborative grouping, ESL (English as a Second Language) instruction was conducted during the workshops. The researchers wanted to understand what strategies of teaching related to academic science content could be essential to student teachers. This study found that the use of bilingual pairs, which are student teachers partnered with teachers who were native and non-native speakers, helped student teachers develop cross-cultural relationships, to communicate new information, and to use the new language and/or content (Garza et al., 2014).

This, coupled with multi-sensory approaches where student teachers used fine motor skills and kinesthetic learning, reduced the anxiety or fear of scientific learning. Visuals were another strategy used during the workshop. When visuals were present, participants did not have to rely only on written or oral language for more connections to learning to be made. A third strategy was the use of English and Spanish cognates, words that have similar meaning in both languages. They are used to connect new terminology with prior terminology (Garza et al., 2014). This study underscores the importance of student teacher development of cross-cultural sensitivity as learners of science. It also emphasizes the importance of integrating strategies in order for student teachers to broaden their pedagogical approach, meet the needs of all learners, and aid in the formation of their scientific identities (Garza et al., 2014). This type of observation can produce an enormous amount of language such as great conversations and questions, which in turn can lead to exploring, discovering and investigating further (Texley & Rudd, 2017). All of this falls under the literacy umbrella and fosters communication. Zheng et al. (2014) studied usage of an online science program and technologies with Hispanic and ELL (English Language Learner) children through interviews and observations. These researchers suggest visual clues and instructional support can help children scaffold material, especially if they are at risk when learning science. They also suggest science related videos can strengthen children's motivation to follow STEM related career paths (Zheng et al., 2014).

Informal learning environments can provide the context to facilitate STEM-based learning strategies for student teachers. In one study, researchers set out to explain why a gap exists in STEM learning for Hispanic population student teachers. These researchers point out there is a common assumption Hispanic teachers know how to teach Hispanic youth in STEM areas (Diaz & Bussert-Webb, 2017). They studied the process of science and mathematics interactions between Latino/a student teachers in "third space" as a place to connect school to home (Diaz & Bussert-Webb, 2017). They articulate while the U.S. government uses Hispanic in national reports, they use Latino/a in their paper. Third space, as articulated by these researchers, is a space that is an unofficial, informal learning space where student teachers facilitate authentic learning experiences. In this space, student teachers connected children's home discourses to mathematics and science discourses. This study, which took place on the US/Mexico border and in one of the poorest U.S. communities, suggests student teachers dismantled boundaries between home and school so children could use everyday knowledge and experience from a "strengths-based perspective" (p.631). That means student teachers were able to organize

learning in a space outside of the normal formal schooling environment. Children were motivated to learn by sharing their everyday knowledge of science and mathematics. Especially for low socioeconomic (SES) areas, student teachers that tap into children's funds of knowledge can help eliminate low expectations of culturally diverse youth (Diaz & Bussert-Webb, 2017).

Informal learning spaces have the potential to encourage the development of STEM in dual language environments for Hispanic children. For student teachers, spaces which encourage dialogue with parents can also encourage positive teaching experiences in science and mathematics. Another study near the U.S./Mexico border examined what was learned from Hispanic student teachers and parents at a family mathematics and science night in an elementary school (Ramirez et al., 2016). The student teachers in the study prepared a poster and discussion related to a mathematics and science lesson. The posters and discussion connected to a culturally related mathematics and science topic as well as a reflective report. Prior to the event, researchers engaged in discussions with student teachers concerning parental involvement and culturally relevant mathematics and science content (Ramirez et al., 2016). The researchers studied the results from a Parental Involvement Questionnaire, reflection papers of student teachers, and parent interviews. Prior to the event, 45% of parent participants felt unqualified to support their children with mathematics instruction but after the event, 89% of parents realized they could assist with mathematics instruction. The parents discovered that using activities related to everyday life could be a way for their children to learn mathematics (Ramirez et al., 2016). This study exemplifies how student teachers can develop positive models of acceptance when they examine their own ideas about culture, language, parents, and diversity. Student teachers can then apply what they know to science and mathematics teaching (Ramirez et al., 2016).

Culturally responsive teaching can also ensure children succeed in STEM fields. Hernandez & Shroyer (2017) studied twelve Hispanic first generation college students in their final semester of teaching. The researchers in this study documented the student teachers' use of culturally responsive teaching practices during science and mathematics demonstrations as teachers utilized children's cultural and academic profiles. They developed a culturally responsive framework to guide their study which included content integration, facilitating knowledge construction, prejudice reduction, social justice, and academic development. They also analyzed teaching portfolios, observations of mathematics and science lessons, evaluations of the student teaching internship, and teacher interviews. Hispanic teachers helped children develop academically by fostering opportunities for learning utilizing the children's personal and academic profiles. The researchers point out that when teachers develop positive relationships with children by supporting their native language in a safe environment and with high expectations, children are excited about learning.

While formal learning environments include the standards of instruction and the mandated policies of instruction for school districts, these articles suggest informal spaces, those not contained in the formal school day, or outside of schooling experiences, can help students learn in more authentic ways. Collectively, these research articles suggest informal science learning events can incorporate positive models of acceptance especially in bilingual settings. Using similar models of teaching practices, this study will discuss the pedagogical strategies utilized by a Hispanic bilingual student teacher with STEM based discrepant events in an informal service-learning event. This study will analyze how this student teacher generated new teaching practices under these conditions.

Methods/Design of the Service-Learning Event

The service-learning event was hosted by Puerto Educativo, an indoor space in an open-air mall. This public educational space was intended to support literacy-oriented teaching and activities for early childhood through elementary age children. The STEM-DED (Science, Technology, Engineering, and Mathematics Discrepant Event Demonstrations) were implemented as a service-learning activity. These demonstrations were practiced in a science methods class for undergraduate student teachers prior to this event. Student teachers were invited to participate as volunteers and demonstrate their STEM-DED from the science methods class. Twenty-five of the student teachers decided to participate. Parents, adults, and children visited the Puerto Educativo space and stayed as long as they wished. The student teachers, children, and adults varied in their ability to speak Spanish and/or English. Thus, student teachers were encouraged to use dual language instruction when appropriate.

The STEM-DED consist of discrepant events, which are science demonstrations with an unexpected outcome, in order to engage the curiosity of participants. Student teachers practiced the components during the science methods class at least once prior to the Puerto Educativo event. During this class, as encouraged by Goldston & Downey (2012), student teachers used questioning techniques and basic process skills with children such as: estimating, communicating data, observing, inferring, utilizing mathematics applications of data in charts, and explaining content/concepts with the STEM-DED. Student teachers were also encouraged to engineer different situations in which the STEM-DED could have other outcomes, to include technology that featured scientific instruments and/or interactive charts to display data on tablets, and use manipulatives located inside a paper foldable called the STEM toolbox. The use of the STEM toolbox alongside the STEM-DED aided in the understanding of mathematics and science applications. The use of mathematics is an underlying basic process skill to be able to use STEM tools therefore tools were used to apply mathematics skills when practicing the tools to collect evidence and data in the STEM-DED. The STEM toolbox was given to all participants that came to Puerto Educativo. Some of the manipulatives in the toolbox included: paper rulers, a plastic pipette, Ziploc bags, differing lengths of yarn, a plastic spoon, and pictures with names of 28 typical mathematics and science tools (microscope, tweezers, safety goggles, magnifying glass, funnel, digital balance, graduated cylinder, and others student teachers included) in both Spanish and English.

One bilingual student teacher was asked to complete a separate activity utilizing the STEM toolbox. The bilingual student teacher taught participants about manipulatives in the STEM toolbox such as the tool name, their usage, and pronunciation of both Spanish and English names of the tools. The bilingual student teacher was encouraged to use cognates, which are words that have similar meaning in Spanish and English, while translating and relating the terms to children that are not native English speakers before children and family experienced the STEM-DED. She was interviewed for this study and recounted her past experiences when she moved to the US as a bilingual student, and transitioned to be a bilingual Spanish student teacher. This study will help inform other teacher educators and student teachers about the experiences of bilingual students and how to integrate the STEM toolbox and culturally relevant teaching experiences prior to demonstrating a STEM-DED. A qualitative case study methodology was used to interview the bilingual Spanish teacher. Two teacher educators analyzed the answers and coded data to develop themes learned. Some of the questions and follow up questions which guided this case study analysis were:

1. How did the STEM toolbox activity increase knowledge of science and mathematics tools prior to the demonstrations (STEM-DED)?
2. How does your background/cultural knowledge affect the way STEM activities are implemented in classrooms?
3. How has this STEM toolbox activity increased your knowledge and application of STEM in bilingual settings and for future teaching?

Method of Analysis of Data

This study utilized a narrative analysis style for the qualitative study, which is described as examining experiences of people in a descriptive manner as if told in a story (Rubin & Rubin, 2012). This particular method of analysis values how the analysis is told. If particular attention is paid to how stories are told, the stories can reveal what the narrator is emphasizing, omitting, or hesitating to discuss. Using this method, the communication process of the interview was analyzed (Rubin & Rubin, 2020). The teacher educators in this study position themselves as responsive interviewers which means data and questions are continuous, flexible, and adaptable. This interview style allowed the researchers to probe into questions that needed to be answered and to reformulate questions during the interview. This involves intense and active listening to a life history and assumes people create realities by narrating their stories (Rubin & Rubin, 2020; Marshall & Rossman, 2011). The theoretical framework of this study is from the perspective of Feminist Standpoint Theory. This lens focuses on the standpoint of the oppressed and disempowered groups so that we can better understand and reveal the nature of dominant groups. In particular, the specific situatedness of women's social and cultural position is important. Also, the context of global and local systems of empowerment and exploitation inform us of different perspectives of the sciences.

Harding (2008) states the women's movement provided a place for political struggle-the perspective or standpoint of a women, that is to say, a scientifically and morally preferable way for thinking about our social and life and/or understanding or nature (Harding, 2008). The female bilingual student teacher that participated in the in-depth interview was asked questions in the reflexive format of the methodology. Her perspective, as a female bilingual student teacher, underscores her strategies for success. The transcribed interview and field notes were used to determine coding categories and themes related to the analysis. Based on the research questions, data was coded according to the categories that related to increasing knowledge for female students, relevance of the study as a pre-teaching event prior to demonstrations, and future application of STEM-based learning events in bilingual settings. Selected data, questions, and quotes related to major themes are discussed in the next section.

Analysis of data

Research Question 1: How did the STEM toolbox activity increase knowledge of science and math tools?

Theme summary: The quote from the student teacher below suggests she was eager to use the STEM toolbox and to teach Spanish and English. The student teacher translated the contents of the STEM toolbox and conducted a separate activity to help children master the STEM tools in both Spanish and English. It also suggests her strategy is to connect participants' cultural backgrounds to the science and mathematics manipulatives/tools. For this student teacher, it was important children learn terms first, and then incorporate the manipulatives with the

STEM-DED, a tiered strategy of instruction. This method helps children in incorporating two different languages.

Example 1:

> "ok so I walked in and there were a couple of discrepant events showcasing and it was a just a nice environment for me to invite the kids to sit with me and review some of the instruments that were in the toolbox that were handed to them and I had the visuals which were the instruments laminated and then they had the names of the instruments in Spanish and English and I helped um them to talk about their pronunciation, their main purpose, how they function, and how they use it, and had a little conversation with one student that you use them in the laboratory and that you are supposed to be careful with the instruments and the student explained further about what they did, she was very eager, and I kept on going with the names of the instruments and I explained how to pronounce them in Spanish and that was about it."
>
> "the stem toolbox it's all just very new and I thought it was innovative to incorporate the math and the science and I am learning how important it is to connect different subjects when you are speaking about science it's important for the students that it connects to math and English and ELA"

Research Question 2: How does your background/cultural knowledge affect the way STEM activities are implemented in classrooms?

Theme summary: For this student teacher, some strategies she used to learn science in Mexico were: learning from mistakes, using her confidence to ask questions in class, and peer tutoring/asking for help from other students. These specific strategies helped this student to bridge the language gap and assisted her to master the difficulties of conversational English.
Example 1: Culture difference:

> "I grew up in Mexican city but I would come here every summer to the us to have that conversation with my cousins and since I was a kid I was learning ..I was uh I wasn't afraid to make mistakes and when someone told me you aren't supposed to say it like that you are supposed to say it like this I fixed it right away …and I was like a sponge I would make mistakes."

Example 2: Culture difference:

> "When I used to go to school in Mexico there was a lot of communication with the students but when I came to us city there was a culture shock because students tend to be very quiet, they are different the culture is different even though the two cities are close to one another. The students are very very quiet during class time and I was not used to that I was confused why everybody kept to themselves and I was very outspoken I was the only student or one of the only students that keep asking and asking questions because I was not shy at all and I was not afraid of asking a lot of questions I would just eager to find out or challenge the teacher to further explain to help me understand the terminology."
>
> "When I started middle school, I was in a very competitive classroom a teacher asked a question there are at least 7 hands up and I come to high school and Im the only one

asking a question or the teacher does not apply wait time that's the main difference that I noticed."

Example 3: peer tutoring:

"I don't think I read from a textbook I don't think we had a textbook in high school what we did have is um notes from the teacher but I had to go every morning to the library so she could explain it I couldn't understand it, my dad couldn't help me, so he had to drop me off early so I could work on the homework before the class started, I guess I didn't have the connection with the teacher I didn't understand her so I was better off understood from my friend."

Example 1 cognates:

"I explained it in English when I gave the explanation at the Puerto Educativo I had a student that was eager to learn the instruments in Spanish so that's when I incorporated the tools the lab tools and I had the visuals and they were written in Spanish and English and that's when I incorporated the cognates the true cognates and that's how I incorporated the literacy to it. So, for example the microscope the student was very eager to pronounce it and learned the pronunciation. In Spanish and I wrote it on the white board and showed her how it only changes a few letter and uh..that's a big part for students that come from different backgrounds but can use the cognates..they already have the prior knowledge they can apply it to the new language in this complex terminology in science."

Example 2 cognates:

"...very hard for me to learn the new concepts but there were some cognates that helped me out but when (professor) sent me the list that I was going to base myself and translate those instruments it was hard because in the little chemistry I learned in middle school we did not get to use all of the instruments I mean we were limited but I did recall a lot of the instruments and their names in Spanish."

Example 3 cognates:

"...so I basically incorporated the cognates because that's the easiest way they could understand the bigger picture and they could visually see how their pronunciation of microscopio and tool will help them..and thermometer – thermometro- it just changes a few letters and that helps them a lot what I prepared was 28 instruments I had a list in English then I translated this into Spanish and I'm ready for the students and as soon as I met the student I knew the students was not English speaker so that's how I did the other way around I spoke to them in Spanish and I incorporated the function of the instrument how to use it and I incorporated some lab safety information but most of the literacy incorporated here..um..the big thing in cognates and I showed them on the white board for the little student."

Research Question 3: How has this STEM toolbox activity increased your knowledge and application of STEM in bilingual settings and for future teaching?

Theme summary: The bilingual student teacher emphasized the importance of connecting learning to both Spanish and English. She discusses the particular importance of this practice with children and to encourage peer tutoring and the pursuit of STEM fields. Moreover, she used the STEM toolbox as a conversational piece, which encourages children to use the paper manipulatives/tools and understand their use when they experience the context of the STEM-DED. The student teacher was enthusiastic when applying what she learned as a student and adapting it to her own activity.

Example 1 STEM toolbox quote:

> "so I walked in and there were a couple of discrepant events showcasing and it was a just a nice environment for me to invite the kids to sit with me and review some of the instruments that were in the toolbox that were handed to them and I had the visuals which were the instruments laminated and then they had the names of the instruments in Spanish and English and I helped um them to talk about their pronunciation, their main purpose, how they function, and how they use it, and had a little conversation with one student that you use them in the laboratory and that you are supposed to be careful with the instruments and the student explained further about what they did, she was very eager, and I kept on going with the names of the instruments and I explained how to pronounce them in Spanish and that was about it. They are very good to know them in Spanish because we live in a border city and it's very important in the future in case they have uh classmates that do not know how to answer the instruments in English maybe they can help their classmates students are very eager to learn at that age in elementary and they are very interested in the science field so it's important to encourage their learning and its more than just the science behind it, it's about them um getting to know that they can be scientists as well and to encourage to go into STEM fields."

Example 2 STEM toolbox quote:

> "ok so the STEM toolbox it's a great tool for them to understand that they can there is science everywhere and they can create their own toolbox once they understand the meaning behind the basic skills and they can connect with parents to do their own experiments at home to understand the science concepts."

Example 3 STEM toolbox quote:

> "I think that the students that are doing the discrepant events could incorporate the Spanish name for the instruments or ask questions in Spanish that are ELLs because so are very afraid or very discouraged since they have that barrier ..so they could have the instruments um they can see the connection between the discrepant event that is going on over there and what instrument did you see that were being used around the discrepant event that you just saw? you can ask did you see the instrument? Do you know the name in Spanish or have you used it ..just have the discussion with them and it will help them learn about the stem toolbox and learn about how science is everywhere and they can create their own toolbox."

Example 4 STEM toolbox quote:

> "I am totally going to use the STEM toolbox and I'm going to ask students to bring their own and I'm going to try and take them into the lab as much as possible and try to get them involved in science."

Example 5 STEM toolbox quote:

> "I feel like science is pushed back in elementary and the focus is on ELL and math and I believe it's a big part of their development as students and their exploring they love to learn new um experiments and I feel like the discrepant events are a great way to learn the concepts following the 5 E model because they need to be more exposed to this."

Interviewer: And the other thing I noticed is that when you communicated with the parents, it seemed like you were speaking in Spanish so you built a rapport with her.
Student: Yes, you have to make them feel comfortable and um feel that connection with you. I felt like a superstar and I think its great because they get so engaged and as a future elementary teacher I think we put on this show- I had my teacher voice on and I act out so they get engaged and certain things to be entertained as they are learning.

Literacy connections

The researchers were able to sit with the bilingual student teacher and observe her as she began the STEM-DED activity. Through this observation, the interview, and her reflection, the researchers were able to observe the importance of literacy and bilingual education in a risk-free setting where children and parents participate voluntarily. The bilingual student teacher used both Spanish and English to help comprehension and to teach content vocabulary in both languages.

Researchers observed the student teacher speaking both languages and switching between them to aid in comprehension or teach new content vocabulary. This is a strategy that affirms the child's culture and promotes equality in both Spanish and English. The student teacher reflected upon her experience here in the United States when she came in as an international college freshman and was required to take high-school chemistry. Some of the main difficulties that she faced concerned understanding the terminology and concepts in English. She states:

> "So for chemistry when I was a freshman and I came into Laredo and I have some knowledge in chemistry and Spanish from my middle school then I came in high schools I was a straight A student in (home town in Mexico) and I come here (to the US city she studies and I made 70s and 60s in chemistry and I am so frustrated because I don't understand the vocabulary its hard for me to make the transition so I asked for a lot of help and lot of library time but it was truly very… it was a challenge for me to learn all of this complex terminology and how to apply it because I had to work out how science and all the periodic table and all the hydrogen and and add that but I didn't understand the vocabulary so it was very hard for me to already be expected to apply the knowledge that classmates learn in previous years"

The student teacher is explaining the difficulties that she herself experienced. Sadly, she states, often, even though you may pass an English test, it does not mean that you have command of the language academically. The student stated that she took an English test and passed. However, this did not assess her academic English required for the chemistry classroom. Many textbooks can be challenging even for native speakers. Studies suggest students require 5-7 years to

become as fluent as native speakers academically, whereas conversational English can be achieved in about two years depending upon exposure. We know that English learners need instruction to acquire vocabulary and to develop academic and conversational English (Graves, 2006). Word learning strategies are critical for students. As the student teacher states in her previous responses, cognates can be quite helpful. Cognates are useful to students who speak Spanish because English words have Spanish cognates.

When the student teacher was asked about cultural differences, she said she experienced quite a bit of cultural difference despite the shared border both cities have between Mexico and the US. Though the two towns are close geographically, sharing a border along the Rio Grande, they are different culturally. One of the differences between the cultures was the amount of communication that happened in the classroom between teacher and student. She suggested her class in Mexico had much more communication with the teacher than compared to the US classes. She felt students in the US were very quiet and that she was very "outspoken".
It is important to allow children to feel empowered and be given opportunities to flourish. Teachers need to be familiar with their children's background and provide a pathway to equity pedagogy for all. This can happen in spaces that are not in the classroom but are created voluntarily. These types of spaces can enhance, empower, encourage, and equip student teachers and children for a bright academic future. Such spaces are a celebration of knowledge and allow for families, student teachers, children, and professors to reflect, research, and instill the joy of learning while paving the way for more equitable pedagogy.

Discussion

Culturally relevant teaching has been developed and used in schools to educate student teachers. Culturally relevant teaching is a pedagogy focused on teaching marginalized children to be successful in schools academically, it also focuses on the aspect of cultural identity and affirmation (Gay 2000, 2013; Howard, 2003; Ladson-Billings, 1994). Viewing the children's cultural background as a plus rather than a subtractive model and building bridges to connect children's backgrounds with the school, is an important aspect in allowing students and the school to create a positive experience for both parents and students (Ladson-Billings 1995b, 1995a). This also holds true for any additional education that can be provided outside of the school as a support system too. Children come into a classroom or educational settings with different cultural backgrounds than the mainstream culture.

Theorists such as Delpit (1992), Gay (1994, 2003) and Ladson-Billings (1992-1995) are advocates of cultural difference. These theorists advocated the idea that school and classrooms had to change to allow for academic success by respecting the cultural identity of the children to flourish. Viewing the cultural identity as a strength and having the teacher use strategies that reflect the child's culture, paves the way for academic success. C.A.M Banks and J.A. Banks (1995) referred to this type of teaching as "equity pedagogy" (p.152). Ladson-Billings referred to this as "culturally relevant teaching" (Ladson-Billings, 1995, p. 312). Gay (1994, p.149) called this "culturally responsive teaching."

This is very different from the cultural-deficit model that was prevalent before. It is important to provide settings outside of schools that advocate this type of teaching as well. Encouraging multiple learning avenues through various settings and spaces help children not only academically, but also capitalize upon their cultural strengths. This is an opportunity for the bilingual student teacher to practice using culturally relevant teaching and in turn, helps the teacher to become equipped with these types of opportunities.

For years we have been trying to move towards more equitable pedagogy. This type of pedagogy requires practice and opportunities so that both children and student teachers can benefit. Bilingual education can help all children to understand concepts that may be difficult to comprehend that are not in their native language. Being proficient in two languages has many benefits. It has been found that children who develop bi-literacy skills are less likely to leave school than those children who do not develop their first language (Rumbaut, 2014). We also know that Latinx students who continue to use their native language and are bi-literate are more likely to attend college compared to students who are not bi-literate (Santibanez & Zarate, 2014). Needless to say, the ability to speak two languages has many benefits and is associated with increased divergent thinking, problem solving, and pattern recognition (Bialystok, 2011). The student teacher made use of cognates which helped the children with content vocabulary in both Spanish and English because instruction happened in both languages. Seeing the spelling in both languages helps to promote bi-literacy skills. Children were developing and learning words that they did not know in Spanish and in English.

The STEM-DED involved a great amount of conversation which helped children with language development, acquisition of content vocabulary in both languages, and listening and speaking skills. All of the skills mentioned fall under the literacy umbrella even though this was a STEM-DED. A large amount of literacy learning was happening at the same time as STEM learning was going on. The importance of this in an informal setting, outside school, also allows parents to stop by and spend time with their children while they are learning with a student teacher. The bilingual student teacher was able to connect with the parents very quickly and spoke Spanish with the parents.

Data/Conclusions

This case study interview was intended to understand how children used the STEM toolbox during the discrepant event demonstrations, to assess how the student teacher used bilingual language with the STEM toolbox, and how the culture/knowledge of this student teacher affected the ways in which the activities were implemented.

This student teacher shared her personal experiences growing up in a border city and struggling with science. After sharing her experiences, common themes around strategies and methods emerged. She used these strategies to adapt and learn English, and to succeed in her studies. In particular, she challenged the idea of being shy and in doing so, she also challenged traditional assumptions of femininity in her culture. At the beginning of the discussion, she said a common phrase told to women in her hometown, “Calladita te ves mas bonita.” This translates to “If you stay quiet you will look prettier.” She declared a desire to change this ideal and other traditional values placed upon women. The bilingual student teacher explained how children were outspoken in the Spanish speaking border city she grew up in, whereas in the United States most of her female classmates were very shy and less confident in speaking.

After our discussion and the interview, she explained the use of the STEM toolbox, pictures of science equipment, and the activity she created in order for children to be prepared to participate in the STEM-DED. She explained if children learn the names of the tools in Spanish and English first, and use the pictures to understand how they are modeled, they will be better able to participate in the various STEM-DED. Garza et al. (2014) stated the use of visuals for kinesthetic and fine motor skills helps children to not solely rely on written or oral language. The use of cognates also assists students to identify prior terminology that has been conceptually developed.

After the STEM-DED concluded, the children were given a STEM toolbox to take with them. The STEM toolbox can be used as an informal learning strategy so children can teach others, perhaps even their family. As Ramirez et al. (2016) suggests, parental involvement can help parents believe they can be a resource to their children, and encourage better home and school connections. She situates the STEM toolbox as a conversational piece and encourages the use of Spanish and English after translating the terms. The activities took place in an informal space which can encourage children to learn science and mathematics because it is outside of a formal learning environment (Diaz & Bussert-Webb, 2017).

She helps the parents attending the event to be comfortable and welcomes them in conversation about the STEM toolbox. The student teacher emphasizes how she grew up in a border city and the need to encourage the use of both languages, especially if children are to socially interact and help one another. This underscores her emphasis on peer-tutoring as a teaching strategy. This strategy instills confidence in children so they can readily pursue STEM careers in the future. Her situated perspective growing up in a border city and her cultural knowledge informs us of her different experiences as a science student and now a student teacher. Harding (1986, 2008) suggests women's positions can change their perspective or standpoint to a scientifically preferable way of being in nature and in life. Through her perspective, she has taught others about her own grounding and her own struggle in sciences. Her story can move us to challenge English-only STEM-based teaching in informal environments. Ultimately the strategies she suggests can help children in dual language settings develop understanding of scientific literacy in both languages and hopefully encourage students to pursue STEM careers.

Educational leaders can harness the assets teachers bring with them, especially as bicultural learners and bilingual speakers in informal environments and stimulate parent interest in STEM based activities. Informal settings break down barriers of learning and help inform bilingual parents that science is accessible, it can relate to tools used in everyday life which underscores the idea that science is practiced daily. As Ramirez et al. (2016) pointed out, parents can discover activities at informal events that help them relate learning to everyday experiences and make them better qualified to support children in mathematics instruction.

The implications for K-12 teachers and leaders are to encourage inquiry-oriented teaching, especially with visuals, and tools that encourage scientific literacy, peer-tutoring, and discussion amongst native and non-native speakers in informal environments which harness the connection to the community. Informal events can help to normalize language use, which is a cultural asset, between native and fellow native speakers or native and non-native speakers so each is able to contribute to the discussion. This informal learning space and the use of her native language and non-native language motivated the student teacher and she gained pride in her ability as a female bilingual speaker. The STEM toolbox including the visuals and tools inside motivated children and parent interest in science and bilingual language use and created a community of learners. Educational leaders should challenge each other to create this community of learners, through service-learning events or informal events. These types of events can motivate teachers, parents and students, while helping to break down gender barriers, socioeconomic status, language, and other social and cultural stereotypes so we understand the enterprise of science is meant for many different voices.

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