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Pre-service Teachers Perspectives of Google Expedition

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Abstract
This article explores pre-service teachers' personal experiences as they implemented immersive virtual reality using Google Expedition during a summer STEM camp for primary students. The research is situated around semi-structured interviews conducted to determine how pre-service teachers view their experiences using Google Expedition in primary classrooms, and the pedagogical challenges they encountered during this process. The semi-structured interviews provided insight into the planning, the pedagogical applications, and the obstacles or challenges they encountered during the planning stage and execution of their lesson using a highly interactive, three-dimensional tool such as Google Expedition. The data indicated that pre-service teachers had confidence in implementing virtual reality lessons in the class and considered it a new horizon for teaching. Yet, it also identified pedagogical challenges associated with implementing virtual reality in a primary classroom.

Keywords Virtual reality · Pedagogy · Google Goggles · Google Expedition · STEM camp · Pre-service teachers

Introduction

Virtual Reality

Virtual reality can be defined by the technology and the effects within the technology tool. Virtual reality fills your field of vision so that you occupy an entire virtual world. When you physically move your head, your virtual perspective changes accordingly, so you can look around the virtual world. Virtual reality places a person in a situated environment that looks and feels to some degree, like the real world (Psotka 1995). COVID-19 shifted teaching to online platforms, and many teachers have created virtual classrooms. These online classroom rooms are emerging as teachers create a virtual space that represents their traditional classrooms (Pointer 2020).

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Immersive Virtual Reality

Hedberg and Alexander (1994) stated that the conception of immersion arises from the complex interaction of the physical changes and interactions within a virtual environment. Using immersive virtual reality, rich cultural experiences can increase immersion, add fidelity, and provide a higher level of learner participation (Dalgarno and Lee 2010). Immersive experiences, such as augmented reality, virtual reality, and mixed reality experiences, have recently become readily available, including Wearable Technology such as Google glasses. Virtual reality is applicable for clinical applications such as empathy training, rehabilitation for treatable conditions, and pain distraction. Recent research indicates that children are "extremely" or "fairly" interested in experiencing virtual reality (Yamada-Rice et al. 2017).

While virtual reality seems like a new concept, teachers and researchers have been exploring virtual reality for decades (Aubrey et al. 2018; Christou 2010; Choi et al. 2015; Mazuryk and Gervautz 1996; Sutherland 1965, 1968). Currently, due to the technological advancements with virtual reality, the popularity is particularly high. Advancements with Google Cardboard, Google Goggles, and augmented reality have positioned these learning environments as critical spaces for exploring disciplines in Science, Technology, Engineering, and Mathematics (STEM) (Shapovalov et al. 2018a). Research into the pedagogical effect of using

Immersive Virtual Reality has not kept pace with the technological developments within educational settings. Teachers and researchers are yearnings for an evidence base for how and why to use immersive virtual tools. Although virtual reality has been available for a relatively low cost, consumer-grade hardware is a more recent phenomenon. The low-cost virtual reality hardware has shown promise as an instructional tool and a media production that allows students to gain experiences or develop expertise in a productive virtual reality environment.

Experts in business (Cearley et al. 2017) predict technology trends in business and commercial applications are moving faster than PreK-12 education technology trends (Kinshuk et al. 2013; Lim et al. 2013; Stein 2015). As an expert on emerging technologies, Dede (2017) suggests that preparation at all levels of education should not focus on knowledge and skills for today's jobs. Schools need to prepare students with the thinking and collaboration skills required for careers yet to be developed and these will change as technologies change. Virtual reality has the potential to change how people perceive the world (Cearley et al. 2017). The way we interact with technology will change in the next 5 to 10 years, if not sooner, due to the COVID-19 pandemic. Conversational platforms within virtual reality will provide a more immersive and natural interaction with the digital world.

The virtual learning environment is characterized in one of three ways. First, a learner will encounter some type of explanation or description that will provide the opportunity to learn new content. This is often equated to traditional learning, such as direct instruction or textbook instruction, to understand concepts. Second, the learner must complete a task to deepen their understanding; they start to explore, ask questions, or perform some action with the new concept to generate feedback. This immersion is now a task rather than just a representation of an idea. The third characteristic of learning is situated in a broader social context. Mayes and Fowler (1999) define this stage of learning as dialogue. This is the stage in which the learner tests their emerging understanding of a concept through some type of interaction with others. Virtual reality positions learning within the third characteristic of a broader social context.

The use of virtual reality holds great potential for learning environments, yet it also contains many challenges. More than 10 million virtual reality systems are circulating around the United States (Aubrey et al. 2018). "Virtual reality is likely to have powerful effects on children because it can provoke a response to virtual experiences similar to a response to actual experiences" (Aubrey et al. 2018, p. 2). While technology uses are ubiquitous in our ever-changing digital society, young children's involvement in appropriate interactive media and selected types of technologies requires intentional guidance to optimize cognitive, social, emotional, physical, and linguistic learning and development (Paciga and Donohue 2017). While children are interested, some suggest that virtual reality is not advisable for children younger than eight years of age (Aubrey et al. 2018; Bailenson 2018) due to possible confusion in the brain and eye strain (Mon-Williams 2017). When used appropriately, technology and media can enhance children's cognitive and social abilities. To accomplish this, "the child's developmental trajectory matters, and the place and purpose of the media and technology use matters" (Paciga and Donohue 2017, p. 10).

One of the challenges is understanding the pedagogical underpinning that should inform the lessons' design and the implementation of expeditions in the classroom. Mikropoulos and Natsis (2011) reviewed over fifty papers spanning 10 years (1999–2009) to explore virtual reality, specifically virtual reality, within an educational environment. The analysis indicated that very few of the studies reviewed had a clear pedagogical framework. Dalagarno and Lee's (2010) structure positions virtual reality within a high level of interactivity, smooth temporal and physical changes, and an illusion of three dimensions. These three defining characteristics impact the learner's experience and the psychological experience they describe as a sense of being there or a sense of presence.

Challenges exist, but research studies report the benefits of carefully selected, developmentally appropriate, and interactive technology tools and materials to enhance children's learning and development as being as effective as playing and working with non-technology materials. "The active, appropriate use of technology and media can support and extend traditional materials in valuable ways" (Paciga and Donohue 2017, p. 7). This requires professional development for teachers and clear, specific guidelines for families.

Google Expedition

Goggle Expedition is an innovative non- profit educational technology, that provides support for teachers, students, and educational institutions (Sujon 2019) using a virtual reality platform specifically for k-12 classrooms. Expeditions are linked collections of virtual reality content and supporting curricula that can be used alongside the classroom's current curriculum. The virtual "trips" are a collection of panoramas-360° and 3d images. The Expedition can take students on virtual field trips to museums, oceans, and outer space without ever leaving the classroom. These expeditions can take teachers and students to places they may not be able to visit due to lack of time, geographic location, and safety issues. Each journey is a guided tour of places throughout the world, including outer space and deep in the ocean.

In 2016, Google introduced the Expedition program, which facilitates instructor-led field trips. Google has created

more than 500 virtual reality journeys. All expeditions come with written guides or annotations to guide the virtual tour. They are annotated with details, points of interest, and questions that easily integrate into the existing school curriculum. As in an ordinary classroom, the teacher relies on pedagogical practices to gain students' attention, check on understanding, and assess the activity. Google Expedition provides a few tools to monitor aspects of teaching within the virtual environment. The teacher uses a tablet to guide the tours and draw attention to the virtual world's specific elements. During guided tours, the teacher can highlight locations and bring up information on the teacher tablet to discuss what the students are viewing. The teacher tablet screen acts as a sight indicator and displays a smiley face of all students who are logged on, indicating where students are looking in the virtual world. There is a pause button that turns the screen black indicating to the students the teacher would like their attention. The teacher tablet includes descriptions of the location, along with several points of interest. When the teacher points to the object on her screen, an arrow appears on the student's screen, directing them to look at a specific element within the virtual world (Alizadeh 2019).

To set up a Google Expedition, the teacher could use Google Cardboard and smartphones (relatively inexpensive). The device (smartphone in the Google Cardboard) connects to a router. The router allows the program to run over the school's Wi-Fi to download the virtual reality content simultaneously on to all student devices. The teacher device (tablet) then acts as a local server for each of the connected student devices.

The teacher could also use Google Expedition kits, which are preconfigured and ready for use. The kit includes one teacher's chrome tablet, router, charging station cart, headsets, and student virtual reality device (class set of ten about $4000). Through an internal grant, we were able to purchase a Google Expedition kit, which supported exploration for thirty students, a dedicated router, and a teacher tablet; the estimated cost was $10,000, including the charging cart. Google Expedition kits are not cheap, but it is a technology that can support a gap in access to learning for all students. There is no replacement for an actual field trip. Still, virtual reality does provide an opportunity for a new level of immersion to a place they have never been—or like colonial America, a place they would otherwise be unable to go.

Constructs for Consideration of Virtual Reality and Pedagogical Practices

Dewey (1938) noted the importance of experiential learning, stating that learning environments should not be restrictive but rather fit into a broader social world. Digital tools such as Google Expedition enhance physical spaces, create new virtual spaces, increase the psychological experience, and push many traditional restrictions in the classroom aside. The place of learning is no longer a single space but rather a multitude of geographical spaces. The challenge for educators is to identify the appropriate learning goals and pedagogies that can be integrated into such tools. Witmer and Singer define involvement as "a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events. Involvement depends on the degree of significance or meaning that the individual attaches to the stimuli, activities, or events" (1998, p. 227). It is the intense engagement with the media environment, the active and intense process of the world around them (Böcking et al. 2004).

What are the expected learning outcomes from wearing a headset and visiting a geographical location virtually using Google Expedition? A virtual learning environment fosters active learning and helps students grasp abstract knowledge (Ray and Deb 2016). Low spatial learners particularly benefit from virtual reality because visualizations help lower the cognitive load of the learning objectives. It allows the learner to look at the bigger picture of how an entire system works and to explore the individual components of this system. There are few research articles related to the use of Google Expedition (Fisher-Maltese 2019; Parmaxi et al. 2017a, b; Shapovalov et al. 2018b). Yet, Google Expeditions has already serviced over 2 million students (Melnick 2017). There is some acknowledgment that students can more directly experience places around the world, rather than just by looking at pictures and there are a few pedagogical suggestions that to embody effective pedagogy, educators and students need to create their content, in virtual spaces related to them (Parson et al. 2019).

There are many challenging constructs related to the implementation of this type of pedagogy; these include elements related to time, money, poor planning, and the alignment of objectives. One unavoidable drawback is the reliance on a virtual tool. In young children, virtual reality devices should not be used for more than five minutes without a break. This is to avoid "simulator sickness" caused by the lag time between the child's movements and the virtual world (Bailenson 2018). Additionally, virtual reality blocks out all objects in the physical world, this is critical for young children as they may struggle with the representational nature of their bodies and actions in the virtual world and not be aware of the physical world (Bailey and Bailenson 2017).

As with any other computer, virtual devices break, crash, or malfunction (Wu et al. 2013). Having a back-up plan is essential. There is also the additional time required for both the teacher and the student to learn how to use it (Hussein and Natterdal 2015). There may be an extra cognitive load of

learning placed upon students as they learn how to navigate and explore a virtual world (Wu et al. 2013).

Most importantly, it is critical to remember that virtual reality technology does not reduce the importance of lesson planning or the teacher's role. The shift in teacher role moves the teacher to the roles of a coach and mentor (Zhang 2013). The teacher's guidance is critical when using virtual reality tools such as Google Expedition, causing the teacher to multitask, putting an additional strain on their cognitive load. Integrating the virtual reality curriculum can be challenging; therefore, it is essential to start with clear educational objectives and goals. Virtual reality devices can be challenging to use and are often expensive, and this may discourage teachers from developing lessons that support these applications. The early development of experiences with pre-service teachers may help to bridge some of these fears and apprehensions.

Questions to Guide the Exploration

This study explores the personal experiences of pre-service teachers as they implemented immersive virtual reality using Google Expedition during a summer STEM camp for primary students. We sought to examine pre-service teachers' views as they reflected upon their experiences using Google Expedition, offering insight into how a given person, in a given context, makes sense of a given phenomenon. The following questions guided our interpretation of these personal experiences using Google Expedition: (1) How do pre-service teachers view their experiences with Google Expedition in primary classrooms?, (2) What pedagogical challenges do pre-service teachers encounter as they implement Google Expedition in primary classrooms?

Method

Design

Using purposeful sampling, we developed a case-by-case analysis of semi-structured interviews. We examined three pre-service teachers' personal experiences to determine their perceptions and understandings of using virtual reality tools such as Google Expedition in primary grades. Therefore, each participant was regarded as a single case.

Participants

The summer STEM camp consisted of 50 pre-service teachers and approximately 150 elementary students. A university in the southeastern United States hosts the summer STEM camp. It runs for three weeks. Fifty percent of the the camp attendees are on scholarship, while 60% of the student population is considered to have low SES. During the camp, all pre-service teachers (N = 50) had the opportunity to explore the Google Expedition and "practice using" it. Three participants were purposefully chosen for this research based on their use of Google Expedition during the summer STEM camp in the primary grades. All participants were assigned pseudonyms (i.e., Carol, Betty, and Mary) to assure anonymity. Carol, Betty, and Mary are all twenty-one-year-old females in their second semester of methods courses at the university, who participated in the summer STEM camp and actively used the Google Expedition.

Instruments

Semi-structured interviews were conducted to determine how pre-service teachers' experiences using Google Expedition impacted their summer STEM camp teaching and student learning. The 13-item interview was developed primarily to explore the personal experiences of these three pre-service teachers as they implemented immersive virtual reality using Google Expedition during a summer STEM camp for primary students. The items were open-ended and easy to understand and expand upon. The interview questions were framed around a cognitive load, affordances, and pedagogical application (see Appendix).

Data Collection and Analysis

Personal experiences were collected using the 13-item semi-structured interview. After the participants completed the summer camp, the researcher purposefully selected three participants. Each participant represented each level of familiarity with the device (Experienced, Moderate Experience, Beginner) and interviewed them to understand their perceptions of the application of Google Expedition. Each interview lasted approximately 20–30 min. Each interview was audio-recorded and transcribed. Data were analyzed using thematic analysis (Creswell 2013a, b) to identify and report patterns (themes) within the interview transcriptions. Transcripts were read and reread by multiple reviewers utilizing an eye for recurrent ideas, themes, and patterns.

Research memos were capture by the first author to identify first thoughts and tentative ideas related to the data. The ideas generated were shared and used to organize the data. After reviewing the data, reading and discussing the memos, we went back to our questions, We sought to identify the views of pre-service teachers as they reflected upon their experiences using Google Expedition, offering insights into how a given person, in a given context, makes sense of a given phenomenon. Using the interview questions to guide the organization and the collection of the data, we brought together all participant responses aligned to a particular

question. We generated a table to create a summary sheet. O'Connor and Gibson (2003) call this "thinking inside the box." Responses were grouped using hierarchical coding to categorize the three overarching themes that emerged: teaching, learning, and challenges.

Organization around the original questions helped us to see the data set at a glance. This step was instrumental as we identified the emerging categories and themes, offering insight into how a given person, in a given context, makes sense of a given phenomenon. The thematic analysis was conducted following the 6-step approach (Nowell et al. 2017): be familiar with the data (transcription of verbal data), coding data, generating the themes based on the codes, reviewing themes, defining and naming themes, and finally generating the report.

Results

The following three overarching themes emerged from the results of the interview analysis: Teaching, Learning, and Challenges (see Table 1). Within these themes, three levels of experience also emerged: Experienced (E), Moderate Experience (M), Beginner (Limited Experience) (B). The table provides an overview of the data followed by a close up view of each case.

The themes organized from the interview data gave voice to the participants as they tried to make sense of using Google Expedition for learning. Each case is unique, based on their experiences and understanding. Each case will be discussed individually to uncover their personal experiences and insight with Google Expedition as each participant discussed their experience in context.

Carol

Teaching

Carol found the Google Expeditions to be very useful for educational purposes, often fully immersing students in adventures from all over the world. She felt these tools "allowed students the ability to engage with learning with a whole new depth" (Interview Question 1 (IQ1)). Carol felt that teaching looked different when using the Google Expedition; she stated that she thought "it [the device] completely changed [her] role with the students. One of the biggest shifts was not having the students look at me" (IQ5) when giving instructions or delivering content. In a traditional classroom setting, "this is a key indicator I, and many [other teachers], look for to track student engagement. Removing this made it somewhat difficult to assess student involvement" (IQ5). She often relied upon the device features, such as the pause button, to get student

Table 1 Themes

	Teaching	Learning	Challenges
Experienced (E)	New perspectives in teaching (E), teachers move from the front to back (EM), Confidence in implementation (E: confident + opportunities), Need a new way to assess student engagement (E)	Exploring and building knowledge on various topics without concerns (EMB), Inquiry learning (E), Student Center learning (E), Authentic learning experiences (E), A change in cognitive load ("see" not "read" to reduce cognitive process, but might over stimuli on the other hand), the student might have a learning curve (E), Students could explore new and 3D experiences (E)	Technology Challenges (E)Wi-Fi connection; Limited location student can visit through VIRTUAL REALITY; Need to download the specific app onto the cellphone *Individual Physically Challenges* headaches, feel sick, need a break; Cannot use it while wearing glasses (E) Need a new way to assess student engagement (E)
Moderate experience (M)	Teachers move from the front to back (EM), the teacher is the key to make VIRTUAL REALITY interactive (M), Need an opportunity to explore	Exploring and building knowledge on various topics without concerns (EMB), Students are often considered easy adapters (M)	Teachers need to learn technology first (M). Increased cognitive load (M), requires a lot of guidance(M)
Beginner (Limited Experience) (B)	Lacks confidence (B)	Exploring and building knowledge on various topics without concerns (EMB). It takes extra time to learn how to use (B); the teacher needs time to explore (B), opportunity to play(B)	Required more guidance from teachers (B) *Device Challenges* It takes extra time to learn how to use (B); the teacher needs time to explore (B), opportunity to play(B)

attention and the sight indicator to see who is paying attention. It also gave the teacher a "somewhat backseat role" as the teacher was more responsible for providing answers when prompted by the students. She felt students' "inquiry" (IQ2) was driving the students' exploration and wondered about the "different way[s] to assess students" in this new environment (IQ5).

Throughout the interview, Carol talked about the immersive environment that the Expedition provides and the illusion of 3D. She felt students were able to "dive deep underwater" and come face to face with an angler fish and many other creatures many have never seen before. She postulated that these experiences don't come without some caution, stating that the illusion of 3D can cause headaches and blurred vision, that these symptoms could cause students to feel sick (IQ4), and that it was somewhat strenuous on students' eyes (students who wear glasses must remove them), thus causing a potential strain on a student's cognitive load (IQ4).

Carol discussed the multilayer stimuli of an immersive environment in a virtual world that could potentially impact a student's cognitive processing. She felt that many individuals could handle the stimuli being presented virtually, but for some, she thought it was essential to be able to differentiate based on one's knowledge of their students and "adjust teaching based on [the] student" (IQ2).

Learning

Throughout the interview, Carol positions the use of Google Expedition as "a whole new learning style that [she] had never even had the resources to think about" (IQ 2). She is grateful for the development of the Expeditions as that helped to lessen her cognitive load. She stated that the application within the Goggles helped her teaching experience because "she [could see] exactly where the students were looking and exploring. In certain cases, this allowed for a large degree of inquiry learning. This allowed the learning to be student lead" (IQ 2).

Overall, she felt that student learning was more authentic, "rather than reading from a book or other source they were able to look around [in the virtual environment] and find their interests and learn from it rather than the traditional sequencing of learning everything and then finding interests" (IQ9). Carol quickly realized that "she had to seriously rethink [her] lessons. [She] had initially planned them in a very specific way, with a very specific lesson, on a specific day" (IQ7). Carol felt that the initial application of devices in the classroom could be "jarring"; however, she thought it was worth the initial "acclimation" as it is a "huge difference from traditional classroom norms" (IQ11).

Challenges

Carol felt this was a "fantastic experience that [she] doubted at first"; she was overly concerned that they [the goggles] "would get broken, [would] not be developmentally appropriate, [or they would] not have the content [she] needed" (IQ13). However, she completely changed her mind after using them. She felt she had limited challenges in her teaching and student learning as she "personally [felt] as though [she] had a firm handle on the understanding of how and why to implement the technology during [her] STEM camp experience." During our final conversation, Carol talked about the apprehensions she has with technology: lack of Wi-Fi, challenging to use the devices outside of the Expedition, student illness (headaches, nausea, blurred vision). However, she felt the best way to overcome many of these issues was through planning, attention to detail, and multiple breaks while using the devices. Carol closed our interview session, stating, "Overall, the Expeditions were incredibly helpful in giving students a more authentic and meaningful way of exploring the world around them" (IQ13).

Betty

Teaching

Betty found the Google Expeditions "required routine and opportunity to explore" (IQ4). She mentioned several times in her interview that "while establishing routines and responsibilities with Google Expedition, I was just the facilitator. However, as students became more comfortable with Google Expedition, I was able to take part in the expeditions with them" (IQ4). She felt that the Goggles benefited student learning and helped to bridge background knowledge. She stated that she "teaches in a diverse community where some students spend every summer going to the beach, and others have never even dreamed of seeing the ocean in person" (IQ3). She felt the Google Expedition "allowed every student to learn more about the ocean, seeing it first-hand. Whether it was a revisit to the beach or [their] first time seeing the coast, each student was able to walk away interested and excited about our ocean study" (IQ3).

Throughout the interview, Betty talked about the need for the teacher to explore the pedagogical uses of the Expedition kits. She positioned this device as a new tool stating, "when something new is brought into the elementary classroom it is the teacher's role to understand the applications and guide students through its use" (IQ10). She felt strongly that "teachers need the opportunity to use the Google Expedition and explore with them before implementing them in the classroom (IQ10). When we asked Betty about her teaching style when using the Google Expedition, she felt she had to "focus more on

motivational teaching," encouraging exploration and inquiry (IQ2).

Learning

Betty found the Google Expeditions "provide[d] students the opportunity to build background knowledge through [learning] experiences they might not receive outside of the classroom" (IQ1). She felt they were very interactive and provided "a smooth change in learning in the classroom" (IQ11). She thought that this "change" helped elementary "learners… remain engaged," stating, "when there is change and implementation of something new in the classroom" (IQ11), students are more motivated and excited to learn. Yet she was often stressed about the additional time it took time outside of the classroom to learn how to use them before introducing them to [her] students" (IQ9).

Betty felt students picked up this new learning quickly, stating, "anytime students are given a new technological tool in the classroom, there is natural anxiety in the teacher. However, we don't give students enough credit. They easily adapt to new technology. They are a generation that craves the use of technology, especially in the classroom" (IQ 8). She also noted that the teacher's role is to understand the applications and guide students through their use (IQ9). Teachers are the ones who make the device interactive as there are hundreds of new Expeditions that offer new knowledge and experiences. However, teachers can manage the activity in the classroom by "either allowing students to get up and walk around or ask them to remain seated while they look around with the goggles." She concluded that, "certain expeditions allow more opportunities for the environment to appear three-dimensional compared to others" (IQ12).

Challenges

Betty did not mention any challenges related to the device itself, as Carol did above (Strain on eyes, nausea). She did note more pedagogical challenges as the teacher. There is a need to have an "opportunity to use the Google Expedition and explore with them before implementing them in the classroom" (IQ9). She discussed the need to be a facilitator as "one establishes routines and responsibilities with the virtual reality goggles" (IQ4). She also noted the teacher's responsibility to create an interactive environment, stating, "Teachers can make it as interactive as they would like" (IQ10).

Mary

Teaching

Mary found Google Expeditions to be a little taxing. She felt she had to "give extremely explicit directions and constant reinforcement, more-so than usual" (IQ2) as students interacted with the device. Mary stated that she understood why the Expeditions should be implemented in a lesson, but she is "not one-hundred percent confident in setting up the device" (IQ5). She felt it took time to learn how to use the device, set up the equipment, "learn how to work the router," and develop lessons (IQ5). Interestingly, Mary did not feel her teaching style should be adjusted (IQ2). There is no additional cognitive load placed on the teacher (IQ 7), she noted that there are additional cognitive demands placed on students (IQ8).

Learning

Mary felt that the Google Expedition supported student learning with little change in her teaching. She stated that "students are engaged in the learning because they can experience the visual reality of the content they are exploring" (IQ10). In addition, Mary discussed the use of these devices across the curriculum. Mary feels that students "can easily use them in class in daily lessons across multiple subjects" (IQ11). She explained her thoughts, stating that "the goggles allow[ed] [her] students the opportunity to explore relevant content in a real-world setting" and that students were able to "take virtual field trips" (IQ1).

Challenges

Overall, Mary spoke of very few challenges associated with the use of Google Expedition in the classroom. She did briefly mention, "time constraints" (IQ6) and the need for "extremely explicit directions and constant reinforcement" (IQ3). During her interview, Mary stated that she often saw "students reach, move, or dodge as if they were in reality, as opposed to viewing it virtually" (IQ12). She stated these experiences could add to a student's cognitive load and that "it was important to provide time for students to explore and take breaks in the learning activity" (IQ3). Mary wished for more time to explore the device, set up the device, and identify key expeditions for the learning.

Discussion

We sought to explore the views of pre-service teachers as they reflected upon their experiences using Google Expedition, offering insight into how a given person, in a given context, makes sense of a given phenomenon. The personal experiences of Carol, Betty, and Mary, all pre-service teachers in the College of Education, were used to determine their perceptions and understandings of using Google Expedition in the primary grades. Carol felt that the key to an interactive approach is repositioning the teacher and redesigning the

lesson to be more intentional. Whereas Betty felt the device requires more guidance from the teacher. Teachers need to learn the technology first. And Mary felt that teaching using the devices required her to be much more explicit with her direction, and she had to reinforce behaviors continually. All three pre-service teachers told a different story, from a different perspective.

Carol was much more comfortable with the devices and more willing to take the initiative and explore how, when, and why to use the tools. Betty was eager yet apprehensive and felt that her role shifted to a facilitator until students became acclimated with the devices. Betty thought it was the teacher's role to understand the application and guide students through the use of the tools. Mary felt the whole thing was taxing, and she wasn't 100% confident in using the devices. Yet, she also thought that with time and planning, they could easily be used across multiple subjects. Carol was the only participant to acknowledge the need for a new mindset in regards to assessment.

All three pre-service teachers felt that the devices lead to a more student-centered classroom. Carol felt an inquiry approach was emerging through the use of the Expeditions, whereas Betty adjusted her teaching to the students' needs, becoming a facilitator to scaffold learning. Mary lacked confidence and needed more time to explore the devices, positioning that students are engaged when they use the tools, often positioning the Expedition as a "virtual field trip."

Few challenges arose throughout the process of using Google Googles; however, there was some mention of limited locations of the already pre-loaded specific expeditions. Although there were no issues, Carol was cautious about potential Wi-Fi connections, physical ailment because of the devices, and additional cognitive demands on the students because of multilayer stimuli. Although Betty felt her role changed to be more of a facilitator, she did note some pedagogical challenges she encountered. Mary positioned the learning more on the students, stating that the "students can easily use them in class in daily lessons across multiple subjects" (IQ11), indicating that her teaching had "little change"(IQ2) the only adjustment was being more explicit with direction and provide constant reinforcement.

Conclusion

In this article we reflected upon the experiences of Carol, Betty, and Mary, three pre-service teachers using Google Expedition, offering insights into how a given person, in a given context, makes sense of a given phenomenon. We explored pre-service teachers' experiences and perceptions as they implemented Google Expedition during a summer STEM camp for primary students. Semi-structured interviews were conducted with three pre-service teachers with different levels of technology familiarity. Overall, pre-service teachers with moderate and advanced technology experiences had more positive experiences and attitudes toward implementing Google Expedition in the classroom.

Teaching

Except for the pre-service teacher who was a new adaptor of the technology, the other teachers indicated that they have confidence in implementing Google Expedition in the class and consider it as a new horizon for teaching. Teachers no longer need to stand in front of the classroom to lecture, but can rather facilitate the virtual reality interaction for students. Their reflection corresponded to Zhang's (2013) idea that a teacher's guidance is critical when implementing virtual reality in the classroom. Their role is shifting to a coach or mentor instead of that of a typical teacher. In addition, the pedagogical and teacher's role shifting influence the way teachers assess students' engagement in the classroom. Further, teachers need to have more opportunities in exploring the contents provided in the Google Expedition kits to more effectively guide students in the class. However, if a teacher lacks confidence with technology, it could lower teaching effectiveness when implementing virtual reality in the classroom (Bakar et al. 2018).

Learning

All three pre-service teachers expressed the belief that implementing Google Expedition in the classroom could help students build knowledge on various topics without the concerns of location, time, finance, and risks. Virtual reality provides an immersive environment for individuals to "experience" it in a way in which they would experience the real world (Psotka 1995). Hence, teachers can use this immersion experience as a means for education based on Dewey's experiential learning theory (1938). Further, it also shifts the learning experiences to be a student center and authentic learning focus. In addition, teachers could implement inquiry learning strategies to facilitate meaningful learning. However, due to this new teaching approach, students might have a learning curve and spend more time learning how to use the latest technology to adapt to new learning settings.

Challenge in Implementations

The pre-service teachers in this study also point out several challenges, including technology, devices, and individual physical challenges. Software for virtual reality needs to be pre-downloaded into students' devices. Hence, a limited number of virtual reality curricula that were developed, downloaded, or purchased could limit the experiences/learning through Google Expedition. Further, some software

requires specific requirements in the hardware, such as storage capacity or operational system. The software needs to be developed in a way that allows students with various devices to have access and download it. In addition, some virtual reality software requires interaction between device and server. Poor Wi-Fi connection leads to unstable communication between devices and servers, leading to poor experiences in the virtual reality learning environment. Teachers need to spend extra time to explore the downloaded software, so they know how to facilitate its use when coaching students in the classroom. Students need to learn how to use the software during class time, which could potentially occupy the time for the regular curriculum.

Google Expedition is one type of head-mounted display (HMD) for virtual reality. The most significant restriction is that teachers or students cannot wear it while wearing their prescription glasses. Further, motion sickness, such as headache and a feeling of being sick, is one of the complaints people reported while using virtual reality devices like the head-mounted displays. Some researchers suggested that lowering the resolution could reduce virtual reality motion sickness (Blum et al. 2010; Carnegie and Rhee 2015); others strongly recommend reduced time on the device. In young children, virtual reality devices should not be used for more than five minutes without a break. This is to avoid "simulator sickness," which is caused by the lag time between the child's movements and the virtual world (Bailenson 2018). In addition, teachers need to learn technology first before they can guide students. Also, students need a lot of guidance from teachers so they can learn how to use the materials more efficiently. While learning the technology and materials at the same time, it could potentially increase the cognitive load, putting unnecessary demands imposed on the learner.

Implications

One of the pedagogical challenges in implementing Google Expedition in the classroom is whether teachers have the knowledge and skills to integrate the technology into the classroom settings appropriately. Hence, it is essential to improve pre-service and in-service teachers' technology literacy before implementing virtual reality in their classroom. Incorporation of virtual experiences with tools such as Google Expedition during pre-service teacher education and in-service teachers' professional development is a means to increase their confidence in using technology as a tool in teaching. Further, districts and schools need to provide support to teachers using virtual reality in the class by purchasing classroom kits such as Google Expedition and providing training opportunities. Technology companies could support the education system by developing software that can fit into various operational systems/devices and offer affordable prices for schools, teachers, and parents.

Limitations

With a limited interview pool, the experiences of these three pre-service teachers Carol, Betty, and Mary, offer a snapshot into the insight into how a given person, in a given context, makes sense of a given phenomenon. In addition, our story is only focused on pre-service teachers and their experiences in implementing Google Expedition in a STEM summer camp. Their experiences might not apply to in-service teachers in a formal school setting. The cost has the potential to be a limitation. Depending on the direction schools take for implementation, cardboard goggles cost about $6.99, and schools often have BYOD to school, keeping the cost relatively low. If a school decides to implement a kit, it could range in price from a few thousand to several thousand dollars depending on quality. If we look at the increasing cost of field trips, safety, transportation, and experience, the price may be more effective in the long run for virtual field trips.

The National Association for the Education of Young Children & Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College (2012) position statement calls for caution when using technology with young children. The "appeal of technology can lead to appropriate uses in early childhood" (p. 4) therefore it is critical to train educators to become digitally literate educators who are grounded in theory and best practices:

> In development theory, and developmentally appropriate practices [educators] have the knowledge, skills, and experience to select and use technology tools and interactive media that suit the ages and developmental levels of the children in their care, and they know when and how to integrate technology into the program effectively (p.4).

The NAEYC position statement echoes that interactive media can promote effective learning and development when the implementation of technology is intentional by early childhood educators. Thus, supporting the need for early experiences with preservice teachers to explore and apply new technologies. Therefore, developmentally appropriate practices must guide the decisions about whether an educator should integrate technology into early childhood curricula.

Appendix: Interview Questions

1. What learning affordance do you feel these tools (Google Expedition) offered students in regards to learning?

2. In thinking about your teaching style and the implementation of Google Expedition, do you feel you had to adjust your teaching method? (Different models of learning-constructivist, motivational)?
3. Do you feel Google Expedition added to the cognitive load of student's learning?
4. Was there an increased cognitive overload due to multimedia learning demands? If so, what did you do as the instructor to help support student learning?
5. Do you feel your roles and responsibilities in the educational use of virtual reality such as Google Expedition with elementary students shifted?
6. Do you feel like you had a firm handle on the understanding the how and why to use Google Expedition during your STEM camp experience? If so, why, if not, what would have supported your knowledge?
7. Do you feel like there were additional cognitive demands placed on you as a pre-service teacher trying to implement Google Expedition during the STEM camp?
8. Were you aware of the additional cognitive demands placed on the elementary students as they explored Google Expedition for learning?
9. Do you feel a deeper understanding of the pedagogical applications of virtual reality are needed as Google Expedition is used with elementary students?
10. Do you feel Google Expedition provided a high level of interactivity? Why or why not please explain your thoughts.
11. Do you think Google Expeditions offer a smooth temporal and physical change in learning? Why or why not please explain your thoughts.
12. Do you think there is an illusion of three-dimension when using the Google Expedition? Why or why not please explain your thoughts.
13. Is there anything you would like to add?

References

Alizadeh, M. (2019). Virtual reality in the language classroom: Theory and practice. *CALL-EJ, 20*(3), 21–30.

Aubrey, J. S., Robb, M. B., Bailey, J., & Bailenson, J. (2018). *Virtual REALITY 101: What you need to know about kids and VR*. San Francisco, CA: Common Sense.

Bakar, N. S. A., Maat, S. M., & Rosli, R. (2018). A systematic review of teacher's self-efficacy and technology integration. *International Journal of Academic Research in Business and Social Sciences*. https://doi.org/10.6007/IJARBSS/v8-i8/4611.

Bailenson, J. (2018). *Experience on-demand: What virtual reality is, how it works, and what it can do*. New York: WW Norton & Company.

Bailey, J. O., & Bailenson, J. N. (2017). Considering virtual reality in children's lives. *Journal of Children and Media, 11*(1), 107–113.

Blum, T., Wieczorek, M., Aichert, A., Tibrewal, R., & Navab, N. (2010). The effect of out-of-focus blur on visual discomfort when using stereo displays. *In Proceedings of the VIIII IEEE International Symposium on Mixed and Augmented Reality. Science and Technology, ISMAR*, pp. 475–48.

Böcking, S., Gysbers, A., Wirth, W., Klimmt, C., Hartmann, T., Schramm, H., … Vorderer, P. (2004). Theoretical and empirical support for distinctions between components and conditions of spatial presence. *In Proceedings of the VII. International Workshop on Presence*–Presence (pp. 224–231).

Carnegie, K., & Rhee, T. (2015). Reducing visual discomfort with HMDS using dynamic depth of field. *IEEE Computer Graphs and Applications, 35*(5), 34–41.

Cearley, D., Burke, B., Searle, S., & Walker, M. (2017). *Top 10 strategic technology trends for 2018: A Gartner trend insight report*. Stamford, CT: Gartner Inc.

Christou, C. (2010). Virtual Reality in Education. In C. Christou (Ed.), *Affective, interactive and cognitive methods for e-learning design: creating an optimal education experience*. Hershey: IGI Global.

Creswell, J. W. (2013a). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE.

Creswell, J. W. (2013b). Steps in conducting a scholarly mixed methods study.

Choi, S., Jung, K., & Noh, S. D. (2015). Virtual reality applications in manufacturing industries: Past research, present findings, and future directions. *Concurrent Engineering, 23*(1), 40–63.

Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology, 41*(1), 10–32.

Dede, C. (2017). What will the job market look like in 2030? *Education Week, 37*(15), 32.

Dewey, J. (1997). *Experience and Education [1938]* (pp. 64–67). New York: First Touchstone Edition.

Fisher-Maltese, C. (2019). Google expeditions: Expanding classroom spaces with a virtual reality teaching tool. In *Innovations in Teaching & Learning Conference Proceedings* (Vol. 11, pp. Room-G).

Hedberg, J., & Alexander, S. (1994). Virtual reality in education: Defining researchable issues. *Educational Media International, 31*(4), 214–220.

Hussein, M., & Nätterdal, C. (2015). *The benefits of VR-VIRTUAL REALITY in education-A comparison study.*

Kinshuk, H.-W., Sampson, D., & Chen, N.-S. (2013). Trends in educational technology through the lens of the highly cited articles published in the Journal of Educational Technology and Society. *Educational Technology & Society, 16*(2), 3–20.

Lim, C.-P., Zhao, Y., Tondeur, J., Chai, C.-S., & Tsai, C.-C. (2013). Bridging the gap: Technology trends and use of technology in schools. *Educational Technology & Society, 16*(2), 59–68.

Mayes, J. T., & Fowler, C. J. (1999). Learning technology and usability: A framework for understanding courseware. *Interacting with Computers, 11*(5), 485–497.

Mazuryk, T., & Gervautz, M. (1996). Virtual reality-history, applications, technology and future.

Melnick, K. (2017). Google Brings AR into the Classroom with 'Expeditions *AR' Program. VRVIRTUAL REALITYScout.*

Mirkropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999–2009). *Computer and Education, 56,* 769–780.

Mon-Williams, M. (2017). Is virtual reality bad for our health the risks and opportunities of a technology revolution. Retrieved 4 December.

National Association for the Education of Young Children & Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College. (2012). Technology and interactive media as tools in early childhood programs serving children from birth through age

8. Washington, DC: NAEYC; Latrobe, PA: Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College.
Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1609406917733847.
O'Connor, H., & Gibson, N. (2003). A step-by-step guide to qualitative data analysis. *Pimatisiwin: A Journal of Indigenous and Aboriginal Community Health, 1*(1), 63–90.
Paciga, K. A., & Donohue, C. (2017). *Technology and interactive media for young children: A whole child approach connecting the vision of Fred Rogers with research and practice*. Latrobe, PA: Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College.
Parmaxi, A., Stylianou, K., & Zaphiris, P. (2017a). Enabling social exploration through virtual guidance in google expeditions: An exploratory study. In *Interactive mobile communication, technologies and learning* (pp. 397–408). Cham: Springer.
Parmaxi, A., Stylianou, K., & Zaphiris, P. (2017b). Leveraging virtual trips in Google expeditions to elevate students' social exploration. In *IFIP Conference on Human-Computer interaction* (pp. 368–371). Cham: Springer.
Parsons, D., Inkila, M., & Lynch, J. (2019). Navigating learning worlds: Using digital tools to learn in physical and virtual spaces. *Australasian Journal of Educational Technology, 35*(4), 144–159.
Pointer, A. (2020). 'Bitmoji whisperer': Metro Atlanta teachers recreate classrooms online. Retrieved from https://www.ajc.com/news/atlanta-news/bitmoji-whisperer-metro-atlanta-teachers-recreate-classrooms-online/UATYVSR5NVAYTLRM35DI26NJLQ/?fbclid=IwAR0CpkH7hV2Sps7p9ueT0tPYJIi8gokj9mRsXEouBAnQP39O8zr95dEvEj0.
Psotka, J. (1995). Immersive training systems: VRVIRTUAL REALITY and education and training. *Instructional Science, 23,* 405–431.
Ray, A. B., & Deb, S. (2016). Smartphone-based VRVIRTUAL REALITY systems in classroom teaching—A study on the effects of learning outcome. In *2016 IEEE Eighth International Conference on Technology for Education (T4E)* (pp. 68–71). IEEE.
Shapovalov, V. B., Atamas, A. I., Bilyk, Z. I., Shapovalov, Y. B., & Uchitel, A. D. (2018a). Structuring Augmented Reality Information on the stemua. Science. In *Proceedings of the 1st international workshop on augmented reality in education* Kryvyi Rih, Ukraine, October 2, 2018 (No. 2257, pp. 75–86). CEUR-WS. Org.
Shapovalov, Y. B., Bilyk, Z. I., Atamas, A. I., Shapovalov, V. B., & Uchitel, A. D. (2018b). The potential of using Google expeditions and Google lens tools under STEM-education in Ukraine. *Educational Dimension*, *51*, 90–101.
Stein, J. (2015). Why virtual reality is about to change the world. *Time (Aug 17, 2015)*.
Sujon, Z. (2019). Disruptive play or platform colonialism? The contradictory dynamics of Google expeditions and educational virtual reality. *Digital Culture & Education, 11*(1), 1–21.
Sutherland, I. E. (1965). The ultimate display. *Multimedia: From Wagner to virtual reality*, *1*.
Sutherland, I. E. (1968). A head-mounted three-dimensional display. In *Proceedings of the December 9–11, 1968, fall joint computer conference, part I* (pp. 757–764).
Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence, 7*(3), 225–240.
Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities, and challenges of augmented reality in education. *Computers and Education, 62,* 41–49.
Yamada-Rice, D., Mushtaq, F., Woodgate, A., Bosmans, D., Douthwaite, A., Douthwaite, I., … Milovidov, E. (2017). Children and virtual reality: Emerging possibilities and challenges.
Zhang, H. (2013). Pedagogical challenges of spoken English learning in the Second Life virtual world: A case study. *British Journal of Educational Technology, 44*(2), 243–254.