Motivations to Implement Augmented Reality:

A Qualitative Study of Utah Educators

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Abstract

High school teachers generally do not use augmented reality (AR) in teaching, although empirical evidence suggests students experience positive learning outcomes from its use. The problem was a lack of clarity about what motivates high school teachers to use AR in classrooms at suburban high schools in northern Utah. The purpose of the research was to explore what motivates high school teachers to use AR in teaching and what support is needed for teachers to apply AR effectively in a classroom setting. Research Question 1 examined factors influencing teachers' motivation to use AR as a teaching strategy. Research Question 2 explored the support needed by teachers to integrate the use of AR successfully into teaching practices. The theoretical foundation of the theory of planned behavior and the technology acceptance model helped establish a framework for exploring participants' motivation regarding AR use. The qualitative methodology integrated a basic qualitative design to collect data from 17 teachers who volunteered to participate in virtual or in-person semistructured interviews. Interview data were transcribed and analyzed using qualitative coding and Braun and Clarke's 2019 thematic approach. Results indicated most teachers lacked an accurate awareness of AR, viewed AR as advantageous for learning, expected barriers to using AR, expected leaders and peers to support the use of AR in school, and viewed training as a possible motivating factor for using AR as a teaching strategy. Education and industry leaders should increase teachers' awareness of AR, understand and address teachers' perceived barriers to AR use in the classroom, and provide training on the effective use of AR for learning.

Keywords: augmented reality, virtual reality, mixed reality, motivation, education, theory of planned behavior, technology acceptance model, immersive technology, computer vision, computer augmented environment, active learning, education technology

Dedication

This dissertation is dedicated to my wife, Heidi, for her patience, support, and encouragement during the ups and downs of the dissertation journey.

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This dissertation would have been unlikely without the encouragement and support of my wife, who filled our family void, and my mother, who genuinely believed in me.

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Chapter 1: Introduction

Augmented reality (AR) and virtual reality are considered useful technologies for helping users have an immersive experience by engaging with rich media. Virtual reality submerses the individual in a completely digital reproduction as a replacement for the actual environment (Pegrum, 2021). To use virtual reality, a participant wears goggles or a headset to conceal the real setting and substitute it with a fully digital experience. Augmented reality technology allows users to introduce digital objects into the real-world environment using digital technology and can enhance learning environments (Altınpulluk et al., 2020).

Because AR can combine abstract concepts with a learner's actual setting, students can benefit from a better understanding of abstract ideas that have historically been more challenging through traditional learning environments (Sural, 2018). Educational benefits of using AR involve learning outcomes such as facilitating skills development, increased student motivation, higher satisfaction in learning, and students being engaged in more active learning. Despite the strong evidence supporting the use of AR in learning, many high school teachers do not integrate AR into learning activities (Oliveira da Silva et al., 2019). The research explored what motivates teachers to use AR and the support needed to effectively use AR in the classroom. Findings may make school administrators aware of how to help teachers adopt AR in teaching. Conclusions may positively influence people who design AR applications (apps) to make resources more pedagogically operational. A description of the research includes an explanation of the background of the problem, statement of the problem, purpose, significance, research questions, theoretical framework, definitions of terms, assumptions, scope and delimitations, limitations, and chapter summary.

Background of the Problem

Augmented reality is an effective technology for learning and offers teachers a low-cost and low-stress possibility compared to many other media resources (Alzahrani, 2020). Because AR can digitally present abstract concepts within a learner's actual environment, students can benefit from a better understanding of intangible ideas that have historically been more challenging through traditional learning environments (Sural, 2018). Syawaludin et al. (2019) indicated 95% of elementary education students at a university in Indonesia experienced significantly increased critical thinking skills after participating in an AR-based learning activity about Earth and its rock structures. Three overall themes emerged from an evaluation of 12 peer-reviewed articles about AR and education: the impact of AR learning experiences on student learning outcomes, challenges of using AR for learning, and how teacher perceptions about AR impact a learning experience with the technology. The strongest themes about AR in learning involved learning outcomes such as facilitated skills development, increased student motivation, higher satisfaction in learning, and students being engaged in more active learning. Literature indicated high school teachers generally do not capitalize on the opportunity to use AR in the classroom despite empirical evidence suggesting positive associated learning outcomes for students (Oliveira da Silva et al., 2019). Notwithstanding the evidence in favor of using AR in teaching and learning, little is known about what motivates teachers to use or not use AR in classrooms.

Statement of the Problem

The problem was a lack of clarity about what motivates high school teachers to use AR in classrooms at a suburban high school in northern Utah. The support teachers need to involve AR effectively in instruction was unclear. Previous research accepts AR as helpful in eliciting positive learning outcomes for students, but many teachers do not use it (Oliveira da Silva et al.,

2019). Chicioreanu and Amza (2014) found 94% of teachers surveyed said AR is an "excellent and good" (p. 3) teaching method, but only 19% intended to use the technology with students. In a study by Tzima et al. (2019), 100% of junior and senior high school teachers reported never having used AR for teaching; 50% of teachers indicated having previously read or heard about AR. The lack of information about teacher motivation to use AR and the support needed to use AR may limit how school and district leaders train and support teachers. A deficiency of knowledge may impede how designers create AR apps for successful educational use. Results from the study may help education leaders and AR designers encourage and support the effective use of AR in teaching.

Purpose of the Study

The purpose of this basic qualitative study was to explore what motivates teachers at suburban high schools in northern Utah to use AR in teaching and what support is needed for teachers to apply AR effectively in a classroom setting. The qualitative research methodology enabled effective investigation of the research questions pertaining to teachers' experiences. Following a basic qualitative design provided the right structure and practices for increasing knowledge of what motivates or demotivates teachers to implement AR in teaching. Findings may assist school administrators and AR designers in effectively improving how teachers incorporate AR into teaching and learning. Semistructured interviews facilitated data collection, data analysis, and coding of how participants' experiences influenced motivation to use AR.

Significance of the Study

The information gained through the research may have a positive impact by developing awareness about obstacles preventing teachers from using AR in classrooms. Added knowledge about factors affecting high school teachers' motivation to use AR could help school

administrators better train teachers on effective practices for media integration, including using AR. Teachers play a pivotal role in whether and how emerging technology is integrated and accepted in education (Tzima et al., 2019). Of 20 secondary teachers in Greece, 60% indicated the need for continuous technology training is stressful (Tzima et al., 2019). Many AR apps do not include the necessary features to support teaching and are not designed with education in mind (Grinshkun et al., 2021). Empirical data about how to use AR experiences to support learning is lacking (Koutromanos et al., 2015). Conclusions may help developers design AR apps to create better products to facilitate learning. Finally, knowledge gained from this study may positively influence policies and procedures to help teachers integrate AR into teaching for improved student learning outcomes.

Research Questions

The following research questions guided the study:

Research Question 1: What motivates teachers at suburban high schools in northern Utah to implement augmented reality in teaching practices?

Research Question 2: What support is needed for motivated teachers at suburban high schools in northern Utah to effectively implement augmented reality in teaching practices?

Theoretical Framework

Many teachers do not take advantage of AR's media-rich environment for students to experience the associated valuable learning outcomes (Oliveira da Silva et al., 2019). The theoretical foundation for this study was based on the theory of planned behavior (TPB; Ajzen & Driver, 1992) and integrated the technology acceptance model (TAM; Davis et al., 1989). The TPB and the TAM provided a construct for examining what motivates teachers to integrate AR technology into teaching high school and the potential support needed to do it well.

Icek Ajzen developed the TPB in the early 1990s as a framework for understanding how people's motivation and perceptions of behavioral control can help predict actual behavior (Ajzen & Driver, 1992). The TPB has been used in many disciplines to explain and predict human behavior, including willingness to use emerging technology (Ajzen, 2020). Originating with Fred Davis, the TAM provides a framework to help calculate the prospect of a person's or group's successfully applying a new classification of technology (Davis et al., 1989). Motivation is a focal element of the TAM and influences the probability someone will use emerging technology. A person's motivation to implement a new technology corresponds to its features (Dziak, 2020).

The phenomenon of people's perceptions influencing motivation to use technology, such as AR, based on the participants' experiences was explored through a basic qualitative research design. Semistructured interviews and an interview protocol were influenced by the TPB and the TAM to aid in soliciting participant perspectives about motivation to use relatively new technology for teaching. Together, the TPB and the TAM afforded a theoretical framework to explore what motivates high school teachers in northern Utah to use AR in classrooms and what support is needed to help do it with efficacy.

Definitions of Terms

The following terms are discussed in this dissertation and are defined to facilitate the reader's understanding.

Augmented reality (AR) is defined as digital technology to superimpose virtual objects onto a live view of physical environments to help users visualize how objects would operate in the actual environment (Tan et al., 2022).

Technology acceptance model (TAM) is defined as an information systems theory

outlining how customers acquire and utilize modern technology (Teo et al., 2007).

Theory of planned behavior (TPB) asserts people behave socially for specific reasons, following planned intentions, and according to certain factors (Erten & Köseoğlu, 2022).

Virtual reality employs computer technology to produce an interactive virtual simulation in which users see a digital environment in three dimensions replicating the real world (L. Chen & Zhu, 2022).

Assumptions

An assumption involves a researcher's beliefs and values and influences problems to be studied, methods used, and the significance of results (Creswell, 2015). Every research methodology possesses unique assumptions about reality, social life, and knowledge (Wilson & Anagnostopoulos, 2021). The research questions and methods were driven by fundamental philosophical assumptions and denote beliefs about the nature of reality regarding the phenomenon under investigation (Bleiker et al., 2019). According to Walters (2001), the nature of qualitative research assumes a reliance on inductive reasoning, which includes the human involvement of a researcher and personal bias. Individual paradigms held by researchers regarding the nature of knowledge and of existence can impact how a researcher chooses to approach a study (Mazandarani, 2022). Readers can better understand a researcher's writings when assumptions are made overtly clear (Wilson & Anagnostopoulos, 2021).

The first assumption for the study was most teachers do not use AR due to a lack of awareness of the immersive technology. The second assumption was teachers will want to use AR with students once teachers understand how digital technology can enrich the learning experience. The third assumption was teachers will need minimal support to integrate AR effectively in classrooms compared to other types of rich media. The three assumptions

influenced the choice to employ qualitative methods to explore teachers' perspectives about motivation to use AR to help teach students. Chapter 3 discusses steps taken to mitigate researcher bias and increase validity.

Scope and Delimitations

A basic qualitative design facilitated the gathering of information about teachers' motivation to use AR. The research was conducted with 17 high school teachers in one school district. Participants were selected from high schools in Utah during the first quarter of 2023. Participation was requested from several schools in the same district. Qualitative coding and thematic analysis supported the emergence of insightful discoveries from interview transcripts to establish knowledge about teacher motivation to use AR. Transferability of results may be reduced due to the limited nature of the scope and delimitations.

Delimitations refer to boundaries researchers set to limit the aims and objectives of a study (Theofanidis & Fountouki, 2018). Such limits assist researchers in maintaining a feasible scope of work. The research questions were about what motivates teachers in northern Utah to use or not use AR and the support needed to integrate AR effectively into teaching. The aim was not to contribute to existing knowledge about how AR benefits student learning outcomes but to shed light on teachers' motivation to use the technology. Due to practical limitations of time and resources, instrumentation for gathering participant data was limited to semistructured interviews while providing enough information for effective analysis. Data gathering through interviews occurred during 8 weeks in January, February, and March of 2023, allowing enough time for coding and analysis.

Limitations

Limitations in a research study are variables relating to the character of the research

methodology or design. Such limitations are out of a researcher's control and can influence findings due to an impact on a study's validity (Theofanidis & Fountouki, 2018). Data produced by a qualitative methodology are not statistically representative and cannot be analyzed mathematically. Qualitative methodologies require a human element to interpret the information through a process of transcribing data and coding and analyzing themes (Mehta, 2020). The use of an interview protocol, recording and transcription technology, and coding software in this study assisted in addressing human limitations during the collection and analysis of data.

The first limitation involves biases naturally possessed by researchers during the interview and coding processes that may reflect a different perspective from that of participants. Personal reflection and recordkeeping regarding personal biases influencing findings helped ensure academic integrity. An attitude of self-reflexivity about potential biases helped minimize and manage personal subjective influences (Carcary, 2020). The second limitation of qualitative research methodology is the inherent inability to be truly replicated and thus verified. In the study, candidate selection was limited to one school district, a relatively small geographical area in northern Utah not representative of an overall scope of responses. Participants were selected for interviews based on volunteering for the study; thus, the sample may not fully represent the population. Seventeen participants yielded sufficient data without overwhelming a robust analysis. No outside funding was allocated for this study, limiting the available resources. Open-source software was used for data collection, transcription, and coding.

Chapter Summary

Augmented reality is a relatively low-cost technology option for teachers to engage students in effective learning, yet most high school teachers do not employ it (Oliveira da Silva et al., 2019). Factors motivating high school teachers in northern Utah to use AR in teaching and

the support needed for teachers to apply AR effectively in a classroom setting are unclear. The TPB and the TAM constitute a theoretical foundation by which the research explored teacher motivation to use AR. A presentation of key terminology helped the reader understand the intent and meaning. A description of the scope and delimitations, limitations, and assumptions helped the reader understand the research. Gaining knowledge of teachers' motivation to use AR may help school administrators provide the needed support and aid developers of AR apps to produce better educational products. Understanding what motivates teachers to use AR may ultimately help teachers integrate AR effectively in classrooms for the benefit of students. The following analysis of peer-reviewed literature reveals generalized themes about the use of AR for educational purposes, with significant implications for positive benefits on learning experiences and student learning outcomes.

Chapter 2: Literature Review

Augmented reality (AR) technology is generally accepted in the literature as potentially beneficial for teaching and learning but is not widely integrated into schools (Oliveira da Silva et al., 2019). Chicioreanu and Amza (2014) found 94% of teachers surveyed said AR is an "excellent and good" (p. 3) teaching method, but only 19% intended to use the technology with students. A gap exists in the literature regarding teachers' usage of AR in northern Utah and what might motivate them to use it as a teaching method. The purpose of this basic qualitative study was to explore the motivation of teachers at suburban high schools in northern Utah to implement AR in teaching and what support is needed for teachers to apply AR effectively as a teaching method. The information gained through this study may influence the adoption rates of AR technology in education and improve learning outcomes.

An explanation of the literature search strategy describes how databases, search engines, and search terms served to facilitate the literature review. A theoretical framework section explains how the TPB and the TAM relate to the research problem and questions. A review of the research literature identifies four generalized themes about AR use in education.

Literature Search Strategy

Many relevant theoretical and empirical articles were referenced for this study. The literature was explored using search engines such as Google Scholar and American College of Education (ACE) OneSearch. The ACE online library was used to access mostly peer-reviewed articles from databases including SAGE, ERIC, and Education Source from EBSCO. Some of the terms used included *augmented reality in education*, *immersive technology for learning*, *teacher perceptions about augmented reality*, *benefits of augmented reality for learning*, *teacher opinions about augmented reality*, *limitations of augmented reality in education*, *teacher training*

and augmented reality, *implementation of augmented reality in school*, *cognitive theory of multimedia learning*, *theory of planned behavior*, *technology acceptance model*, *augmented reality skills*, *augmented reality motivation*, *augmented reality limitations*, *augmented reality learning satisfaction*, *active learning*, *augmented reality applications development*, *augmented reality problems education*, and *augmented reality education satisfaction*.

Theoretical Framework

Though AR technology provides teachers with the potential for a media-rich arena where students can participate in constructivist-based experiences contributing to valuable learning outcomes, it is not widely used by schoolteachers (Oliveira da Silva et al., 2019). The theoretical foundation for the study was based on the TPB (Ajzen & Driver, 1992) and integrated the TAM (Davis et al., 1989). Existing studies confirm many benefits of integrating AR into teaching and learning. Some studies explored possible reasons why adoption rates are low but did not address the impact of teacher perceptions of one's capacity to adopt AR. The TPB provided the theoretical foundation for the TAM. This theory and this model offer a construct wherein to examine teacher perceptions about the ability to integrate AR technology into teaching high school.

Theory of Planned Behavior

Ajzen developed the TPB in the early 1990s as a derivative of the willingness to pay theory (Ajzen & Driver, 1992). The theory has been widely used to explain and predict human behavior across a variety of fields, including the integration of emerging technology (Ajzen, 2020). According to Sussman and Gifford (2018), TPB implies a person's intention to act directly predicts the person's behavior, and such intention is based on three components: attitudes, subjective norms, and perceived behavioral control. Thus, understanding teachers'

responses to developing technology, such as AR, can help influence behavior and help increase willingness to use the technology to achieve learning outcomes for students.

Attitudes

Persada et al. (2021) defined the concept of *attitude* within the TPB frame as a feeling associated with the potential action of using innovative technology. *Behavioral belief* is a term referencing one's perceptions about the expected value of an action, the likely consequences of the action, and the probability of the action providing an anticipated experience (Ajzen, 2020). In theory, positive and negative behavioral beliefs about an action generate an overall attitude about the experience (Ajzen, 2020). The TPB construct asserts public school teachers develop behavioral beliefs creating personal attitudes about AR technology. A lack of AR adoption is due to a dearth of understanding of the affordances offered by immersive technologies (Steffen et al., 2019). These affordances include the capacity to re-create aspects of the existing world, enhance positive aspects of the physical world, and diminish negative aspects of the physical world (Steffen et al., 2019).

Subjective Norms

In the TPB frame, *subjective norms* represent the effect expectations of influential people have on an individual's life regarding a particular action (Persada et al., 2021). Social pressure from friends, family, partners, or colleagues impacts how people view potential behavior. *Injunctive normative belief* suggests the probability a significant life associate would approve or disapprove of the behavior. *Descriptive normative belief* refers to one's conviction about whether other meaningful people perform the behavior themselves (Ajzen, 2020). According to the TPB concept, schoolteachers' subjective norms may influence perceptions of AR technology and the ability to utilize it for teaching.

Perceived Behavioral Control

Viewed through the TPB lens, *perceived behavioral control* denotes how an individual perceives the ease or difficulty of executing a specific behavior (Persada et al., 2021). Behavioral control is influenced by one's accessible control beliefs centered on the existence of factors that may enable or disable the implementation of a given behavior (Ajzen, 2020). Such accessible control beliefs may include needed skills and ability, time, money, or other factors influencing a person's perceived likelihood of an enabling or disabling factor being associated with the behavior (Ajzen, 2020). According to the TPB, perceived behavioral control is believed to temper the effect of attitude and subjective norms on an individual's intention toward a given behavior. Therefore, people with positive attitudes and encouraging subjective norms are viewed as having high intentions toward a behavior, assuming a belief about the ability to perform the behavior (Ajzen, 2020). Within the TPB, a teacher's perceived control about integrating AR technology into the classroom may impact willingness to use it.

Technology Acceptance Model

In 1986, Davis adapted the more general theory of reasoned action to develop the TAM (Davis et al., 1989). The model helps calculate the probability an individual or group will successfully implement a new system of technology, specifically the computer (Davis et al., 1989). Motivation is a prominent element of the model, influences the likelihood of adoption, and is impacted directly by the features of the new technology (Dziak, 2020). Undergirded by the TPB, the TAM forms a framework to evaluate teachers' perceptions about emerging technology, such as how teachers' perceptions about one's ability to use AR motivate willingness to use AR as a teaching method. The evolution of technology continues to enhance productivity and effectiveness of work, and the TAM can help assess a teacher's perceptions of usefulness and

ease of use of a given technology to gauge the intention of use (Bekele et al., 2021). For example, characteristics of the TAM—usefulness and ease of use—had to be perceived by librarians to consider adopting new technology, such as social media, for marketing purposes (Joo et al., 2019). The TAM's concept of perceived ease of use was used to discover an increase in students' acceptance of technology for project-based learning in geometry (Mailizar & Johar, 2021). With reasonably consistent results of empirical studies, researchers generally agree the TAM is valid in predicting a person's acceptance of technological systems (Lee et al., 2011). According to Alsharida et al. (2021), the number of TAM-based studies increases every year.

The issue of teachers not integrating AR suggests a need for more understanding of motivation relating to technology use. A framework constructed by the TPB and the TAM provided a structure to help examine how some teachers' motivation to use AR impacts their willingness to use it. The TPB assumes a link between teachers' behavioral beliefs about AR technology, attitudes, and motivation to use it. Applying the TAM helped the researcher apply the TPB to examine teachers' perceptions of the usefulness and ease of use of AR technology in classrooms.

Research Literature Review

When used effectively, technology and digital tools are empirically proven to help promote learning and development (Alelaimat et al., 2020). Augmented reality technology incorporates digital objects and real objects in the same space using digital technology (Altınpulluk et al., 2020). Virtual elements of AR enhance the real world within an interactive experience (Steffen et al., 2019). Some of the earliest findings showed AR helps enhance the learning experience by stimulating types of environments in ways traditional classroom methods cannot. Compared to many other media resources, AR in education provides a promising low-

cost and low-stress option for generating positive teaching and learning outcomes (Alzahrani, 2020). Ashley-Welbeck and Vlachopoulos (2020) found the virtual reality environment permitted students to survey the relationship between Earth and the sun within the context of the solar system in ways impossible in a real experience. Augmented reality technology has improved quality and fidelity and provides opportunities for computer–human interactive apps, yet its widespread adoption has stalled (Steffen et al., 2019). The analysis of peer-reviewed research on the topic of AR use in education is organized according to a thematic approach. An evaluation of the themes contributes to the understanding of the use of AR learning activities for education and some of its challenges. Analysis of themes within the framework of the TPB and the TAM helps identify gaps in the existing understanding and supports the need for further exploration of how teachers' motivation to use AR impacts a willingness to attempt it in teaching. A review of 12 peer-reviewed articles revealed three generalized themes about AR and education: the positive influence of an AR experience on learning outcomes, the limitations of AR in learning, and the role of teacher perceptions.

Learning Outcomes

Augmented reality learning experiences have been used for classroom education and have been proven as tools for effective learning outcomes (Vuta, 2020). Due to potential benefits for teaching and learning, AR technology is growing in popularity across many disciplines and uses in higher education (Czerkawski & Berti, 2021). Augmented reality has the capacity to expand the limitations of traditional teaching and learning by adding digital elements to learners' physical environment and helping magnify student participation, interaction, and engagement (Hadjistassou et al., 2021). Students who tested the use of AR technology in learning biology experienced a solid understanding and retention of material, benefited from effective repetition,

and were excited and entertained by AR activities (Yapici & Karakoyun, 2021). Understanding the benefits of using AR for teaching and learning within the theoretical framework of the TPB and the TAM may be useful in developing awareness about how teacher motivation to use AR may impact willingness to try it.

A bibliometric analysis by Avila-Garzon et al. (2021) of 3,475 studies reported AR for education generally has a positive effect on student learning outcomes and appears to be a successful method to strengthen traditional forms of instruction. Huertas-Abril et al. (2021) identified seven key educational affordances offered by AR in learning. First, AR facilitates collaboration in new and different contexts closer to an in-person experience. Santos et al. (2014) explained an AR environment has an inherent visual context whereby students view the presentation of visual information in the context of the real environment. Real-life context in AR learning is enhanced with digital cues allowing learners to construct knowledge. Ashley-Welbeck and Vlachopoulos (2020) maintained the importance of context in AR learning by asserting learning cannot be dissociated from the context of the developed content and AR technology can help connect learners to the context, especially within learner-focused experiences such as constructivist and inquiry-based learning methodologies. Çakıroğlu et al. (2022) found students were more capable of using virtual reality to create a concept map of the moon and sun during an eclipse because they could see and understand the relationship of the concept.

Second, AR technology allows people to connect with others and information more quickly, regardless of an individual's physical location (Huertas-Abril et al., 2021). Third, AR provides learners with a more student-centered and situated learning experience. Fourth, AR provides a greater sense of belonging among students. Fifth, AR offers safe environments in

which students can engage in exploration and problem-solving if teachers do not dominate the experience. Constructivist activities in an AR environment let students collaborate to interact with elements in a virtual setting to make records, annotations, and modifications to learning content (Pegrum, 2021). Sixth, AR typically engages a multitude of senses, including visual and auditory; it is also capable of integrating sensations of touch, smell, and taste. Finally, AR learning environments can provide experiences of authenticity, such as representing real-life engagement, a real-world activity, and supporting personal values and interests (Huertas-Abril et al., 2021). Augmented reality offers several affordances to help students experience positive learning outcomes.

Constructivist learning activities in an AR environment help empower students to use tools to design and build digital AR objects and could be made available for others to use (Pegrum, 2021). Those who use AR experience a sense of authentic presence to help learners move from abstract understanding to concrete understanding (Zhao et al., 2022). Kandasamy et al. (2021) studied the impact of visual-based AR learning on students studying about the anatomy and movements of the human spine. Student responses indicated those using AR perceived a higher level of understanding than the group using traditional methods. The researchers concluded AR is another effective tool to support student learning in the field of anatomy (Kandasamy et al., 2021). According to an analysis of the literature, AR educational experiences can positively contribute to four significant learning outcomes: the development of skills, increased student motivation, higher satisfaction, and more active learning.

Skills Development

Participating in AR learning can help students learn skills across a variety of disciplines, including mathematics, engineering, language acquisition, biology, geography, and teaching.

Many students who use AR technology for learning demonstrate improved critical spatial skills (Altınpulluk et al., 2020). Evidence suggests AR also helps students benefit from effectively developing practical motor skills (de Oliveira Spinosa et al., 2020).

Critical Spatial Skills. Critical spatial thinking is the process of combining critical thinking and spatial thinking. Critical spatial skills help learners come to well-reasoned conclusions by deliberately considering the factors of an issue in the context of geographic location (Sinton, 2017). Altınpulluk et al. (2020) determined learning with AR facilitated improved spatial skills and critical thinking skills better than students using traditional learning methods. Critical spatial skills were beneficial when the content involved abstract concepts such as human anatomy and physiology (Syawaludin et al., 2019). Bölek et al. (2021) acknowledged AR technology for learning anatomy generally offers more affordances than traditional cadavers and models because digital apps allow students to disassemble and reassemble parts of the body. The study showed insufficient proof to determine AR educational tools significantly increased learning outcomes (Bölek et al., 2021).

Yonov and Bandrova (2021) tested the effectiveness of using AR technology for teaching difficult concepts to young children and developed an AR app for superimposing digital elements onto a paper geography map intended for 15-year-olds. When interacting with the paper map and AR elements, 10-year-old students were interested in continuing with the advanced content. In addition to the outcome of curiosity, the young students were able to correctly understand very difficult geographical concepts with the help of AR (Yonov & Bandrova, 2021). Similarly, student-teachers who had never stood before actual students benefited by using AR-mediated scenarios and could view and practice a variety of effective solutions for responding to students with disciplinary issues (Hadjistassou et al., 2021). The student-teachers experienced

productive participation and engagement resulting in opportunities to reflect on potential discipline strategies for managing students (Hadjistassou et al., 2021).

Tsai (2020) corroborated the findings of several other studies and suggested using AR for language learning helped students develop important skills. According to Papoutsi et al. (2021), immersive experiences with technology such as augmented and virtual reality promote skills regarding emotional and social development in people of all ages. An experimental study with fifth graders in Taiwan found students in the experimental group using AR for English language learning demonstrated significantly more progress than those in the control group using traditional lecture-based learning methods (Tsai, 2020). Students in a primary education teacher program experienced statistically significantly higher learning outcomes and processing skills when engaged in problem-based learning through AR technology than students through conventional methods (Guntur & Setyaningrum, 2021).

According to Guntur and Setyaningrum (2021), AR is more effective than traditional learning methods; students using AR experienced significantly better development of problem-solving skills and spatial skills. To explore how the use of AR helped biology students develop critical thinking skills, Damopolii et al. (2022) used a pretest and a posttest. Responses from students and test scores indicated interacting with the 3D display in the AR environment empowered critical thinking. McCord et al. (2022) tested the effectiveness of AR with civil and construction engineering undergraduate students. Students in a control group were provided with a paper copy of a 2D wood frame and those in the experiment group were given the same frame but in an AR environment. The paper-based activity proved simple but lacking in critical thinking and was not mentally demanding. Students in the test group found the AR experience more cognitively taxing but easier to recognize and fix errors during the learning exercise

(McCord et al., 2022). According to Syawaludin et al. (2019), improved critical thinking skills through AR use are best leveraged when apps are improved in the design phase. Tsai (2020) identified the benefits of skill acquisition through AR occurred because students using the technology were more motivated to learn than those using traditional methods.

Practical Motor Skills. According to de Oliveira Spinosa et al. (2020), developing motor skills involves changing one's ability to execute movements needed for daily living. Progress usually begins with simple movements and develops into complex movements. Students who used AR to observe a motor skill demonstration achieved mastery of the skill as successfully as those who observed a live demonstration (de Oliveira Spinosa et al., 2020). Thus, an AR digital demonstration can be considered an effective tool for teaching and training motor skills. Students with disabilities and adaptive needs learned important social and academic skills with the contribution of AR; skills learned through AR motivated these students to participate in social and daily activities (Jdaitawi & Kan'an, 2022).

Findings by Baragash et al. (2022) corroborate the effectiveness of AR in helping students with special needs to learn important skills. The researchers discovered students could develop functional skills leading to independence, such as wayfinding, using numbers, shopping, literacy, and others. Kollmann and Santner (2021) found students learning to operate ultrasound machines benefited from the flexibility provided by an AR app. Students gained needed skills through access to real-time information about the locations and functions of the various mechanical knobs on the ultrasound machines in an AR environment as effectively as in a lab (Kollmann & Santner, 2021). Similarly, a case study of a machinist learning to use a bending tool in a metalworking factory suggested training through AR technology effectively tailored the skills training to each learner while eliminating the usual risk of injury (Mourtzis et al., 2019).

Motivation

Motivation plays an important role in successful learning. According to Zhao et al. (2022), *learning motivation* can be understood as the internal drive inducing students to learn spontaneously and is a key factor affecting student scholastic performance. Saptariana et al. (2021) explained motivation as the first principle of teaching and learning and learning activities likely will not succeed without it. The literature review by Avila-Garzon et al. (2021) found using AR in learning had a positive effect on student motivation. All research on motivation as an element in AR learning concluded learners experienced a significant increase in motivation when engaged in AR-related learning activities (Ashley-Welbeck & Vlachopoulos, 2020).

Majid and Salam (2021) performed a literature review of language learning with AR and discovered a common theme about students' positive increase in learning motivation and performance. Gómez-Galán et al. (2020) found learner motivation stemmed from a greater interest in and understanding of course content while engaged in AR learning. In an experimental study about middle school girls and AR, Bagherpur et al. (2021) discovered students who engaged in learning via AR experienced statistically significantly higher levels of motivation and critical thinking than students in the control group who engaged through conventional methods. Augmented reality learning environments are especially motivating for students when designed with elements of gamification (Pegrum, 2021). Tsai's (2020) study with fifth graders in Taiwan supported the idea of gamification for integration into AR learning to bring several beneficial learning outcomes, especially motivation to learn. Fan et al. (2020) proposed AR for trial-and-error learning contributed to increased motivation.

An experiment about academic study strategies in China found third-grade students who studied using AR materials experienced higher achievement motivation than students who used

typical text materials (Zhao et al., 2022). A study in India showed middle school mathematics students in an AR environment experienced higher achievement motivation and visual thinking than students in the control group with nondigital resources (Elsayed & Al-Najrani, 2021). Sixth-grade math students with high anxiety experienced higher satisfaction with the ease, usefulness, and playfulness of an AR learning experience; the students also reported lower anxiety than those learning math with traditional methods (Y. Chen, 2019). J. Y. Lai and Chang (2021) declared AR apps increased student motivation among students learning English vocabulary compared to students without AR. Sáez-López et al. (2020) asserted student motivation is the "key and most notable factor" (p. 8) for using AR for effective teaching and learning.

Satisfaction

Fan et al. (2020) presented a systematic review of the literature between 2010 and 2019 on language learning with virtual reality and found user satisfaction was a common outcome of AR learning participation. Students who used AR technology in a learning workshop reported higher levels of satisfaction and enjoyment than those who used traditional learning methods (Jesionkowska et al., 2020). A study of 600 undergraduate students in Iran indicated students immersed in learning content such as AR experienced more satisfaction in the form of self-confidence and competence (Darvishi et al., 2020). These students experienced a significant statistical increase in perceived enjoyment. Learners who engaged in the AR environment may have been less likely to feel the passage of time. This phenomenon could lead to more student engagement and increased learner success (Darvishi et al., 2020).

Çakıroğlu et al. (2022) reported students experienced a sense of enjoyment and curiosity while using AR to create concept maps to learn about lunar and solar eclipses. The enjoyment and curiosity also increased learner motivation to accomplish the learning tasks (Çakıroğlu et al.,

2022). Menon et al. (2022) designed an AR simulation to test its effectiveness in improving psychomotor skills and clinical competence in nursing education. Students in the group using AR reported higher satisfaction than those in the control group. Pipattanasuk and Songsriwittaya (2020) developed an instructional model for vocational students in Thailand and evaluated its effectiveness and student satisfaction. While learning achievement was higher for students who used the AR, perceived satisfaction was also discovered to be at a high level. The researchers concluded AR technology is suitable for helping teach vocational students (Pipattanasuk & Songsriwittaya, 2020).

Active Learning

Active learning includes the learner as a participant in the learning process (Zureck, 2021). According to Jesionkowska et al. (2020), active learning requires inquiry, critical thinking, and problem solving on the part of students. For active learning, the teacher assumes the role of a facilitator, so students can become actively engaged. Active learning is a prerequisite for true learning and occurs when learners awaken curiosity and work toward goals (Jesionkowska et al., 2020). According to Zureck (2021), strategic use of digital media in teaching and learning can help engage students in active learning because it encourages curiosity and interest in the study topic. Teachers can support many parts of active learning by integrating a variety of digital media, such as social media, webinars, simulations, blogs, games, and videos (Zureck, 2021). In a review of literature about the use of media and active learning, Zureck found many forms of digital media actively engaged learners through collaboration, interaction, and memorization. Dahdal (2020) surveyed and interviewed undergraduate students in a class on social media about using the social media app WhatsApp for graded assignments and weekly class discussions. Results showed students who used the social media platform embedded in the

structure of the course perceived it led to more active learning, collaboration, and learner motivation (Dahdal, 2020).

Sumarmi et al. (2021) found students who participated in a blend of traditional and digital media to learn about disaster preparedness experienced a greater sense of activity and innovation than those in the control group, who only used traditional resources. Augmented reality integrates a multiplicity of media and may encourage active learning in educational environments. Students assigned to engage in designing workshop prototypes through AR technology reported having experiences aligned with the benefits associated with active learning (Jesionkowska et al., 2020). Similarly, to help minimize job-related accidents in Malaysia, AR-based occupational safety and health training was developed. Ten untrained individuals participated in a training blending the in-person training with AR experiences; empirical results from a pretest, posttest, and survey indicated the students generally gained higher levels of active learning and motivation through the AR experience (Kamal et al., 2021).

Limitations

The educational use of AR has been studied at every level of education and among diverse types of learners, and the common conclusion is it potentially offers several benefits to teaching and learning (Tzima et al., 2019). In addition to the many benefits, AR has limitations regarding ease of use, need for training, and need for more apps. Through an analysis of research literature, Alzahrani (2020) postulated attempts to integrate AR in education settings could result in other challenges, such as resistance from teachers, usability issues, and information overload. The theoretical framework of the TPB and the TAM helps uncover how teachers' perceptions of the potential limitations of AR may impact motivation to use it.

Findings in a study by Osuna et al. (2019) coincided with other studies suggesting teacher

training on using AR in the classroom should include content about technical and pedagogical knowledge to empower teachers to incorporate it effectively with teaching. As immersive technology is not ubiquitous, increased student interest and motivation while using AR may be due in part to a novelty effect and may not endure (Tsai, 2020).

Similarly, Quintero et al. (2019) reported a literature review of 50 scholarly articles showed a strong need for the creation of AR apps based on technical and didactic merits. An evaluation of research exposed that AR, like most technologies, has conceivable limitations. Alzahrani (2020) identified three primary categories of how using AR for education might be challenging. First, learning challenges can occur within AR environments. Second, people using AR technology can confront pedagogical issues. Third, AR technology may introduce technological challenges for teachers and students (Alzahrani, 2020).

Learning Challenges

According to Alzahrani (2020), challenges related to using AR pertain to learners and the process of learning. Usability issues have been reported by some users who find AR technology complicated and struggle with technical problems. Students may become overwhelmed by a large amount of complex, media-rich content in AR. Learners may be expected to interact with highly technical and unfamiliar devices that involve confusing tasks under intense situations. The implication is students who use AR without assistance, guidance, or support may experience delayed or negative effects in learning (Alzahrani, 2020). Students and teachers alike must have at least some basic working knowledge of AR if it is to aid in teaching and learning (Ashley-Welbeck & Vlachopoulos, 2020). Augmented reality apps specifically designed for learning may help teachers provide learner-centric, effective, and meaningful experiences for students (Czerkawski & Berti, 2021).

Pedagogy Challenges

Pedagogy involves the theories and practices implicated in a formal academic discipline surrounding the effective transmission of knowledge (Mercadal, 2020). According to Czerkawski and Berti (2021), while some literature cites attempts to design AR apps, most apps using AR for educational purposes still lack a clear focus on basing effectiveness on educational outcomes. Augmented reality learning activities typically include studio-type learning involving simulations for participants, contradicting the usual teacher-centered delivery methods (Alzahrani, 2020). Such differences can hinder how teachers implement AR technology and speak to the lack of training afforded to most teachers about effective media-related pedagogy. Teachers generally have an understanding and experience with effectively evaluating the quality of traditional teaching resources (Karacan & Akoglu, 2021). With the number of digital teaching resources increasing, teachers have the added burden of evaluating and determining the effectiveness of resources. Teachers experienced a sense of confusion when attempting to integrate AR into usual teaching methods when lacking training on how to effectively use AR (Karacan & Akoglu, 2021). Proper training can help teachers learn and implement effective pedagogical practices and resolve issues related to ineffective instructional strategies using AR (Alzahrani, 2020).

As with all media for teaching and learning, quality instructional design is critical in allowing learners to have an effective learning experience. Poor instructional design will unnecessarily burden a learner's cognitive capacity and reduce long-term understanding. The theory of cognitive load suggests a person's working memory has a limit, and, if overloaded, reduces the ability to understand, remember, and perform (Ashley-Welbeck & Vlachopoulos, 2020).

Augmented reality is a promising technology for educational purposes because it reduces students' intrinsic and extrinsic cognitive load (A. Lai et al., 2019). A literary evaluation by Avila-Garzon et al. (2021) indicated AR for education provides students with a reduced cognitive load. However, Ashley-Welbeck and Vlachopoulos (2020) suggested mobile learning mixing real-world and digital data resulted in unfavorable learning environments by increasing cognitive load. However, the researchers described a potential flaw in the research because the findings failed to identify the type of cognitive load, indicating an increase in cognitive load on students could have been caused by factors other than digital technology, including an ineffective use of materials or by the assessment itself. The findings may reiterate the need for quality instructional design in AR apps. Regardless of the accuracy of the findings on cognitive load, the study indicated students reported having experienced an increase in positive attitudes and motivation regarding the learning process using AR technology (Ashley-Welbeck & Vlachopoulos, 2020). Pegrum (2021) challenged the assertion AR technology reduces a user's cognitive load by suggesting cognitive overload and distraction are potential issues regarding AR and education.

Augmented reality technology is most effective for learning when designers and teachers understand how and when to integrate it appropriately into the learning experience (Steffen et al., 2019). According to Sural (2018), AR allows learners to study abstract concepts that are traditionally difficult to understand through a textbook by digitally merging the abstract within a real-world setting. Research supports the efficacy of AR technology as applied to educational apps when designers and teachers understand the framework for how and when to integrate the technology to facilitate sound pedagogy (Steffen et al., 2019).

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difficult to understand through a textbook by digitally merging the abstract concepts within a real-world setting. Research supports the efficacy of AR technology as applied to educational apps when designers and teachers understand the framework for how and when to appropriately integrate the technology to facilitate sound pedagogy (Steffen et al., 2019). Czerkawski and Berti (2021) suggested teachers should evaluate and determine how a potential technology will help support learning outcomes when considering implementation. When applied effectively, AR can allow learners to use multiple senses to construct meaning about abstract concepts such as learning a foreign language (Tsai, 2020). Students can use AR to view, hear, and interact with digital learning assets about many academic subjects that are traditionally difficult to represent.

Augmented reality has been shown to assist students in learning a wide range of subjects, including early language learning, geology, and social sciences, and developing professional skills (Fan et al., 2020; Gómez-Galán et al., 2020; Syawaludin et al., 2019). However, Fan et al. (2020) noted the benefits of learner motivation are reduced when the presentation design of the AR learning experiences is not supported by effective pedagogy. Several AR apps exist for learning a language, but none is specifically designed for language learning in education. Integrating such apps into formal learning designs places an additional burden on teachers. These types of AR apps are less than optimal in organized education (Karacan & Akoglu, 2021). Research implies the importance of intentional pedagogical design in the creation of AR experiences for learning (Fan et al., 2020). Sembayev et al. (2021) attempted to apply principles of effective AR design in assessment activities. Students interacted within an AR app to take a test and used touch-based interactions, voice commands, gestures, and gaze interaction to respond to true-or-false, multiple-choice, fill-in-the-blank, and other test items. Survey responses from teachers and students showed the AR testing app was effective for evaluating educational

activities and met validity and reliability standards for evaluation (Sembayev et al., 2021).

Technology Challenges

Technical issues involve challenges in integrating and using hardware or software for AR, including elements such as the expense of the technology, connectivity challenges, global positioning errors, and a lag in device responsiveness and sensitivity. Challenges with using AR technology can be cumbersome and frustrate the entire process of learning (Alzahrani, 2020). Using immersive technology like AR can cause a bottleneck effect limiting the number of students who can engage when not all students have access to the needed hardware (Doerner & Horst, 2022). The need for supervision to encourage safety and avoid cybersickness in a digital environment can also dominate a teacher's time and availability to meet the needs of all students. Additional challenges with using AR in formal education may include limited access to AR hardware and software for student use outside of class, the requisite time and effort for teachers to prepare for and execute AR learning experiences, and physical space requirements competing with space for instruction within a classroom.

An observation of preservice teachers using AR to teach biology found, even amid a host of positive outcomes, teachers experienced some drawbacks, including unreliable internet connection, instability of mobile devices, and related expenses, and the nature of AR was not appropriate for every learning subject (Yapici & Karakoyun, 2021). According to Czerkawski and Berti (2021), designing curriculum and activity resources to help teachers integrate AR into teaching may shift the burden away from teachers. Teachers may be challenged in getting access to AR apps suitable for teaching and the learning needs of students. Teachers may discover a compulsion to adapt existing apps to meet educational needs or to learn to develop an app themselves. The TPB and the TAM may serve to help determine how teachers' perceptions of

the need to access AR apps for teaching may impact motivation to use them.

Using Existing Apps. Koutromanos et al. (2015) identified the challenge of not having enough pedagogically sound research supporting how to integrate AR experiences successfully into curriculum, assessments, and teacher preparation. Existing AR software can be expensive; is often insufficient for educational purposes as it is not designed with learning in mind; and lacks administrative features, such as the ability to monitor student use and the inclusion of assessment tools, to support teachers (Grinshkun et al., 2021). According to Czerkawski and Berti (2021), one of the most universal technical limitations of using existing AR apps in education not designed by professionals pertains to an immature development phase and its poor maintenance during implementation. In addition, there is not a strong market for pedagogically sound AR apps specifically designed for various educational topics. The few existing high-quality learning AR apps are typically financially prohibitive and usually require users to have a mobile device such as a smartphone or tablet (Czerkawski & Berti, 2021). According to Hadjistassou et al. (2021), students who used an existing AR app to engage in a learning activity solving a mystery imposed an added burden on teachers by becoming especially distracted by the environment. Accordingly, tasks within a digitally immersive learning experience are most beneficial when explicitly structured and providing clear guidelines (Hadjistassou et al., 2021).

Creating New Apps. According to Arifin et al. (2018), many AR apps are created by people without training or expertise due to the relative availability of AR development software. Nonprofessional developers typically do not have the needed knowledge and skill to consider the design elements in AR apps to optimize the user experience and facilitate learning. Designers should consider whether the app is intended to involve one user or multiple users, how to have users interact with the physical environment, and how to design learning tasks within the app

(Arifin et al., 2018). Research supporting the benefits of using AR for teaching and learning is plentiful; however, most teachers do not know how to implement strategies to implement it to promote learning experiences based on effective instructional design (Czerkawski & Berti, 2021).

A bibliometric analysis of 3,475 studies by Avila-Garzon et al. (2021) revealed themes about the lack of desired tools for aiding teachers in developing AR apps. Developing AR software specifically for education is complex and time consuming, requires explicit technical skills, and would overburden the typical teacher. The desire for teachers to create AR software for proprietary educational purposes would reiterate the strong need for training and related resources. Findings by Jesionkowska et al. (2020) suggested teachers and students can produce simple and effective AR apps for science, math, art, and other subjects when given the opportunity and resources to develop the needed skills.

Yonov and Bandrova (2021) experimented with young learners by developing new AR apps for testing. The researchers reported the process of creating an AR app was very complex and time consuming. Developing an AR app for educational purposes requires data collection, modeling, design, and visualization. Sound instructional design is required for AR to be a quality tool for teaching and learning (Yonov & Bandrova, 2021). The value of AR in the classroom is diminished when teachers or designers erroneously assume it meets the needs of all learners equally (Jesionkowska et al., 2020). Grinshkun et al. (2021) reported AR technology could possess a distractive quality whereby too many stimuli can overload the student's perception.

Using immersive technology in classrooms may contribute to a generational "digital gap" (Gómez-Galán et al., 2020, p. 9) between students and teachers requiring additional training to help teachers keep up with advancements in technology. Poorly trained teachers, requisite

technical proficiency, and negative attitudes toward innovative technologies contribute to the need for continuous training (Grinshkun et al., 2021). According to Sáez-López et al. (2020), teachers and students can benefit from AR in the classroom once resources are made sufficiently available, proper planning has been put in place, and teachers receive the requisite training.

Teacher Perceptions

The effective implementation of AR in the classroom not only is dependent on learners but also relies significantly on the teacher's ability and willingness to use it (Ashley-Welbeck & Vlachopoulos, 2020). It is not unusual for teachers to experience a sense of hesitation when facing the possibility of needing to replace conventional teaching approaches in favor of adopting technological innovations, such as integrating AR into teaching methods (Alzahrani, 2020). The literature offers a limited understanding of teacher motivation to use AR in the classroom. Findings generally indicate teachers perceive the potentially positive impact of using AR in teaching but shed little light on teacher motivation to implement AR and suggest the need for further study. The theoretical framework of the TPB and the TAM may offer insight into how teachers' motivation to use AR may impact their willingness to use it.

Tzima et al. (2019) asserted personal development was the number one reason teachers reported having an interest in continuous training. Nearly all surveyed teachers indicated time constraints as a reason against wanting to attend a training seminar to learn how to use AR. All of the participants indicated the need for training about changes in technology and social demand for proficiency-produced stress with 60% indicating *stressful enough* or *very stressful*. Findings revealed teacher interest in personal development overcame other concerns such as time limitations. Most teachers were not familiar with 3D creation, nor had they created a 3D model. Teachers reported limited familiarity and experience with AR technology, but the results were

flipped when asked about being interested in training on creating 3D; the teachers showed a significant willingness to learn more (Tzima et al., 2019). Tzima et al. reported 100% of study participants indicated never having used AR technology in teaching, while about half reported having read about or heard about AR. Yapici and Karakoyun (2021) conducted a study with 16 preservice biology teachers who integrated AR activities into teaching; nearly all participants reported having positive perceptions about the impact of AR on teaching biology. According to Chicioreanu and Amza (2014), most respondents indicated believing AR is beneficial to children as a teaching method. To integrate AR effectively, teachers should know the needs of students; have time to prepare materials; have basic information technology skills for using AR hardware and software; know the subject matter, so AR use enhances the learning experience and not merely mesmerizes students; make the experience learner-centered; keep in mind learning outcomes and needs regarding assessing students; and be enthusiastic about AR (Chicioreanu & Amza, 2014).

According to Marín-Díaz et al. (2022), high school teachers had a generally positive disposition about the use of AR for learning at the respective education level. The youngest group of teachers (24–30 years) and the oldest group (over 50 years) had less favorable perceptions of AR than those in the middle group (31–40 years). High school teachers considered AR as a change agent for more autonomous and experiential learning. The teachers perceived the need for more training, reduced costs, and more resources. Responses from elementary school student-teachers indicated only having a fair amount of knowledge about AR, but when informed about it, they became very excited about its potential use in learning and learning materials (Sural, 2018). Student-teachers reported wanting to see AR in self-designed lessons and learning environments (Sural, 2018).

According to Sáez-López et al. (2020), education students in Spain valued the idea of training teachers in AR use. The university students reported not typically using AR during university education and had not considered using AR in personal work as teachers. Positive perceptions by teachers about AR in the classroom are not sufficient for effective integration. Other barriers, such as a lack of access to professional development opportunities to help teachers use AR technology, will make many teachers less likely to utilize it in teaching (Ashley-Welbeck & Vlachopoulos, 2020). According to Ashley-Welbeck and Vlachopoulos (2020), the greatest limitation to maximizing the benefits of AR in learning is the lack of teachers' vision.

Chapter Summary

The literature indicated researchers generally accept AR technology as potentially beneficial for teaching and learning and it is not widely integrated into schools (Oliveira da Silva et al., 2019). Benefits of using AR for learning include skills development, greater student motivation, higher satisfaction, and increased active learning. In addition to benefits, AR learning may introduce some challenges, including learning issues, problems with pedagogy, and technological challenges. Emerging themes from the extant research pointed to the opportunity to apply AR technology more effectively in educational settings and underscored the need for added knowledge of teacher motivation to use it in the classroom.

The literature indicated teachers generally view AR as a valuable tool for teaching and learning. No data exist about what motivates teachers in northern Utah to use AR in teaching or what kinds of support teachers need to use AR. The purpose of this basic qualitative study was to explore what motivates teachers in northern Utah to use AR in teaching and what assistance is needed to implement AR effectively as a teaching method. Included in the following chapter is a description of the methodology, research questions, research design and rationale, research

population and sampling method, instrumentation, and procedures for data collection and analysis.

Chapter 3: Methodology

Augmented reality (AR) can enhance learning environments by using virtual objects through digital technology (Altınpulluk et al., 2020). This merging of abstract concepts within a real-world setting is beneficial in education because it can help students understand abstract ideas that are typically more difficult through traditional methods (Sural, 2018). While not widely used in schools, AR is generally accepted in the literature as having a strong potential for positively influencing learning outcomes (Oliveira da Silva et al., 2019). Chicioreanu and Amza (2014) found 94% of teachers surveyed said AR is an "excellent and good" (p. 3) teaching method, but only 19% intended to use the technology with students. Teacher motivation for implementing AR as a teaching method at suburban high schools in northern Utah are unclear, as is what support the teachers need to effectively involve AR in classroom instruction. The purpose of this basic qualitative study was to explore what motivates teachers at suburban high schools in northern Utah to use AR in teaching and what support is needed for teachers to apply AR effectively in a classroom setting. The information gained through this study may influence the adoption of AR technology in education and improve learning outcomes. The following research questions guided the study:

Research Question 1: What motivates teachers at suburban high schools in northern Utah to implement augmented reality in teaching practices?

Research Question 2: What support is needed for motivated teachers at suburban high schools in northern Utah to effectively implement augmented reality in teaching practices?

The following sections include research methodology, design, and rationale; role of the researcher; research procedures; reliability and validity; ethical procedures; and chapter summary.

Research Methodology, Design, and Rationale

This section provides a rationale for the selection of the research methodology and design. The research methodology describes why a qualitative study aligned with the research questions. The research design explains why basic qualitative was appropriate for collecting and analyzing information from teachers about motivation for using AR and necessary support.

Methodology

The qualitative research methodology was appropriate for this study and best aligned with the research questions, problem, and purpose by seeking to understand how teachers make meaning based on personal experience with AR. Qualitative research is used to extrapolate an understanding of the phenomenon from the individuals' experiences in the natural setting (Johnson et al., 2020). A qualitative approach allowed the collection of more knowledge of what motivates high school teachers at suburban high schools in northern Utah to implement AR technology in teaching practices and what support is needed to integrate AR effectively into teaching.

Design

According to Merriam and Tisdell (2015), a basic qualitative design has the potential to inform types of implementations and practices, but its primary purpose is to increase knowledge about people's meaning derived from a particular phenomenon, activity, or experience. The rationale for using a basic qualitative design is the research questions cannot be explored strictly by following other established methodologies (Kahlke, 2014). The methodology of phenomenology helps people gain understanding based on a subject's lived experience, not the motivation behind a particular practice. Time restraints and limitations of resources prohibited the use of more intensive research designs such as phenomenology. Therefore, a basic qualitative

design was appropriate for the study and facilitated the exploration of what motivates high school teachers at suburban high schools in northern Utah to implement AR technology in teaching and what support is needed to integrate AR effectively. The research purpose was achieved by discovering themes and subthemes through initial open coding (Percy et al., 2015). Data collection and analysis may reveal in-depth information about the participants' experiences and how experiences inform how people respond (Merriam & Tisdell, 2015). A basic qualitative design solicited the emergence of data for coding, analysis, and development of ideas about what motivates teachers to utilize AR technology in teaching practices.

Role of the Researcher

My role in this qualitative study was as the researcher and interviewer. I had no working relationship or other formal or informal connection with the subjects. While not a member of the population group, a researcher brings opinions to a study as a participant, which drives motivation to learn more about a given topic (Altenmüller et al., 2021). To remain impartial, I attempted to approach each participant with a neutral mindset. The use of a reflection journal served as a tool for expressing feelings that surfaced and challenged my impartiality. Sometimes researchers are inclined to express positionality with participants by sharing personal experiences during the interview (Darwin Holmes, 2020). Efforts were taken to ensure participants were not influenced by my opinions during the interview process. According to Rutakumwa et al. (2020), novice interviewers may influence data by underestimating how one's approach, tone, and responses during the interview process may influence how participants respond to interview questions. This limitation was avoided by applying the practice of bracketing while executing the interviews. According to Weatherford and Maitra (2019), bracketing is a critical element when studying a phenomenon and occurs when researchers refrain from viewing a topic in a common

way and separate personal experiences from the study. Researchers apply bracketing by abstaining from judgment during the research process. The interview questions were read from an interview protocol, and respondents were encouraged to explain answers in detail. Follow-up questions were used as needed to seek clarification of participants' answers. I reacted to comments from interviewees with objective responses.

Research Procedures

This study followed accepted practices for qualitative research. Research procedures ensured proper permissions were gained to interact with the selected sample and consent was voluntarily granted. Methods of data collection were aligned with the research questions and the design using semistructured interviews. The interview questions were adapted from an existing protocol and were validated by subject matter experts regarding form and content.

Population and Sample Selection

Identifying a research site with people who were accessible, willing, and able to contribute to the issue was an important part of this research. The target population for this study was teachers at suburban high schools in one school district in northern Utah. Five of the seven high schools in the district were available for research and employed 322 teachers. This study obtained interviews from a sample of 17 teachers and relied on convenience sampling to procure teachers to participate in interviews. Convenience sampling allows the most accessible individuals to be selected (Raifman et al., 2022). With convenience sampling, participants are enrolled in a study based on willingness, approachability, or otherwise easy access to the researcher. Scholtz (2021) suggested convenience sampling may challenge the validity of data, and convenience samples do not necessarily represent the population of interest in a study. All teachers at the approved schools were invited to participate in the study. The first 17 teachers to

respond with interest and availability to be interviewed about AR and teaching were considered for participation. Implementing convenience sampling facilitated an expeditious identification of the sample for the study.

District administrators were required to grant approval and provide a signed letter of permission for the research to be conducted at schools in the district (see Appendix A). Communication with potential interviewees was initiated and maintained via email. Access to participants' email contact information was granted by each school's administration. A recruitment letter informed participants of the purpose of the study and the responsibility to grant informed consent (see Appendix B). Each participant was required to physically sign and submit an informed consent form (see Appendix C). Respondents provided information regarding demographics as part of the initial interview phase. To protect the confidentiality of participants, an arbitrary identification number was assigned to each person.

Instruments

Tools were employed to collect data from the research participants. Content from the semistructured interviews was captured using digital recording tools. Subject matter experts validated the adapted interview protocol.

Semistructured Interviews

Ascertaining how participants use and perceive AR technology in teaching was an integral part of preparing the research questions. Semistructured interviews and audio recordings were a proper fit to answer the research questions. Properly designed interviews guide participants to recount experiences to represent a perspective of what happened (Bearman, 2019). A semistructured interview is a reciprocal conversation and is an effective instrument to collect qualitative data for garnering insight into participants' opinions of technology use (Brown &

Danaher, 2019). Semistructured interviews provide a flexible structure to assist participants in sharing feelings for data collection and can lead to a deeper understanding of the phenomenon in question (Peesker et al., 2019). Through the interviews, experiential descriptions by respondents provide insights into the social aspects of the data for interpretation by both the participant and the interviewer.

Audio interviews were transcribed using Microsoft Word. Semistructured interviews and an audio recording device aided in capturing participant feelings and opinions. Findings brought light to what motivates high school teachers at suburban high schools in northern Utah to implement AR technology in the classroom and what support is needed to integrate it effectively into teaching methods.

Interview Protocol Instrument Validation

According to Bearman (2019), researchers can design an effective interview outline to align the interview questions with the research questions and approach of the study. Accordingly, the interview protocol for this study was designed following Bearman's three steps for developing interview questions: (a) articulating questions based on a core event to illustrate the phenomenon of interest, (b) using an intuitive order of conversation, and (c) refining the interview outline based on the needs of each person. The interview protocol was designed to avoid yes–no questions in favor of open-ended questions to assist in producing generative responses (Bearman, 2019). The interview questions were written to elicit descriptions from participants about experiences instead of opinions, encourage brainstorming around AR use, begin with tangible and easy ideas, and conclude with more abstract and difficult ideas.

The computer company Intel developed an interview protocol to evaluate the integration of specific technology by teachers (see Appendix D). The interview questions were published in

a document called *Intel Guide to Monitoring eLearning Programs* (Intel, 2011). The protocol was used to interview teachers about the integration of e-learning programs using Intel-powered technology. Intel granted permission to adapt the content of the teacher interview protocol for use in this study (see Appendix E). Most of the questions are open-ended in nature with follow-up questions where appropriate. The Intel interview protocol aligned with the design of this study and guided the preparation of interview questions to elicit information about teachers' use of AR technology and the support needed to use AR in teaching. The interview questions in the Intel protocol applied Bearman's steps for developing effective interview questions.

Four subject matter experts who work as professionals in research evaluation of a large institution were invited to review the adaptations to the interview protocol and provide feedback (see Appendix F). While two did not respond to the request, two provided feedback to contribute to the validity of the interview protocol. The first subject matter expert offered recommendations to adjust interview themes to better align with the research questions, including adding a section about motivating factors for teachers to use AR in the classroom (see Appendix G). The second subject matter expert made suggestions to add bullet points under interview questions to aid in follow-up questioning during the interviews and data coding after the interviews. Feedback from the subject matter experts was adopted to adapt the interview protocol produced by Intel for the purpose of gathering data from teachers about motivation to use AR as a teaching method (see Appendix H).

Data Collection

Data collection began once Institutional Review Board (IRB) approval was obtained (see Appendix H). Semistructured interviews revealed participants' feelings and opinions about motivation to use AR in the classroom. Each interview was intended to last around 60 minutes.

According to Elhami and Khoshnevisan (2022), a semistructured interview is a flexible tool for conducting qualitative research by assisting researchers in uncovering knowledge through conversations about participants' feelings, emotions, and ideas. The semistructured interviews utilized topics related to what motivates teachers' professional use of AR technology in the classroom and what support is needed to integrate it into methods of teaching. Where possible, interviews were conducted in person at a location chosen by each participant. Otherwise, the conversations were held via the free and ubiquitous digital telecommunication technology Google Meet. At the conclusion of each interview, the participant was given the opportunity to express any final ideas and opinions relating to the research topic. Interviewees were thanked for participating and were asked for permission to be contacted in the case of necessary follow-up questions.

Some researchers assert the presence of an audio recording device adds an element of intimidation to the interview process (Rutakumwa et al., 2020). However, significant academic literature accepts recording devices as positively impacting the accuracy, validity, and trustworthiness of interview data. The in-person interviews for this study were audio recorded to an SD card using a digital audio recorder. The SD card was kept in the possession of the researcher until the audio files were uploaded. Participants of virtual interviews were informed the audio and video would be recorded. Only the audio was used for transcription. Text, video, and audio files were copied to the interviewer's laptop and placed in a secure, password-protected Microsoft One Drive folder to safeguard the privacy of participants. The researcher alone had access to the One Drive folder. Once transferred, media files were deleted from the SD card. The free voice-to-text transcription service associated with Microsoft Word was used for creating textual transcripts of interviews. Transcripts from the interviews aided the data analysis

process.

Data Analysis

Qualitative coding makes meaning within the data collected through the semistructured interviews. A qualitative code is a word or brief phrase used to represent a major attribute of a portion of data (Hemmler et al., 2022). The process of coding information qualitatively serves as a connection between data and their analysis. Next, the data were transformed into similar codes using axial coding to identify redundancy in the data. Axial coding reveals connections among the various codes and is accomplished by exploring the causal conditions, developing a central phenomenon, and determining its consequence (Hossain & Jaradat, 2018). Selective coding was then used to select broader codes based on the connections identified during axial coding to generate knowledge about what motivates teachers to use AR. Analyzing data through selective coding involves producing a primary theme from the main category, analyzing it against all emerging categories, and developing new ideas about the phenomenon (Cao et al., 2019).

Codes were analyzed using a thematic approach, which allowed categories to emerge and aided in developing a framework of meaning around participant responses. According to Nowell et al. (2017), a thematic approach to data analysis is a method for identifying, analyzing, organizing, describing, and reporting themes found within a set of information. While a thematic analysis may be disadvantageous in its ability to allow researchers to make claims about the use of language in the data, it is beneficial in offering a flexible approach for producing insightful findings for a diversity of research questions.

Braun and Clarke (2019) designed six steps to facilitate a thematic analysis: familiarity, codes, themes, meaning frames, review, and refinement. Accordingly, to facilitate a thematic analysis of data gathered through semistructured interviews with teachers at suburban high

schools in northern Utah, the researcher became familiar with the participants' responses to gain a broad sense of what participants experienced. Developing a framework of codes helped identify emerging themes. Arranging the themes from the codes initiated the building of meaning frames. The developing themes were reviewed against the data to ensure consistency. Themes were refined and named. QDA Miner Lite, a computer-assisted qualitative analysis software, was used to analyze data from interviews and open-ended responses. A written report solidifies and presents an interpretation of how the organized themes contribute to the body of knowledge on the topic (Achmat & Brown, 2019).

Reliability and Validity

According to Carcary (2020), qualitative research generates a large amount of data and immerses the researcher in the body of evidence. Researcher bias is often considered a challenge in qualitative research, as the researcher usually serves as the study's primary research instrument (Jones & Donmoyer, 2021). The trustworthiness of a qualitative study is demonstrated by its credibility, dependability, and transferability (Carcary, 2020). This study employed strategies to establish the reliability and validity of the research to mitigate the potential influence of researcher subjectivity.

Credibility

Credibility in research signifies the methods used were appropriate for studying what it claimed to study and for truthfully reporting the findings (Coleman, 2021). A mechanical recording was used to contribute to the credibility of the data. The mechanical recording used an audio-recording device to capture verbatim transcripts of interviews. Rich data are produced through the transcripts to uncover a broader view of the topic, while relieving the researcher of the obligation to take copious notes during interviews (Coleman, 2021).

Additionally, the interview process involved member checking, a strategy to strengthen the validity of a study. Member checking occurs when a researcher informally confirms the accurate understanding of what the participants said in the interviews (Coleman, 2021). The researcher echoed, paraphrased, or asked for further clarification from interviewees regarding responses to questions to allow the opportunity to confirm or correct the researcher's understanding of what was said. Unlike respondent validation, which requires additional participant engagement after the interview to review a written transcript, member checking was performed in real time during the interviews and did not place further demands on respondents.

Dependability

Dependability refers to the consistency of the data being investigated in a qualitative study. To foster research dependability, data triangulation was implemented by interviewing multiple participants and by looking for commonalities among responses. The purpose of data triangulation is to enhance the breadth and depth of a study's findings (Janis, 2022). In the context of research, *triangulation* is the employment of multiple practices or resources to gain a complete view of the situation under investigation and enhances the validity of a study (Natow, 2020). Triangulating the data by interviewing several participants ensured diversity of respondents had the opportunity to participate in interview conversations regardless of grade or subject taught. According to Cobern and Adams (2020), interviews are used to determine people's opinions, and enough people should be questioned to gain an accurate representation of the population. Standard qualitative practice suggests an acceptable number of interviewees is between 15 and 20 for a research topic of limited scope. This study involved semistructured interviews with 17 teachers for the purpose of strengthening research dependability.

According to Jones and Donmoyer (2021), researchers can strive for strong objectivity by

acknowledging how one's personal history, language, methods, and other factors may influence the study. In this study, the researcher strove to maintain objectivity by reflecting on how personal background, use of language, and execution of research methods may impact results. Perceived challenges to objectivity were documented for full transparency.

Transferability

Transferability is an important consideration in defining reliability within a qualitative study. Sometimes called *replicability*, *transferability* refers to a study's consistency in findings and replicable outcomes. Within qualitative research, transferability can be described as the dependability of its findings, regardless of the researcher, if the established procedures are followed (Coleman, 2021). This study supported transferability by implementing reliability tests such as the comparison of data and the use of tables to record data. The use of a consistent interview protocol with all participants enhanced the reliability of the interviews. However, some researchers suggest such a structure may negatively impact the study's validity as participants may feel less free to express candid opinions (Coleman, 2021). Accordingly, each interview followed the established protocol with the option to use varied follow-up questions as deemed necessary. The report of this study included an expression of transparency and a detailed rationale for the research design and implementation, so the reader can better evaluate its reliability. These strategies aided in the formal organization of the data and established authenticity.

Trustworthiness

Trustworthiness, also referred to as *confirmability*, can be achieved when the researcher makes a physical and intellectual audit trail (Carcary, 2020). The physical audit involves making a record of significant process decisions during a study. The researcher strove for integrity by

reflecting on and recording any personal biases developed during the process of the study that may influence findings. The intellectual audit consists of documenting how a researcher's thinking changes over the course of the project. Keeping such records during the research process encourages an element of self-reflexivity by the researcher and can help one to minimize and manage one's subjective influence (Carcary, 2020).

Ethical Procedures

This study aligned with the principles of research ethics outlined in *The Belmont Report* prepared by the U.S. government in response to ethical infractions in medical research (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). Writers of *The Belmont Report* proposed three principles to guide ethical conduct when research involves human subjects: respect for persons, beneficence, and justice.

Respect for persons assumes every respondent's autonomy by requiring them to give consent to participate in the study. Participants in this study had the opportunity to give consent as a requisite to contribute. The consent form apprised participants of information relevant to the study in a language easy to understand, ensured the participants consented voluntarily, and documented consent to participate freely (Manti & Licari, 2018).

The principle of beneficence guides researchers to keep in mind the participants' safety and welfare throughout the study (Adashi et al., 2018). During the study, the researcher maintained recognition of the benefits gained through more knowledge of teacher motivation for using AR technology with students and the associated risks were minimal. All participants were adults and chose to participate. While being interviewed, no participant indicated belonging to a protected class. Had information indicating a protected class been revealed during the interview, the participant would have been assured the information would not be included in the data

analysis.

The principle of justice aided the researcher to endeavor to distribute the burdens and benefits of the study as evenly as possible (Brear & Gordon, 2021). Participants were treated as equally as possible, regardless of distinctions such as age, biological sex, position, and race. Archival data relating to participant responses were kept on a digital server behind a password-protected log-in. Findings and completed dissertation implications may be shared with interested parties, including interviewees and school district leaders. Three years after completion of the study, participant data, including interview audio recordings and transcripts, will be destroyed, digital files will be deleted, and paper files will be shredded.

Chapter Summary

Augmented reality technology is effective in helping students achieve learning outcomes; however, it is not yet widely adopted by high school teachers. Teachers' motivation for using AR may impact whether teachers offer students opportunities for AR learning experiences. The study may contribute to an increased understanding of what motivates teachers at suburban high schools in northern Utah to implement AR in teaching and what support is needed to integrate the technology effectively into teaching. A qualitative research method and a basic qualitative design enabled data gathering about what motivates teachers to use AR technology in classrooms and what support teachers need to do it effectively. Semistructured interviews assisted in collecting rich data about the topic. A thematic analysis of the data produced themes to interpret teacher responses into a framework of meaning. Applying principles of research ethics assisted in protecting the human subjects who participated in the interviews. Analysis of data from participants uncovered findings to benefit teachers and administrators by helping them understand what factors motivate teachers to integrate AR technology in classrooms and what

support is needed to help teachers implement it effectively.

Chapter 4: Research Findings and Data Analysis Results

Learning environments can be enhanced using augmented reality (AR) to integrate virtual objects through digital technology (Altınpulluk et al., 2020). Augmented reality can enrich learning by helping students understand abstract concepts through the superimposing of digital components onto the actual environment (Sural, 2018). Though AR is generally accepted as having a strong potential for positively influencing learning outcomes, AR is not regularly used in formal education (Oliveira da Silva et al., 2019). Chicioreanu and Amza (2014) noted 94% of teachers surveyed said AR is an "excellent and good" (p. 3) teaching method, but only 19% intended to use the technology with students.

The problem was a lack of clarity about what motivates high school teachers to use AR in classrooms at a suburban high school in northern Utah. The support teachers need to involve AR effectively in instruction was unclear. In a study by Tzima et al. (2019), 100% of junior and senior high school teachers reported never having used AR for teaching, while 50% indicated having previously read or heard about AR. The lack of information about teacher motivation to use AR and the support needed to use AR may limit how school and district leaders train and support teachers. A deficiency of knowledge may impede how designers create AR apps for successful educational use. Results from the study may prompt education leaders and AR designers to encourage the effective use of AR in teaching. The following research questions guided the study:

Research Question 1: What motivates teachers at suburban high schools in northern Utah to implement augmented reality in teaching practices?

Research Question 2: What support is needed for motivated teachers at suburban high schools in northern Utah to effectively implement augmented reality in teaching practices?

An explanation of the data collection and analysis processes describes how interviews were conducted to uncover participants' motivation to use AR and the support teachers need to integrate AR into their teaching. The method of coding and analyzing interview data is reported. Descriptions include the processes of data collection, data analysis and results, and reliability and validity.

Data Collection

A total of 226 teachers from five high schools in one school district were asked via email to participate in one semistructured interview. Nine (4%) teachers responded by declining an interview, four (2%) teachers accepting the interview request were ultimately unable to participate, and 17 (8%) teachers shared their perspectives about AR in synchronous interviews between January 19 and March 14 of 2023. All respondents were given the option to meet in person or virtually. Four participants opted for an in-person interview, and 11 chose a virtual interview (see Table 1).

Table 1

Number of Interviews by School

School	In-person interviews	Virtual interviews	Total interviews
School A	1	3	4
School B	3	5	8
School C	1	0	1
School D	1	1	2
School E	0	2	2
Total	6	11	17

The virtual meetings were held via Google Meet, a video conferencing platform. Individuals being interviewed in person were presented with a consent form immediately before the interview. Those participating virtually returned the signed consent form electronically preceding the video conference meeting. The interviews lasted 30–70 minutes. Thirty percent of participants were female, and 70% were male (see Table 2).

Table 2

Number and Gender of Participants by School

School	Males	Females
School A	3	1
School B	6	2
School C	0	1
School D	2	0
School E	1	1
Total	12	5

Participants' years of teaching experience ranged from 1 to 27. Convenience sampling includes the risk of attracting a disproportionate number of participants who teach subjects traditionally inclusive of visual technology. However, subjects taught by participants represented a broad sample of the population, including social studies, physical education, English, science, automotive mechanics, computer science, technology, art, and music.

During the data collection process, minor adjustments were made to the proposed methodology, including recruitment strategies, the interview protocol, and the transcription tool.

The request to make the modifications was approved by the IRB on January 24, 2023. While snowball sampling was eventually added to convenience sampling to encourage the recruitment of participants, all interviews resulted from convenience sampling. The third question in the interview protocol was originally designed to prompt respondents to explain their current teaching situation. Instead, the question was asked at the beginning of the interview to initiate a more natural flow of conversation. When teachers revealed their unfamiliarity with AR, a simple example of AR for presenting educational content was shown.

oTranscribe, an audio-to-text software, was originally planned to aid in the transcription of the interviews but was found to be insufficient. A satisfactory voice-to-text function within Microsoft Word was employed for transcription.

Data Analysis and Results

Data collected through the semistructured teacher interviews were organized using qualitative coding with a computer-assisted qualitative analysis software, QDA Miner Lite. A qualitative code is a word or brief phrase identified to represent a major theme for a portion of data (Hemmler et al., 2022). Following the six-step model developed by Braun and Clarke (2019) provided a framework for thematically analyzing the interview transcripts for insights into what motivates teachers to use AR and what support is needed to use AR in teaching. The steps include becoming familiar with the raw data, developing codes, identifying themes, creating meaning frames, reviewing themes, and refining themes (Braun & Clarke, 2019).

Achieving Familiarity

To achieve familiarity with the raw data, a high-level review of the raw interview transcript data was conducted. Each interview transcript was scanned to quickly distinguish relevant content from the irrelevant and see how respondents addressed topics shedding light on

motivation to use AR. The review afforded a broad view of what participants expressed in the study.

Developing Codes

In responding to interview questions, participants contributed a host of comments on a range of subjects about what motivates teachers to use AR and what forms of support would be needed. An evaluation of the interview transcripts led to the identification, naming, and assigning of 108 pertinent codes to scores of interview excerpts. The combined open process of inductive and deductive coding allowed ideas to emerge from the raw data bringing light to the research questions pertaining to teachers' motivation to use AR and the support needed to apply AR effectively in teaching.

Identifying Themes

The open codes were collapsed into similar codes using axial coding to identify redundancy in the data. Axial coding was used to discover connections among the various codes and was realized by exploring the causal conditions, developing a central phenomenon, and determining its consequence (Hossain & Jaradat, 2018).

Repetition in the transcripts revealed themes about teachers' perceptions of AR in teaching, including teachers' awareness and use of AR in teaching, how teachers perceive AR could benefit student learning, how teachers perceive AR could benefit teachers, factors motivating teachers to use AR, perceptions of expected difficulties of using AR in teaching, support needed by teachers to use AR effectively, how colleagues influence teachers' motivation to use AR, how teachers perceive the support of colleagues, and how teachers perceive the support of their school administrators.

Creating Meaning Frames, Reviewing Codes, and Refining Themes

Selective coding based on the thematic connections identified during axial coding generated a framework of meaning about what motivates the teachers to use AR. Analyzing data through selective coding yielded a primary theme from each main category (Cao et al., 2019). A review of assigned codes preceded the creation of meaning to double-check the accuracy of the interpretation and develop new ideas about the phenomenon. Quotations from teachers were aligned with the final themes to validate the meaning frames.

A thematic approach to the creation of meaning resulted in the generation of seven unique insights about the teachers' motivation to use AR and the support needed to apply AR in their teaching. The collapsed categories involved teachers' misperceptions of AR, how teachers perceive AR could positively impact learning, the perceived benefits of using AR on a teacher's ability to engage students and prepare lessons, teachers' interest in having AR apps that can be customized to align with curriculum and learning outcomes, the perceived barriers to using AR, the desire for support through professional development, and how supportive teachers feel their peers and administrators would be if they desired to integrate AR as a teaching strategy (see Table 3).

Four final themes evolved from the coded and collapsed interview data relevant to what motivates teachers to use AR as a teaching method and the needed support for the effective implementation of AR by teachers. First, teacher awareness of AR can impact motivation to implement it with students. Second, motivation to use AR may be influenced by teachers' perceptions of potential benefits to students and teachers. Third, teachers' motivation to incorporate AR into classroom instruction may be affected by anticipated difficulties. Fourth, teachers sense the need for formal support to effectively use AR in the classroom.

Table 3

Final Themes Resulting From Coding

Emergent codes	Coded	Collapsed
• Accurate perception of augmented reality (AR) • Aware of AR • Inaccurate perception of AR • Introduced to AR • Seeing an example increased motivation • Unaware of AR	Awareness of AR	While most teachers believed they were accurately aware of AR, they were not.
• Aware of digital tech	Awareness of digital technology in the classroom	
• Career awareness • Enhance curriculum • Experience the impossible • Improved test scores • New experiences • No benefit • Preparation for future • Student-directed • Student engagement • Student interest • Student motivation • Student satisfaction • Variety	How AR benefits students	Most teachers think AR would contribute to increased learner interest, engagement, motivation, and satisfaction by allowing students to experience content in ways that are traditionally impossible.

Emergent codes	Coded	Collapsed
• Assessing students • Attract student interest • Gives objective feedback • Help students interact with content • Incentivize students • Increased teacher motivation • Makeup work • No extra work • Options for learning activities • Prepared content • Reach different types of learners • Replicate teacher tasks • Save time • Support learner focus • Customizable	How AR benefits teachers	• Most teachers perceive AR as helpful in increasing students' interest in learning among varied learning styles. • Teachers view AR as potentially saving time in preparation.
• Ability to create apps • Ability to create AR activities • Age-appropriate for interest • Can envision use needs • Designed to align with learning outcomes • Easy to use • Fast processing • It is the way of the future • Manipulate cause/effect • One-to-one technology • Student enjoyment • Support from administration • Time to learn • Useful to all subjects	Components increasing teacher motivation to use AR	Teachers would be more motivated to use AR if they could customize the activity to align with curriculum and learning outcomes.

Emergent codes	Coded	Collapsed
• Apprehensive students • Apps not relevant to all subjects • AR does not achieve learning outcomes • AR sounds intimidating • Can't use AR at home • Cost prohibitive • Difficult to use • Distracted by technology • District approval • Entertainment only • Fear of being replaced by tech • Fear of damage • Inferior to current methods • Insufficient devices • Lack of internet bandwidth • Lack of teacher confidence • Lack of training • Limited access • No perceived difficulties • Novelty wears off • Overuse • Risk of impermanence • Space limitations • Steep learning curve • Struggle to pedagogically integrate AR • Takes time to learn • Unreliable technology • Unwilling to try something new	Expected difficulties with using AR for teaching	Most teachers view technical difficulties, use challenges, time requirements, low accessibility, cost, ineffective classroom use, and lack of alignment with curriculum and learning outcomes as barriers to using AR for teaching.
• Applied AR in the classroom • No experience • Used virtual reality	Experience with AR in teaching	

Emergent codes	Coded	Collapsed
• Peers do not motivate to use AR • Peers would motivate AR use	Influence of peers	
• Continual training • Curriculum integration • Effectively presented • Examples of use • Forced • Hands-on experience • Information of educational AR options • Not forced • Professional development • Professional development (PD) locally during PD days • Relevant training • Time to figure it out • Training by experts • Turnkey usability	Support needed by teachers to use AR	Most teachers believe professional development opportunities would be needed to effectively use AR, including recurring training by a subject matter expert, information about AR options, and experiential training on how to use AR to achieve curriculum and learning goals.
• Admin would be supportive • Admin would not provide support • AR checks the technology box • Fad adoption • Lengthy district approval process • Colleagues need evidence to support • Colleagues would be supportive • Indifference • Mixed support • Would not provide resources	Perception of administration and colleagues' support of using AR	Most teachers believe school and district administrators and colleagues would support the use of AR

Emergent codes	Coded	Collapsed
• Accurate perception of digital tech • Kids do not want technology	Perception of digital technology in the classroom	

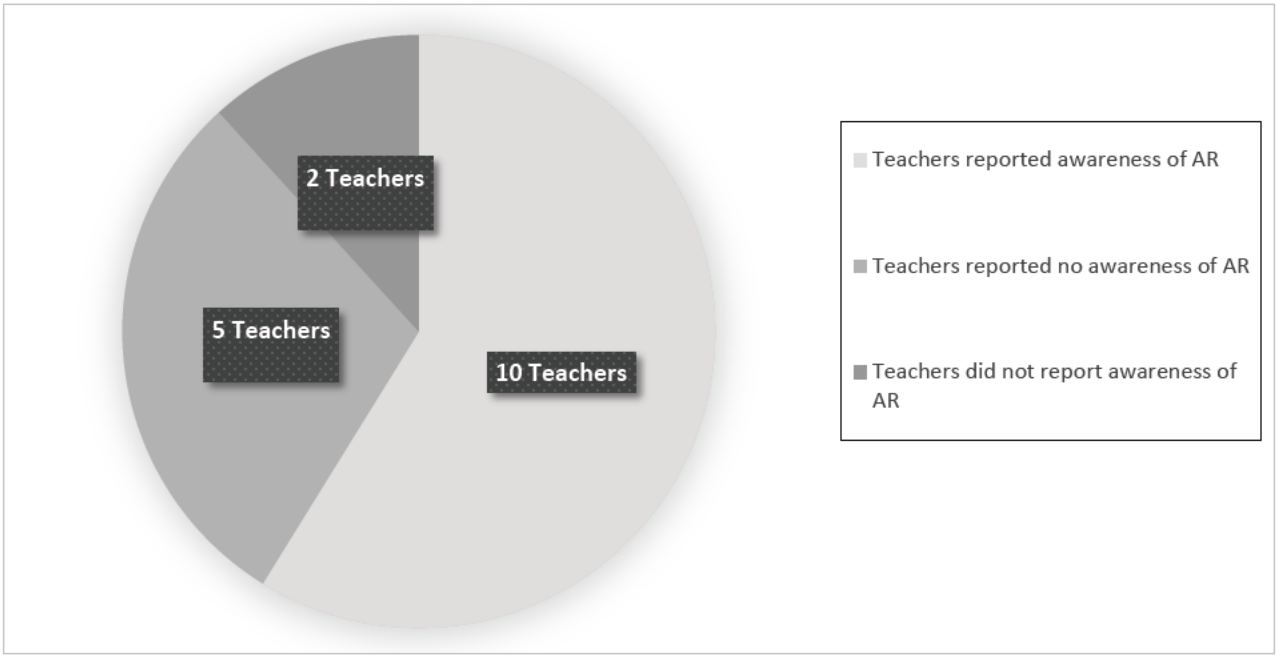
These findings answered the questions at the heart of this study involving what may motivate teachers to use AR and what support is needed for teachers to use AR effectively. Teachers' accurate awareness of the abilities and functions of AR can impact their motivation to utilize the technology with students. The motivation to use AR is influenced by teachers and may be increased by understanding the benefits to student learning and teacher preparation. Teachers may feel less motivated to incorporate AR into classroom instruction by anticipating associated difficulties. Most teachers sense the need for formal support through professional development to effectively use AR in the classroom.

Awareness of AR

Becoming more aware of AR technology during the interview improved how most teachers perceived the value of AR in the classroom. Interview data suggested most high school teachers in the school district were not accurately aware of AR. When asked about individual awareness of the technology called AR, the majority (59%) of participants indicated being aware, some (29%) admitted being unaware, and two (12%) did not answer the question, as shown in Figure 1.

Figure 1

Teacher-Reported Awareness of AR



Of the 10 participants who reported being aware of AR, five (50%) demonstrated having an inaccurate awareness of AR at the time the interview began. Eight of the nine (89%) teachers with an inaccurate view of AR experienced confusion with virtual reality, a different type of immersive technology. One (11%) teacher mistook AR for artificial intelligence. Only one of all 17 (6%) participants had briefly used a simple form of AR in the classroom. The accuracy of a respondent's awareness of AR was measured by words used to correctly describe the function of AR or an actual AR app. Participant 2 accurately recalled having used an AR app superimposing the user's face onto a digital dollar bill. Participant 16 accurately described AR "as a combination between the real world and a virtual world. I played Pokémon Go, so I am familiar with that part of augmented reality."

Study subjects became more familiar with educational AR technology during the

interview process. To facilitate participants' ability to express informed opinions about AR for teaching and learning, each interview included a demonstration of an AR app designed for education. Fifteen (89%) teachers responded positively upon viewing the demonstration. Participant 12 said, "Oh, I like that," and Participant 14 exclaimed, "Oh, that is cool. We are going to have to tinker around with that!" Participant 1 responded, "I have never used [technology] like that for education, which I would actually enjoy doing!" Two (11%) respondents were less positive about the demonstration of the AR app. Participant 5 expressed concern about the AR app being used more as a "gimmick" than a legitimate learning resource. Participant 10 echoed a sentiment of skepticism and responded, "With that example [of AR] . . . I do not know if it would enhance [learning] more than what we already do." Many subjects in the study had an inaccurate understanding or no awareness of AR technology and many favorably viewed the demonstration of an AR app. Therefore, high school teachers in northern Utah may experience increased motivation to use AR when introduced to educational AR apps.

Perceptions About the Benefits of AR on Teaching and Learning

Used to predict human behavior, the TPB assumes people are more likely to take action, such as adopting new technology, when potential value is perceived (Ajzen, 2020). Nearly every (94%) teacher interviewed reported never having used AR as a teaching tool. Most participants could not speak experientially about how AR impacted student learning in their classrooms. A simple AR app designed for education was demonstrated, then teachers were asked questions about the potential usefulness of AR in teaching and learning. Participant responses aligned with the TPB in suggesting teachers generally view AR as a positive tool for teaching and learning and, therefore, may be motivated to use it in the classroom.

Perceptions About How AR Could Benefit Student Learning

When asked to share opinions about how using AR in teaching might impact student learning, nearly every (94%) participant mentioned some kind of potential advantage. One (6%) teacher disagreed with the common perspective and said using AR in education is unlikely to have a positive influence on learning. Perceived benefits of using AR for student learning included a range of perspectives. Seven general themes emerged from the interviews pertaining to possible benefits of applying AR in the classroom, including allowing students to digitally experience unique opportunities, interest, engagement, variety, self-direction, satisfaction, and motivation (see Table 4).

Table 4

Participant Perceptions of the Learning Benefits of Using Augmented Reality

Benefit	No. participants
Experience unique opportunities	9
Interest	7
Engagement	6
Variety	6
Self-direction	6
Satisfaction	4
Motivation	3

Unique Opportunities. A repeated theme among many (53%) participants was the capacity of AR to provide learners with an alternative to experiences otherwise impossible. A

unique learning opportunity may be unrealistic or unfeasible in a high school class due to expense, safety, geographic location, or size. Participant 9 said,

> I think using AR can be beneficial not only because we can manipulate the image, but it allows us to see things in a different way that we have never experienced before. We might not be able to get a human eyeball into the classroom, right? So, [AR] almost puts them in a real-life experience, almost as if they had a real eyeball on their desk.

Participant 6 responded,

> I'd love to be able to take my students on field trips to Boston to go see all those historical things, but I can't. But if I could bring it into the classroom and let them manipulate things within the classroom digitally, that would be a very, very cool experience for the kids.

Participant 12 described how using AR in a history class might expand students' minds:

> I think that the ability to see in a real 3D space what an internment camp might have been like or to see what it might have been like to live during the Great Depression. What does it look like in a shanty town? I think that we have the ability to kind of transport the past to our time, which makes history real in a way that our words can't.

Student Interest. Forty-one percent of teachers mentioned the belief that AR in the classroom would positively affect students' interest in learning. Participant 7 observed how AR could help a teacher "spark" and "keep" the interest of students with course content. Participant 17 believed AR "could generate some excitement" more than traditional teaching methods. Participant 3 held the opinion the visual nature of AR can build on students' interests:

> I think that, especially if you have a student who is interested in cars and you are asking him to write about how to do an alignment for cars, having them visually be able to see it

step-by-step is going to help.

Student Engagement. Forty-one percent of respondents mentioned that implementing AR in the classroom could result in increased learner engagement. Participant 15 believed the interactive nature of AR leads to more engagement than do traditional teaching methods. According to Participant 6, AR in the classroom "would be more engaging for students than just watching a video or listening to a teacher lecture" because students prefer more hands-on interaction. Participant 11 asserted that AR can engage students with learning content through active learning instead of "just sitting" passively in class. Participant 12 said,

> I have noticed students tend to do better when things are more interactive. And so [AR] is more advantageous than showing them a picture of something. . . . I think students would actually enjoy getting up and being able to move around [a digital object] more than seeing a picture on a PowerPoint. [AR] would make history more real to them.

Variety. The added variety introduced into the classroom was mentioned by several (35%) respondents as a potential benefit of AR. Participant 9 acknowledged that every teacher possesses a unique teaching style and AR could provide "a break from the monotonous kind of lifestyle we bring to the table." In addition to traditional activities such as lectures and group work, Participant 1 said using AR could "change things up" for students struggling to interact. Recognizing that people learn differently, Participant 4 said AR could help students because AR "is a different way of learning" and "gives kids an outlet to learn differently."

Self-Direction. The capacity for students to direct their learning was declared by 35% of teachers as a likely outcome of using AR in the classroom. Using AR for learning, according to Participant 9, can permit students to "be in charge of their own learning" and afford teachers a more supportive role. Participant 11 underscored the value of AR to allow students "to delve in,

in a way that best suits them, whether in a linear fashion or in pieces. There is more control in the learning, and I like that." A teacher of art, Participant 17 said,

> I never feel like I have enough images to help the kids really see [a sculpture]. Sometimes I have a video where I have walked around the sculpture, but . . . students can't turn to look at what they want. I cannot rewind a video for everybody in the class to go at the pace they want to go. But if they had access to a way to spin and twirl and look at it . . . I think it could really be pretty dazzling and help [students] appreciate some of the great sculptors.

Student Satisfaction. Twenty-four percent of teachers interviewed identified student satisfaction as a likely value derived from AR in education. Participant 1 suggested using AR would integrate the use of personal mobile devices and "be enjoyable for the majority" of students. According to Participant 9, using educational AR would be "a really new and exciting way to obtain knowledge" instead of traditional means such as "just writing notes or looking at a PowerPoint." Participant 2 said the satisfaction of using AR could "serve as a vehicle to more engagement . . . in a way that suits [students]."

Learner Motivation. Eighteen percent of respondents reported AR in the classroom would motivate more student learning. According to Participant 1, AR provides students more motivation to learn with the opportunity to integrate entertainment technology traditionally "used for fun and jokes" into education. Participant 3 offered that AR could motivate students to complete coursework and reduce common stress by clearly guiding learners through learning activities. Participant 9 said,

> I think [AR] would be great to motivate students. . . . A lot of them are infatuated with video games and doing stuff on their phones, tablets, and computers anyway. They are

> already on it, so why not implement some learning on it? Maybe [AR] is a way for them to be motivated to learn, a cooler way of learning.

While most teachers perceived AR as beneficial for learning, one (6%) teacher skeptically contradicted the prominent positive opinions. Participant 5 viewed an example of an educational AR app and promptly stated, "It looks interesting, but I do not think it is going to do much" to improve learning. Conversely, only the teacher (6%) with experience using AR in teaching held the conviction of improved test scores for students learning with AR. Other perceived benefits of AR in the classroom mentioned by only one (6%) teacher included making students aware of future career opportunities and providing the occasion to try something new.

Repeated comments in the aggregated interview data suggest participants generally viewed AR positively for helping students learn. Teacher motivation to use AR as a teaching strategy may intensify as teachers perceive the benefits of using AR for student learning, including allowing students to experience unique opportunities digitally and profit from increased interest, engagement, variety, self-direction, satisfaction, and motivation.

Perceptions About How AR Could Benefit Teachers

In addition to questions about benefits to students, participants were asked about how AR could help teachers fulfill the responsibilities associated with teaching. Every (100%) respondent offered an opinion suggesting how AR could be advantageous to teachers in completing tasks in class or out of class. Perceived teacher benefits of using AR as a teaching method in class included saving time in lesson preparation, supporting the varied learning styles of students, assessing students' learning, offering more variety, incentivizing student achievement, and supporting a more learner-focused environment (see Table 5).

Table 5

Participant Perceptions of How Using Augmented Reality May Help Teachers

Benefit in class	No. participants
Save time	7
Support learning styles	7
Assess learning	2
Incentivize students	2
Support learner focus	2

Save Time. Forty-one percent of participants mentioned AR may preserve a teacher's time during lesson preparation. According to Participant 17, the question, "Is [AR] going to save me time?" is important because "time is my biggest constraint in teaching." Participant 2 viewed using AR as helpful in saving time by eliminating intensive cleanup following a typically involved learning activity. Participant 10 indicated an inexperienced teacher preparing a lesson could benefit from discovering "something like a good lesson that uses augmented reality to teach that concept." An independently developed AR app provided to a substitute teacher for classroom use might reduce the teacher's preparation time. According to Participant 17, AR would be a type of "preplanned [activity] that is almost like a video in a sense, but kids can do some interaction. . . . I could have something prepared so that if I happen to be gone one day, that would be easy to pop into place."

Meet Learning Needs. Thirty-five percent of respondents expressed the belief AR can help teachers meet the different learning needs of various students. According to Participant 9, AR can offer teachers and students a "multifaceted tool" as a different "way of experiencing

teaching and experiencing school" to meet the needs of learning styles. "More options is always better," intimated Participant 3, because some students may not appreciate AR, but others will. Participant 7 said AR would help teachers by "bringing a different group of students' interest into my classroom, which would benefit me as well." Participant 4 suggested AR adds one more method to differentiate instruction: "Instead of just teaching the one student, you are teaching to all students and kind of getting a span of all the different ways they learn." Participant 12 said,

> Some students like a direct lecture and some students like activity-based learning. Some students like interactive visual learning, and interactive visual learning is something I've been trying to focus on. . . . [AR] is going to take that a step further and provide me an additional thing to differentiate with in regards to visual learning.

Assess Learning. In addition to addressing multiple learning styles, two (12%) teachers viewed AR as a possible effective means for assessing student learning. Participant 9 postulated AR "maybe is a great way to check for scores in testing data that might be a much easier way to assess." Participant 9 added, "We could see if [students] are learning . . . very quickly." Participant 11 exclaimed,

> [Using AR] means it is not just me putting out content for students to absorb, it is an opportunity for students to create and build. I like that a lot because then [AR] is an assessment device and not just a purveyor of information.

Incentivize Students. Two (12%) teachers identified AR as a possible effective means to incentivize student achievement. Participant 4 described how AR could help teachers encourage students in a self-paced learning program:

> I think [AR] would benefit me just because as, like a reward, almost like they get to use [AR] as long as they're staying up [with classwork and assignments]. What our school

> does is, they can move at whatever pace they like, as long as they stay, like, there's a minimum pace. . . . So I think if they're, like, going ahead and doing more, then it's almost like, "Hey, if you get to this point, then you're able to use [AR] as an alternate way of learning."

Participants suggested students might be enticed to engage in content mastery to earn the privilege of using AR. Participant 6 said,

> If I was going to do something using augmented reality, I would have some kind of assignment or activity that students would need to complete before learning whatever content we're working on. And then, as soon as they've mastered that content, then they can move on to basically the application of that knowledge that they've gained, which would be the use of augmented reality. First, let them know that once they're finished, then they're going to be able to use this cool app. But they got to do the nitty-gritty work first, then they can move on and play around with [AR].

Support Learner Focus. Two (12%) teachers viewed implementing AR in teaching might help teachers facilitate a more learner-focused environment. Describing the need to help students orient themselves spatially, Participant 14 suggested the ability to "walk around and see where they would be, and be able to zoom out and look at that would be an extremely beneficial thing." According to Participant 6, AR might help students remain at the center of the learning experience because

> The student gets to direct the learning more and the teacher goes into more of the role of a facilitator. [The teacher] gives [students] the tools and says, "Here are your tools. Here is what you need to figure out," instead of the teacher doing all of the steps and the kids just absorbing the information.

Teachers may experience increased motivation to use AR in teaching when perceiving benefits to responsibilities of teaching such as saving time in lesson preparation, supporting the varied learning styles of students, assessing students' learning, offering more variety, incentivizing student achievement, and supporting a more learner-focused environment. Outliers included unique participant comments (6%) about how using AR could increase teacher motivation, provide objective feedback to students, serve as an option for makeup work, contribute to a teacher's content mastery, and give teachers additional options for class activities.

Perceived Barriers to Using AR

Most (88%) teachers interviewed recognized potential difficulties and barriers to using AR for teaching. Teachers' perception of challenges may decrease teachers' willingness to apply AR in the classroom. In the TPB, perceived behavioral control is an individual's perception of the ease or difficulty of executing a specific behavior (Persada et al., 2021). Such views may involve the anticipation of needed skills, ability, time, money, or other influences associated with the behavior (Ajzen, 2020). Several themes transpired from the teacher interviews to reveal common concerns that might influence a teacher's motivation to use AR: limited student access to technology, internet limitations, cost, difficulty of use, and restrictions imposed by the school district (see Table 6).

Table 6

Participant Perceptions of Barriers to Using Augmented Reality

Barrier	No. participants
Limited student access to technology	8
Limited internet access	5
Cost	5
Difficulty of use	4
District restrictions	4

Limited Student Access to Technology. Nearly half (47%) of the respondents expressed concerns that not every student possesses a digital device compatible with AR. Participant 9 asked, Is the integration of AR "equitable for everyone in the classroom?" While schools in the district have a 1:1 technology policy, four (24%) teachers questioned the capacity of the district-issued Chromebook laptop computers for supporting an AR learning activity. Participant 3 stated, "I do not know if kids would have a device to use. We have the worst Chromebooks, probably low processing." According to Participant 17, "Chromebooks are kind of on the wimpy side. You cannot download much of anything onto it because they have hard drive space of a mouse's bladder." Participant 10 wondered if the lack of access to technology makes using AR less worthwhile than showing a video and asked, "How hard would it be for me to get the kids to access [AR] technology on their Chromebooks? And what do I do with the 5% of kids that do not have a Chromebook?"

Two (12%) teachers speculated whether the use of AR would require the purchase of additional digital devices. Participant 7 recalled prior attempts to acquire classroom technology

resulting in a shared classroom set requiring the teacher to reserve equipment ahead of time:

> You have to sign up for them [virtual reality headsets]. When you have six classes but you can only [reserve] them for four [classes], why would you continue even signing up for them? They eventually end up in one [teacher's] class . . . not being utilized like they were originally meant to.

One (6%) teacher raised the issue of the inconsistent nature of different mobile devices. Participant 15 wondered whether AR apps function equally well on both IOS and Android mobile devices. Participant 13 recognized some students are prohibited by parents from taking a mobile device to school, potentially impacting access to an AR-based learning activity.

Limited Internet Connection. Limited access to a consistent and strong internet connection was cited by five (29%) interviewees as an imaginable barrier to using AR for education. Participant 2 identified limited internet "bandwidth" as a regular "issue" at the school. According to Participant 17, "Having enough bandwidth and Wi-Fi for the kids" to utilize an AR app may be a problem. Participant 4 teaches at a technologically innovative school and said, "The Internet goes out here and we are all just twiddling our fingers." If the school Wi-Fi is not available, "do [students] have a [cellular] data plan that will allow them to utilize [AR]?" mused Participant 13.

Cost. The expense associated with using AR for teaching and learning was cited by five (29%) respondents as a likely barrier. Based on prior experience, Participant 7 said technology options for the classroom "kind of come and go, and the price upfront is usually outrageous," and AR could be "cost prohibitive." According to Participant 9, the most significant impediment to using AR in teaching "would be the price and cost. Is this going to cost us anything? How much is it going to cost? That would be the biggest hurdle I see." Participant 11 recognized the

possibility of sustained expenses following the initial acquisition of technology, including "training and beyond." "If there is a cost associated with [AR]," observed Participant 16, "getting administrators to buy in on the value of doing it" may be a challenge.

Difficulty of Use. The usability of an educational AR app was cited as an important motivating feature by 24% of teachers. This finding is consistent with the TAM positing the perception of ease of use as a motivator to use computer technology (Mailizar & Johar, 2021). "Being user-friendly [and] simple," stated Participant 4, "would be my biggest motivator" to use AR. On the contrary, an AR app that is difficult to use may dissuade teacher use. Participant 1 said, "The user interface would be a big thing. I would imagine if it is hard for me to use, then it is going to be hard for my students to use." Participant 13 implied many students, despite being young, are not proficient with digital technology and could "get stuck" in "the difficulty [of knowing] how to operate" an AR app.

Restrictions From the School District. Nearly a quarter (24%) of teachers interviewed identified district-imposed restrictions on technology use as a conceivable significant barrier to applying AR for learning. Participant 15 lamented the strict "firewalls" established by the school district controlling what technology teachers can access based on "if they want to let you use things like [AR]." Participant 11 asserted,

> Our district keeps a pretty tight leash on which websites and application software we are allowed to use. I think we may have to go through a vetting process to get [AR] approved. There are some wonderful websites out there that do all sorts of amazing things and are on the [district's] no-no list. We do not even know why. So you definitely have to make sure that [AR] is vetted.

Navigating the tedious approval process may discourage teachers from executing AR as a

teaching method. Participant 3 said, “I cannot touch anything in my classroom that is not approved by the school district,” and “It is a very lengthy process to get [technology] approved.” Participant 17 stated,

> We have restrictions, really strong restrictions, for even any of the third-party websites we use for school. . . . So the bureaucratic process of jumping through these certain hoops to be able to get access [to AR] to begin with would be an issue.

Many teachers expressed perceived difficulties and barriers to using AR as a strategy for teaching. Limited access to technology by students, internet limitations, cost, difficulty of use, and restrictions imposed by the school district are concerns that could impact a teacher’s motivation to use AR. Two (12%) teachers contradicted the consensus among interviewees by claiming using AR in the classroom would pose no challenges. Such views may influence teachers’ willingness to apply AR in the classroom.

The Need for Support

During the interviews regarding AR for teaching and learning, most (94%) teachers referred to some variety of support teachers would need to implement the use of AR in their classrooms successfully. Participant comments about the support needed by teachers were organized into three primary categories: professional development, pedagogical support, and institutional support.

Professional Development. The need for professional development to support teachers in using AR was mentioned in some form by 10 (59%) respondents. Professional development support could motivate teachers to use AR as a teaching resource. Categories of valuable components of professional AR development surfaced from the interview data, including introductory training, recurring training, the sources of training, the value of examples of AR,

and the need to train for pedagogical alignment (see Table 7).

Table 7

Types of Professional Development for Using Augmented Reality

Professional development	No. participants
Introductory training	5
Recurring training	3
Sources of training	6
Examples of AR	6
Pedagogical alignment	6

Introductory Training. Five (29%) teachers revealed the desire for some sort of entry-level training to learn to use AR. Participant 4 assumed "initial training on how to use AR" would be sufficient, saying, "It is new to me and I have no idea how to use it." Participant 14 expressed interest in "just having an opportunity to learn and receive proper training on [AR]." Participant 3 self-identified as being "not the most techie" and said, "Having training [on AR use] would make me more comfortable" and "Sometimes I feel like we don't have enough training on techie stuff." According to Participant 11, gaining "a basic understanding of [AR] and what it can do would, for me, be the key to professional development." As reported by Participant 12, training about AR could help provide answers to basic questions like, "How do I use it? How do I get started? and What are ideas I could implement with it?"

Recurring Training. Some (18%) teachers cited the need for follow-up training to support successful AR integration by teachers. Participant 6 doubted whether initial training

alone would provide inadequate support for teachers wanting to use AR and said, "I would need initial training on it and then, like a follow-up training just to make sure I know what I am doing and I feel comfortable using it." Participant 6 echoed the belief: "I would love to be trained and have follow-up training on implementation!" Participant 14 said,

> I would not expect to be able to learn everything there is to know about [AR] in one training session, but [should] have opportunities for follow-up so I can dig deeper in it. Or just be able to show ways I'm using it and see if maybe there is a more effective way to use it than what I have been doing. So I think this is where a follow-up [training] would be really helpful for me.

Sources of Training. Some (24%) teachers expect technology training to come from a reliable source. While "a teacher could go watch a YouTube video to learn almost anything," according to Participant 6, "I feel it would be better to have more formal training to encourage and support the use of this new technology." Participant 6 was of the opinion training should come from the school or the district. A contradicting opinion was expressed by Participant 4: "I am not really picky on where training comes from. As long as whoever is training is an expert in what they are training you on, then I don't really care where they come from." Skeptical that the school district would provide training, Participant 12 retorted, "I would need maybe teachers or experts who are already using [AR] . . . maybe a conference of teachers who are leaning more into technology and education."

Examples of AR. Four (24%) teachers' comments indicated viewing examples of AR technology as part of professional development could be motivating to use AR. Participant 11 said, "I am going to need somebody to show me how to [use AR] and show me how it is effective." Participant 3 offered, "Just even examples of what people have done with it" could be

beneficial. Participant 11 suggested effective training on AR could incorporate "exemplars to show us what it can do to make it amazing, then show us the basics." Participant 6 expressed a desire to have AR modeled and see teachers using AR. To Participants 13 and 17, viewing a demonstration of AR for improving teaching would provide needed support to teachers.

Pedagogical Training. Twenty-four percent of the subjects referred to training on how to integrate AR activities effectively into lesson plans as potentially helpful professional development. Participant 14 expressed interest in learning how to apply AR capabilities to support course content. Participant 3 stated information about "how [others] have incorporated [AR] into their curriculum would be really helpful." Group brainstorming sessions could be included in professional development efforts for teachers to collaborate on ways to implement AR in the lesson plans, according to Participant 6. Participant 12 suggested teachers should be taught "a basic understanding of . . . ways to build [AR] into pedagogy" and not only the functions of the technology.

Pedagogical Support. Many (65%) teachers conveyed wanting an AR app to support teachers by providing a design consistent with effective pedagogy. Two significant themes emerged from the interviews with teachers about the instructional capacity of AR that may motivate the use of AR by teachers. First, teachers want AR technology to help students learn. Second, teachers desire responsive AR activities designed to allow students the chance to interact with related content beyond the simple presentation of information.

Achieve Course Objectives. Ten (59%) teachers discussed wanting AR technology designed to offer students more than entertainment and to provide opportunities for students to participate in activities to achieve course learning objectives. Participant 5 described being more motivated to use AR that is "actually practical" whereby "students are actually learning" versus

playing with "another gimmick" or "just another toy." Participant 5 described that many technologies in the classroom wind up as a diversion on a "lazy Friday" without a "useful place in the curriculum."

Relevant technology enhances the course content, according to Participant 6, while entertainment technology is a waste. Participant 13 stated, "My motivation [to use AR] would increase . . . if I were able to find [AR apps] that are applicable to what I am [teaching in class]." Participant 8 said, "My biggest motivating factor [to use AR] would be if it quickly helps students achieve a positive end result." Participant 11 perceived the substantial advantage of an AR app capable of supporting practical and measurable outcomes and said,

> I think it is more just recognizing how AR could be used for [my subject] in a way that helps us meet standards and helps us prepare for the tests we have to administer. Is it really going to adjust test scores? Is it really going to lead to greater [student] engagement and a higher graduation rate? That sort of clear direct objective data would be a consideration.

Respond to Students. Several (41%) teachers desired responsive AR activities designed to allow students the chance to interact with relevant resources. These participants saw AR as being beneficial in taking students beyond simply viewing the presentation of information and helpful by simulating the cause-and-effect relationships of reality. The ability to digitally "manipulate things via a phone," said Participant 15, "would be awesome because it is interactive." Participant 2 wanted an AR app capable of letting students electronically "feel" the pressure of welding metal, turning a wrench, or removing lug nuts, not merely passively turning the pages of a digital "pop-up book." The participant wants AR to let students experience the scientific method, including "tests and results," and not just present images.

As a science teacher, Participant 9 hoped AR could do more than display a visual and said, “Can [students] click on the retina [of the eye], have it highlighted, and move the retina to the back of the eyeball? Can they manipulate that image to give them a better visual?”

Data from the teacher interviews suggested AR apps designed to support effective pedagogy may increase a teacher’s motivation to use AR in the classroom. Augmented reality supports effective pedagogy when helping students achieve learning outcomes. AR also simulates real-life processes and reactions by allowing students to manipulate and interact with digital assets.

Institutional Support. Teachers’ motivation to use AR as a resource for teaching may be impacted by perceptions of how others in the organization would support the use of the technology. According to the TPB, human action is persuaded by the expectations of influential associations (Persada et al., 2021). Teachers’ opinions about support for using AR include assistance from administrators and colleagues.

Perception of Support From Administrators. While four (24%) individuals cited challenges with the approval process at the district level as a likely barrier to using AR in the classroom, nearly all (88%) respondents expressed the belief that school and district administrators would generally support teachers’ use of AR. “My administration is really, really, really supportive . . . of trying new things . . . and does not micromanage,” reported Participant 6. Participant 16 thought school leaders would be “99%” supportive of teachers using AR. Participant 3 stated, “If I were to go to [administrators with a request to use AR] and if I can give a sound reason, they would probably be supportive.”

Some (18%) teachers conveyed the opinion that administrators would approve emerging technology for the novelty alone. Participant 2 said, “[*Augmented reality*] is a buzzword and so

they would love it," and "I am concerned they would [support] it without knowing how to use it themselves. We call it the 'buzzword pendulum.'" Participant 17 echoed the sentiment: "They love any new technology ideas—anything that is like the hip, trendy, buzzword kind of technology," suggesting administrators would be "very open to the idea" of supporting AR.

Not all teachers expressed a sentiment of school administrators' unconditional support for AR. Thirty-five percent of teachers suggested the support for AR from leaders would be based on the technology's merits for education. To obtain approval, Participant 14 said, "I would need to be able to show that [AR] is effective . . . and improves the student experience in my classroom." Participant 16 expressed the belief that school administrators would support AR for teaching "as long as it aligned with curriculum and the [education standards of Utah]." One (6%) teacher explicitly vented the opinion that school administrators are not supportive of using emerging technology in the classroom. Participant 2 said, "They blocked off the Wi-Fi specifically against virtual reality and any unregistered school device" and "I love playing with technology and seeing where it can go, and I am constantly held back by the technology restraints our schools hold."

Perception of Support From Colleagues. The perception of peer support for using AR in school may influence teachers' motivation to use AR in their teaching. Data from participant interviews imply teachers generally believe fellow teachers would be supportive of one another using AR in the classroom. When asked if associates would support a teacher's use of AR, 10 (59%) teachers responded affirmatively. The comments suggest some people might express support for another teacher using AR but do not want to be bothered by it. Participant 1 responded, "I think [other teachers] would be like, 'Good for you.'" Similarly, Participant 8 communicated colleagues would likely have the attitude, "'That is great if it works for you.'" "I

think they would support me using [AR],” said Participant 14, “but I do not know that they would all jump on the wagon.”

Other (18%) teachers believed peers would support the use of AR and desire collaboration. Participant 2 indicated, “[Colleagues] would probably think it is kind of cool,” and “want to know what it was and how to use it” and “Good ideas do not require twisting of arms.” Participant 11 intimated teaching coworkers would be “especially” supportive of another teacher using AR if the prepared materials were shared. Participant 5 stated peers would likely be interested in adopting the immersive technology.

Twenty-four percent of respondents believed colleagues’ support of using AR to teach would be based on age or teaching experience. Participant 2 discussed the opinion of a technology interest gap between older and younger teachers and said, “I see a lot of younger teachers trying to push for [technology], and some of our older teachers [prefer traditional methods].” Participant 4 responded, “I can think of some [teachers] that would be okay [using AR] and some that . . . have been teaching longer . . . that are a little bit more traditional with their things.” Participant 12 identified a new young colleague who would “like [AR] a lot” and mentioned there are “older teachers who would think it is kind of gimmicky.”

Participants generally observed the need for support for the effective implementation of AR in their classrooms. Categories of formal support discussed by teachers included professional development, pedagogical support, and organizational support. How teachers view the options for support may influence motivation to use AR as a tool for teaching.

Data Saturation

As each interview transcript was analyzed, care was taken to notice redundancy in participant responses and the expression of new ideas. Each repetitive answer relating to an

existing theme was appended with a relevant code (Cao et al., 2019). Unique concepts emerging from respondents were coded with a new label. Distinct codes continued to surface from the conversations until the interview with Participant 14, which achieved data saturation. According to Mwita (2022), data saturation is reached when a researcher finds repetition of the same information from the study subjects and usually occurs between interviews 9 and 17. In the case of the present study, Participants 15, 16, and 17 used individualized words to express the nuances of their perspectives, yet the content of their answers reiterated existing codes and aligned with the themes of previous participants. Thus, data saturation was achieved by the 14th interview.

Reliability and Validity

A large amount of data was generated through semistructured interviews with high school teachers in one school district. The evidence shed light on the research questions concerning factors motivating teachers to use AR in teaching and the support needed to use AR effectively. The data were immersive and nearly overwhelming for the researcher to collect and analyze. Researcher bias is often considered a challenge in qualitative research, as the researcher usually serves as the study's primary research instrument (Jones & Donmoyer, 2021). This study used strategies to establish the validity and reliability of the research to mitigate the potential influence of researcher subjectivity. The trustworthiness of the study is demonstrated by its credibility, dependability, and transferability (Carcary, 2020).

Credibility

Credibility in research using interviews signifies the methods are appropriate for studying what the research claims to study and for truthfully reporting the findings (Coleman, 2021). The integrity and generalizability of the study were strengthened by including participants from multiple research sites (Flynn, 2009). The credibility of responses is strengthened as participants

hailed from a diversity of schools, including traditional campuses, a small school focused on remedial efforts, and a technologically innovative school targeting high-achieving students.

A digital audio recording device contributed to the credibility of the data by enabling verbatim transcripts of interviews (Coleman, 2021). Rich data produced through the transcripts uncovered a broader view of the teachers' motivation for using AR and eliminated the human requirement of taking notes during the interviews. Member checking was regularly performed in real time during interviews and strengthened the validity of the study (Coleman, 2021). Participants were often asked informally to confirm whether the researcher accurately understood their comments. The researcher employed echoing, paraphrasing, and asking for further clarification from interviewees to confirm and ensure a correct understanding of responses.

Dependability

Dependability refers to the consistency of the data being investigated in a qualitative study. To foster research dependability, data triangulation was applied by interviewing multiple participants and looking for commonalities among responses to gain a complete view of the situation. Seventeen persons were questioned qualitatively to establish an accurate representation of high school teachers in one school district. Triangulating the data from 17 participant interviews contributed to a more diverse category of respondents regardless of the grade or subject taught and tenure of the teacher. When a significant statement was unclear in the textual interview transcript, the original audio recording was reviewed to facilitate data accuracy.

In this study, the researcher worked to maintain objectivity by reflecting on how personal background, use of language, and execution of research methods may impact results. Perceived challenges to objectivity were documented for full transparency. The researcher's formal

education and experience in educational technology were determined to have the potential to influence the interview process by promoting AR and persuading respondents' opinions and answers. Reflection on and awareness of such personal sway resulted in deliberate efforts to listen to the participants' views about AR without being persuasive.

Transferability

Transferability is an important consideration in defining reliability within a qualitative study. Sometimes called replicability, transferability refers to a study's consistency in findings and replicable outcomes. Within qualitative research, transferability can be referred to as the dependability of its findings regardless of the researcher if the established procedures are followed (Coleman, 2021). Soliciting participants randomly via email and accepting participants on a first-come basis facilitates transferability. This study additionally established transferability by implementing reliability tests, including the comparison of data and the use of tables to record data. The use of a consistent interview protocol with all participants enhanced the reliability of the interviews and the transferability of the study (see Appendix I). Each interview followed the established protocol but frequently relied on related follow-up questions to accommodate participant individuality. The report of the study includes an expression of transparency and a detailed rationale for the research design and implementation so the reader can better evaluate its reliability. These strategies helped to formally organize the data and establish its authenticity.

Trustworthiness

A physical and intellectual audit trail can help researchers achieve trustworthiness, also referred to as confirmability (Carcary, 2020). A physical audit was made by creating a record of significant process decisions. Potential biases during the study were identified and recorded to contribute to trustworthiness (Carcary, 2020).

Significant Process Decisions

Several process decisions and actions were made during the course of the study. The decisions and actions were recorded to maximize trustworthiness. The process decisions included making an adjustment to the interview protocol, showing an example of AR for education, and making an adjustment to the nature of some questions for participants having never used AR (see Appendix J).

First, the original design of the interview protocol invited participants to share basic personal information before answering interview questions. Most people talked about their professional history, including where they teach and for how long; details were asked for in the third question on the interview protocol. To create a more natural conversational flow, Question 3 was moved to the beginning of the interview, and the pre-interview prompt about personal information was omitted.

Second, an early question on the protocol asked if participants were aware of AR. Some respondents indicated having no awareness of AR, while others' comments revealed an inaccurate understanding, potentially rendering useless the remainder of the interview. An opportunity was identified to educate participants about AR for education by explaining how it works and how it differs from virtual reality. An actual AR educational app was also shown to participants. The impact of educating participants on AR facilitated the continuation of effective interviews.

Third, an early interview question ascertained if participants had prior experience using AR in the classroom, with important follow-up questions. When the first participant indicated having no experience with AR, an opportunity was identified to adapt the question into a hypothetical. Instead of asking teachers to describe the difficulties faced in using AR, they were

asked about anticipated difficulties. The result was positive in allowing participants to share relevant opinions.

Potential Researcher Biases

The researcher worked to maintain trustworthiness by reflecting on and recording personal biases identified during the process of the study. Identified biases included initial perceptions of some participants prior to beginning interviews based on appearance, age, or subject taught (see Appendix K). During the process of convenience sampling and randomly inviting teachers to participate in the study, a potential bias was identified. The idea was briefly entertained questioning the value certain teachers add to a discussion of AR based on the academic subject taught. One teacher of auto mechanics initially appeared misaligned with an interview about AR technology. Another teacher was assumed to be familiar with teaching technology based on youthfulness. Reflecting on and keeping a written record of personal biases minimized and managed the researcher's subjective influence while interviewing participants (Carcary, 2020).

Chapter Summary

Interviews were held with 17 high school teachers in one school district. A thematic analysis of interview data resulted in the development of codes, themes, and meaning frames about teacher motivation to use AR as a teaching method and the support needed for teachers to integrate AR in the classroom. Teachers' accurate awareness of the abilities and functions of AR can impact motivation to utilize technology with students. Motivation to use AR may be increased by understanding the advantages to student learning and teacher preparation. Teachers may feel demotivated to incorporate AR into classroom instruction by anticipated difficulties. Most teachers sense the need for formal support through professional development to effectively

use AR in the classroom. The saturation of qualitative data was reached by the 14th interview. Efforts were made to establish the validity, reliability, and trustworthiness of the research to mitigate the potential influence of researcher subjectivity. An interpretation of the findings from the study may assist school administrators, teachers, instructional designers, technology developers, and other relevant decision makers in successfully motivating and supporting teachers in the use of AR technology for teaching and learning. The following analysis includes an explanation of findings, interpretations, and conclusions.

Chapter 5: Discussion and Conclusions

The purpose of this basic qualitative study was to explore the motivation of high school teachers at suburban high schools in northern Utah to use augmented reality (AR) in classrooms and what support the teachers need to integrate AR successfully. Augmented reality is not regularly used by teachers, but the technology is generally accepted by researchers as potentially beneficial for learning. The lack of information about teacher motivation to use AR and the support needed to use AR may limit how school and district leaders train and support teachers and how designers create beneficial AR resources for education. By exploring the understanding and perceptions of high school teachers, this study underscored perceived components impacting motivation to use AR and the support necessary to use AR effectively. Results may help education leaders, teachers, and AR designers promote and support the effective use of AR for education.

Research Question 1 examined factors influencing teachers' motivation to use AR as a teaching strategy. Emerging themes for the first question involved an awareness of the abilities and functions of AR, the perception of advantages to teaching and learning, and the anticipation of the potential difficulties of using AR. Findings indicate a range of teacher motivators and demotivators to using AR in the classroom. While most teachers viewed AR as beneficial to teaching and learning, the perception of related challenges and concerns persisted.

Research Question 2 explored the support needed by teachers to integrate the use of AR successfully into teaching practices. The common emergent themes were the value of professional development, pedagogical support, and institutional support. Findings suggest nearly all teachers viewed training to develop skills needed to use AR as a critical component of using the technology for education effectively. Teachers generally observed school and district

leaders are supportive of the integration of emerging technology such as AR.

The analysis of research findings includes an explanation of findings, interpretations, and conclusions. A description of the limitations of the study covers transferability, credibility, dependability, and confirmability. Recommendations are given for further research and for changes in practice and policy. Implications for leadership and technology development describe the potential impact toward promoting social change and actions for stakeholders. A concise conclusion recaps key findings relating to the purpose of the study.

Findings, Interpretations, and Conclusions

The views and experiences shared by participating teachers varied. An analysis of the interview transcripts resulted in categories and themes. While generally aligning with prior research about the benefits and difficulties of using AR for learning, the findings of this study revealed possible motivating factors for teacher use of AR not generalized in previous research. The findings are compared to the knowledge about AR and education in extant literature. A theoretical framework of human behavior and technology acceptance undergirded the analysis and interpretation of the findings. Conclusions were drawn from the analysis and interpretations of factors motivating teachers to use AR for teaching.

Findings in Comparison to Literature

Findings from a review of empirical literature about AR and education, as reported in Chapter 2, generally indicate teachers have positive perceptions of AR for teaching. Existing research sheds little light on how teachers feel motivated to implement AR. Emerging themes from this study are compared to the literature and discussed. Findings from this study validate existing knowledge about the advantages of using AR for teaching and learning and of the potential difficulties of using AR. Additional concepts emerged with potential new insights

regarding teachers' motivation to use AR, an awareness of the abilities and functions of AR, and the need for formal support through professional development to use AR effectively in the classroom. Findings contrasting or exceeding the knowledge represented in the extant research literature are noted.

Theme 1: Awareness of AR

Tzima et al. (2019) suggested most teachers are unaware of AR technology for education, but teachers' awareness of AR is not a common subject in the research literature. Results from interviews with high school teachers in one school district indicated over half (59%) of the teachers interviewed were found to have no awareness or an inaccurate awareness of AR technology in general. Steffen et al. (2019) wondered if the lack of adoption of immersive technology in education "has been partly due to a failure to understand the natural affordances of these technologies" (p. 723). In this study, a simple AR app designed for education was shown to participants to increase awareness. Most (89%) responded with a positive perception of the app upon viewing the demonstration. It is noteworthy that many subjects in the study having an inaccurate understanding, or no awareness of AR technology, responded favorably upon viewing the demonstration of an educational AR app.

Theme 2: Positive Views of AR for Student Learning and Teacher Preparation

Based on the literature review presented in Chapter 2, AR educational experiences can positively contribute to four significant learning outcomes. First, using AR to learn supports the development of skills (Altınpulluk et al., 2020; de Oliveira Spinosa et al., 2020). Second, AR increases student motivation (Ashley-Welbeck & Vlachopoulos, 2020; Avila-Garzon et al., 2021). Third, AR results in higher student satisfaction (Fan et al., 2020; Jesionkowska et al., 2020). Fourth, students using AR experience more active learning (Jesionkowska et al., 2020;

Kamal et al., 2021). Teachers in the study reinforced ideas from the literature and similarly identified motivation, satisfaction, and active learning as potential learning benefits of using AR in the classroom. However, themes from the interviews indicated teachers also viewed AR as beneficial in achieving additional outcomes, including helping students have unique learning opportunities and more variety of learning experiences.

In addition to questions about benefits to students, participants were asked about how AR could help teachers fulfill the responsibilities associated with teaching. The topic of AR serving the needs of teachers went relatively unaddressed in the literature reviewed in Chapter 2, though Sembayev et al. (2021) uniquely suggested AR may be an effective means of assessing student learning. Every (100%) respondent in the present study offered an opinion suggesting how AR could be advantageous to teachers in completing tasks in class or out of class. Many teachers viewed using AR for teaching as a way to save time in lesson preparation. Assisting teachers in supporting the varied learning styles of students was identified in participant responses as a potential benefit of using AR. Some teachers said AR might help teachers assess students' learning. Offering more variety, incentivizing student achievement, and supporting a more learner-focused environment emerged as themes in the interviews as being beneficial aspects of using AR for teachers (see Table 5).

Theme 3: Perceived Barriers to Using AR in Teaching

Several issues were identified in the research literature as common limitations associated with using AR for education. The effort to integrate AR technology as a tool for learning can introduce complications to hinder or delay learning (Alzahrani, 2020). Poor instructional design of AR resources may present learning activities misaligned with practices of effective pedagogy and result in unsuccessful learning (Fan et al., 2020). The existing literature presented

technology challenges as cumbersome and frustrating barriers to the integration of AR in schools (Alzahrani, 2020). Equal access to technology was discussed as a problem (Doerner & Horst, 2022). Unstable hardware, software, and unreliable internet access are common issues with using AR in educational settings (Yapici & Karakoyun, 2021).

Most (88%) participants interviewed for this study recognized potential difficulties and barriers to using AR for teaching (see Table 7). Some findings were consistent with empirical data about challenges associated with using AR. Participants noted students' limited access to technology as a likely issue. The limitation of a weak or unsteady internet connection was a common concern among teachers.

Strong themes emerged from the teacher interviews not commonly found in extant research data. Concerns were repeated about the potential expense of acquiring AR. Several teachers mentioned the difficulty of using emerging technology as a probable impediment to the implementation of AR in the classroom. Technology restrictions and a tedious approval process imposed by the school district were commonly referenced as likely challenges to implementing AR in school. Also, in contrast to the research literature, most participants in this study did not cite weak pedagogy when answering questions about potential complications with using AR. However, the topic of sound pedagogy was repeated by teachers as a desired component of an AR app for meaningful curriculum integration.

Theme 4: Perceived Need for Support

The review of research literature about using AR for learning identified the need to support teachers through technical training, pedagogical professional development, and the provision of pedagogically sound AR assets. Findings from a study by Osuna et al. (2019) coincided with findings by other scholars suggesting teacher training on using AR in the

classroom should include content about technical knowledge and pedagogical knowledge to empower teachers to incorporate it with teaching effectively. According to Quintero et al. (2019), a review of 50 scholarly articles showed a strong need to provide specific AR apps designed technically and didactically to enhance learning.

During the interviews about AR for teaching and learning, most (94%) teachers in some way mentioned support teachers would need to implement AR successfully in teaching (see Table 7). Two emergent categories confirmed understanding within existing research. The first emergent category included the need to provide teachers with professional development opportunities for learning how to use AR. In this study, many teachers recognized the need for some type of AR professional development. Emergent themes about training included the need for introductory training, follow-up training, training from competent sources, access to effective examples of AR, and training on the effective integration of AR activities into the teaching curriculum. The second emergent category about teacher support in confirmation with the extant literature underscored teachers' desire to have AR resources capable of sustaining pedagogical success. Teachers indicated wanting responsive AR resources designed to help students achieve learning outcomes directly related to course content.

Theme 5: Perception of Support From Administrators and Peers

Tzima et al. (2019) cited "the enhancement of collaboration among teachers of different specialties" (p. 14) as one important factor in the effective use of AR in education. However, the potential value of support for AR use from peers and leaders in an educational institution was conspicuously absent in the review of literature outlined in Chapter 2. A unique category emerged from the teacher interviews regarding the support of AR implementation. Participants generally believed their administrators and colleagues would support the use of AR as a teaching

strategy.

A few (24%) participants predicted a challenging approval process at the district level to incorporate AR in the classroom. Nearly all (88%) respondents expressed the belief that local administrators in the school district would generally support teachers' use of AR. Many teachers perceived administrators are supportive of classroom technology benefiting student learning. Fifty-nine percent of the interviewees said teacher peers would be supportive of AR use, though not all would want to personally implement the technology. Some (18%) teachers suspected colleagues would likely desire to also use AR. One insight was that teachers in the school district largely have a perception of support from leaders and associates regarding using AR in the classroom.

Findings in Context of Theoretical Framework

The study explored the motivation of high school teachers in northern Utah to use AR as a teaching method and the support needed by teachers to incorporate AR successfully. Combined, the TPB (Ajzen & Driver, 1992) and the TAM (Davis et al., 1989) provided a theoretical framework for the study. The juncture of the TPB and the TAM rests on the assumption that human intention to adopt a behavior, including adopting the use of technology, is impacted by motivating factors.

According to Persada et al. (2021), the TPB frame holds the concept of a person's attitude—a feeling associated with a potential action—as an impactful motivator to use innovative technology. The idea of attitude in behavior adoption is consistent with the observation made by Steffen et al. (2019) stating the lack of AR adoption is limited by a lack of understanding of the benefits. The TPB construct asserts public school teachers develop behavioral beliefs creating personal attitudes about AR technology. By recognizing the

inaccurate or limited awareness of AR among high school teachers in the school district and how participating teachers generally developed a positive attitude about AR during the interviews, education leaders can work to increase an accurate awareness of the functions and benefits of using AR to increase teachers' motivation to use AR.

In the TPB frame, the term *behavioral belief* references a person's perceptions of the likelihood of an action resulting in an anticipated outcome (Ajzen, 2020). An individual's overall attitude about an experience can be impacted by both positive and negative behavioral beliefs. The TAM can be used to calculate the probability an individual or group will successfully implement computer technology (Davis et al., 1989). The features of new technology impact one's motivation to adopt technology (Dziak, 2020). The TAM assumes users must perceive a degree of usefulness of the technology to feel motivated to implement it. Knowing teachers in this study generally viewed AR as useful for supporting student learning outcomes and for fulfilling teacher responsibilities could help school and district decision makers evaluate how teachers may feel motivated to adopt AR. Leaders may facilitate teachers' motivation to use AR as a teaching method by helping teachers clearly understand and anticipate the potential benefits of applying AR in learning.

Perceived behavioral control in the TPB conveys how potential users perceive the ease or difficulty of adopting a specific behavior (Persada et al., 2021). Behavioral control is impacted by beliefs about factors facilitating or limiting the implementation of a given behavior (Ajzen, 2020). Such accessible control beliefs may include the perception of needed skills, ability, time, and money associated with executing the behavior (Ajzen, 2020). Knowing participants in this study identified several likely barriers to using AR in the classroom may help policymakers identify and mitigate the barriers, including some imposed and controlled by the district. School

and district leaders may be informed to implement effective training measures, as most teachers identified professional development as a needed support to facilitate the successful implementation of AR in teaching.

Subjective norms refer to the effect expectations other people have on one's behavior (Persada et al., 2021). Social influence from friends, family, or colleagues impacts a person's motivation to take action. Normative beliefs can involve the assumption of how others might approve or disapprove of conduct and if others would also adopt the behavior (Ajzen, 2020). Understanding teachers' general perception of support from administrators and peers to use AR technology may validate school and district leaders' desire to promote the use of technology. Renewed efforts toward fostering a district culture supportive of technology adoption could result from knowing teachers already anticipate support from leaders to use AR.

The intersecting of the TPB and the TAM afforded the context wherein this study demonstrated the opportunity to affect teachers' motivation to use AR through increasing awareness of the options and benefits of AR technology for learning. The theoretical framework also contextualized the value of preparing a robust technology implementation plan managing the perceived barriers to using AR. The inclusion of a strategy for professional development empowering teachers to use AR successfully for learning also aligned with the theoretical framework.

Conclusions

The findings of this study elevate several conclusions framed in the TPB and the TAM. While many high school teachers in the school district did not accurately understand AR technology, most responded favorably to a demonstration of AR for learning. Augmented reality is generally viewed by teachers as benefiting students and teachers. Nearly all teachers

recognized the challenges and barriers associated with integrating a new technology such as AR. The need for formal support to use AR successfully in the classroom was expressed by most participants, including technical and pedagogical training and access to AR resources designed for education. Teachers generally feel supported by administrators and colleagues in trying new technology options, such as AR, in the classroom. Findings from the study cannot be applied to a broader population due to the limitations of this qualitative study.

Limitations

Research limitations are beyond a researcher's control and involve variables pertaining to the character of the research methodology (Theofanidis & Fountouki, 2018). Research limitations can sway the validity of data collection, analysis, and interpretation. This study included three prime limitations: sample size, participant recruitment, and natural confines of the qualitative design.

Sample Size

The study was centered on one school district in northern Utah. The limited sample size of teachers challenges the legitimate transferability of the findings to other settings and other populations. According to Coleman (2021), transferability is the dependability of research findings of qualitative research and application to other populations. The previous Chapter 4 provided a detailed description of how and when data saturation was achieved in the study. Rich descriptions of interview data from 17 participants at multiple research sites contributed to potential transferability based on the reader's context.

Participant Recruitment

The availability of research participants is another limitation. Requests for interviews were extended through February 2023, and several teachers declined participation, citing

conflicts with the start of a new term, extracurricular activities, and personal circumstances. Relying on convenience sampling limited participant involvement to teachers interested in and willing to respond to interview questions. Perhaps a larger team of researchers and additional recruitment strategies would allow for a broader sample size.

Qualitative Design

The generalizability of the study was limited by the nature of the qualitative design. While rich qualitative information is effective in extrapolating an understanding of a phenomenon (Johnson et al., 2020), an additional layer of data collection may improve the depth of the data. The inclusion of a survey or questionnaire would lend more quantitative triangulation to explore teachers' motivation to use AR in the classroom.

Recommendations

The emergent themes resulting from the data collection, analysis, and findings provided the foundation of recommendations for future research and changes in practice and policy. An application gap exists between the accepted benefits of using AR in education and the low adoption rates by teachers. Few data exist about what motivates teachers to use AR in their classrooms and the support needed to use AR successfully. Supported by the findings, the following recommendations encourage changes in practice and advice for additional research.

Results indicate a general lack of awareness about AR technology among teachers. After being exposed to an AR app designed for education, however, most participants saw the potential for AR to have a positive impact on teaching and learning. The first recommendation is an effort to improve the awareness of AR technology for teaching among teachers and administrators. Education leaders should prepare and offer relevant information to help teachers understand the functions of AR and the associated advantages to students and teachers. Enlisting the expertise of

global industry professionals and leaders in the effort would be ideal, but facilitating the awareness of AR technology at any level is an important step toward change.

Based on the findings of this research, teachers possess strong opinions about the many barriers to adopting emerging technology, such as AR, in the classroom. Many of the concerns pertain to issues that should be addressed by national, state, and school district leaders, including equitable technology access for all, discouraging approval processes, and anticipated difficulties associated with integrating unfamiliar technology. Ideally, national and state education leaders should adopt a standardized, evidence-based technology implementation plan to provide the requisite support and resources to help teachers confidently integrate new technology. Such efforts at the school and district levels would also facilitate positive progress.

Findings from the interview data indicated most teachers in the school district feel supported by school and district administrators in applying new technology in teaching. Education leaders in other areas should conduct an evaluation to know the degree to which teachers feel supported by administrators to integrate emerging technology such as AR. Based on teacher input, administrators should determine actions to create or maintain an organizational culture supportive of AR technology.

Recommendations for additional research about teacher motivation to use AR include a having broader sample of participants and the addition of mixed or quantitative methods. The small sample of 17 teachers in one school district, as noted in the limitations section of the chapter, may limit how the findings transfer to other populations. A more expanded sample including participants from other school districts would increase transferability and offer a more accurate view of what motivates teachers in Utah to use AR. Future research efforts should avoid a solely qualitative design. Incorporating a quantitative element would reveal statistically

representative perspectives through mathematical analysis (Theofanidis & Fountouki, 2018).

Future research should focus on the difficulties of using AR in the classroom identified through the second research question. Obstacles to using technology, be they actual or perceived, affect one's motivation to integrate AR as a teaching tool. Additional research should explore whether internet bandwidth and Wi-Fi speeds impede the use of AR. Researchers should examine how school and district leaders' perceptions of AR influence their willingness to encourage and enable its use. Learning more about the challenges of applying AR for teaching can help district, school, and industry policymakers effect changes impacting teachers' motivation to use AR.

Implications for Leadership

Yoked with existing literature, the results of this study produced implications for leadership. While AR is generally accepted as promoting positive learning outcomes for students, many teachers do not use it (Oliveira da Silva et al., 2019). Leaders can gain a more practical understanding of how to help teachers integrate AR technology successfully by learning how teachers are motivated by viewing the benefits, challenges, and needed support to use AR successfully in teaching. Policymakers can influence meaningful change in the effective use of AR technology in schools by supporting motivating factors and mitigating issues discouraging the application of AR by teachers. Education leaders can strive to provide training and resources to support teachers' use of AR. Industry leaders can influence AR designers and developers to provide AR apps for learning to support curricula and established learning outcomes better pedagogically. The findings of this study possess the potential to inform education and industry leaders in effectively promoting positive change in the successful use of AR technology in schools.

Conclusion

This basic qualitative study focused on the motivation of high school teachers in northern Utah to utilize AR and the needed support to effectively utilize AR as a teaching method. Results indicated most teachers lacked an accurate awareness of AR but viewed the technology as beneficial for teaching and learning when introduced to it. However, results also showed teachers anticipated a variety of barriers to implementing AR successfully in the classroom. Technical and pedagogical training and access to AR resources designed for education were found as possible factors supporting teachers' motivation to integrate AR in the classroom. School administrators and peers were generally expected by teachers to be supportive of using AR as a teaching strategy.

Leaders in education may use the results of the study to identify and address issues related to the adoption of emerging technology, such as AR, for teaching and learning. Industry leaders could apply the results and give greater attention to the design and production of pedagogically aligned AR resources. Implications include the need for leaders to increase teachers' awareness of the functions of AR and the related benefits to teaching and learning, to understand and address the perceived barriers to AR use in the classroom, to provide training on educational AR use, and to evaluate the culture of administrators' support of technology integration. Future research emphasizing the challenges with using AR in the classroom and solutions school and district leaders can offer may help leaders of education and technology effect positive changes impacting teachers' motivation and ability to use AR successfully in the classroom.

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Appendix A

District Site Permission Letter

[redacted]

September 12, 2022

Brian Burnham
American College of Education

Dear Mr. Burnham:

[redacted] School District is committed to quality education and supports the efforts made by all individuals and groups who wish to improve it through research and study. As a state agency charged with the education and safety of the students who attend our schools, we take a close look at the many proposals that are sent to us.

Please recognize our commitment to children and know that all decisions we make are made with them in mind. Your project, ***Motivations to Implement Augmented Reality: A Qualitative Study of Utah Educators***, **has been approved. I will help you with the emails to teachers. You** will be allowed to send the initial email and one reminder. Once your project has concluded, you will need to provide the District with a digital copy.

If you have any questions, please don't hesitate to reach out. We wish you the best and hope for your continued success in education.

Your project is approved ___X___ Date: September 12, 2022

Your project is rejected _____ Date: _____

Continued Success,

[redacted]
Sheri W. Heiter
Director of Curriculum and Assessment
[redacted] School District
[redacted]

Appendix B

Recruitment Letter for Potential Participants

Date: October 21, 2022

Dear [Recipient],

I am a doctoral candidate at American College of Education. I am writing to let you know about an opportunity to participate in a dissertation research study.

Brief description of the study:

The purpose of this basic qualitative study will be to explore what factors motivate teachers at high schools in [redacted], Utah, USA to implement augmented reality in their teaching and what support is needed by motivated teachers to effectively apply it. You are being asked to participate in this quantitative study that may influence the adoption of augmented reality in education and improve learning outcomes.

Description of criteria for participation:

Your participation in the study will be voluntary. If you wish to withdraw from the research at any time, you may do so by contacting me using the information below. I may publish the results of this study; however, I will not use your name nor share identifiable data you provided. Your information will remain confidential.
Contact information:
You may contact the following individuals for additional information about the study.
Researcher: Brian Burnham
Organization: American College of Education
Email: [redacted] **Telephone:** [redacted]

Researcher's Dissertation Chair: Dr. Sandra Johnson
Organization and Position: American College of Education, Instructional Faculty
Email: [redacted]

If you meet the criteria above, are interested in participating in the study, and would like to be included in the potential participant pool, please use the link below to access, review, and accept the informed consent.
https://docs.google.com/document/d/1Be0d3T2a2n6hJyxxoFh0vM0c4D-OyAdh/edit?usp=share_link&ouid=111250780625756925655&rtpof=true&sd=true

Thank you again for considering this dissertation research opportunity.

Brian Burnham

Appendix C

Informed Consent Form for Interview Participants

Prospective Research Participant: Read this consent form carefully and ask as many questions as you like before you decide whether you want to participate in this research study. You are free to ask questions at any time before, during, or after your participation in this research.

Project Information

Project Title: Motivations to Implement Augmented Reality: A Qualitative Study of Utah Educators

Researcher: Brian Burnham
Organization: American College of Education
Email: [redacted] **Telephone:** [redacted]

Date of IRB Approval: XYZ

Please note this research study has been approved by the American College of Education Institutional Review Board. The IRB approved this study on December 12, 2022. A copy of the approval letter will be provided upon request.

Researcher's Dissertation Chair: Dr. Sandra Johnson
Organization and Position: American College of Education, Instructional Faculty
Email: [redacted]

Introduction
I am Brian Burnham and a doctoral candidate at American College of Education. I am performing research under the guidance and supervision of my Chair, Dr. Johnson. I will provide information about the project and invite you to be part of this research. Before you decide, you may talk about the research to anyone with whom you feel comfortable. If you have questions, please ask me to stop as we go through the information, and I will explain. If you have questions later, feel free to ask me then.

Purpose of the Research
The purpose of this basic qualitative study will be to explore what factors motivate teachers at high schools in the [redacted], Utah, USA to implement augmented reality as a teaching method and what support is needed by teachers to effectively use AR. You are being asked to participate in this quantitative study that may influence the adoption of augmented reality in education and improve learning outcomes.

Research Design and Procedures
The study will use a qualitative methodology and a basic qualitative research design. Interviews will be held with 15 specific participants who will participate in the [redacted] in Utah. Interviews will be conducted at the site most convenient for participants or via virtual

technology. Participants will be selected to respond to interview questions specific to the topic of augmented reality.

Participant Selection
You are being invited to take part in this research because of your experience as a high school teacher in the [redacted] who can contribute much to the topic of motivation, which meets the criteria for this study. Participant selection criteria: High school teacher in the [redacted] school district.

Voluntary Participation
Your participation in this research is entirely voluntary. It is your choice whether to participate. If you choose not to participate, there will be no punitive repercussions.

Right to Refuse or Withdraw
Participation is voluntary. Any time you wish to end your participation in the research study, you may do so by sending me an email explaining you are opting out of the study. There will be no repercussions for leaving the study.

Procedures
We are inviting you to participate in this research study. If you agree, you will be asked to participate in an interview. The type of questions asked will range from a demographical perspective to direct inquiries about the topic of motivations for using augmented reality for education.

Duration
The interview portion of the research study will require approximately 60 minutes to complete. If you are chosen to be interviewed, the time allotted for an interview will be 60 minutes at a location and time convenient for the participant. Prior to an interview, you will be asked to provide permission to have the interview recorded for the sake of having accurate transcripts for data.

Risks
The researcher will ask you to share personal and confidential information, and you may feel uncomfortable talking about some of the topics. You do not have to answer any questions or take part in the discussion if you don't wish to do so. You do not have to give any reason for not responding to any question.

Benefits
While there will be no direct financial benefit to you, your participation is likely to help us find out more about teacher motivations and augmented reality. The potential benefits of this study will aid the implementation rates of augmented reality in classrooms.

Confidentiality
I will not share information about you or anything you say to anyone outside of the researcher. During the defense of the doctoral dissertation, data collected will be presented to the dissertation committee. The data collected will be kept in a locked file cabinet or encrypted

computer file. Any information about you will be coded and will not have a direct correlation, which directly identifies you as the participant. Only I will know what your number is, and I will secure your information on a password-protected computer.

Sharing the Results
At the end of the research study, the results will be available for each participant. It is anticipated to publish the results so other interested people may learn from the research.

Questions About the Study
If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact the researcher or dissertation chair listed on this form. This research plan has been reviewed and approved by the Institutional Review Board of American College of Education. This is a committee whose role is to make sure research participants are protected from harm. If you wish to ask questions to this group, email IRB@ace.edu.

Certificate of Consent
I have read the information about this study, or it has been read to me. I acknowledge why I have been asked to be a participant in the research study. I have been provided the opportunity to ask questions about the study, and any questions have been answered to my satisfaction. I certify I am at least 18 years of age. I consent voluntarily to be a participant in this study.

Print or Type Name of Participant: _____

Signature of Participant: _____

Date: _____

I confirm the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered to the best of my ability. I confirm the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily. A copy of this Consent Form has been provided to the participant.

Print or type name of lead researcher: _____

Signature of lead researcher: _____

Date: _____

PLEASE KEEP A COPY OF THIS INFORMED CONSENT FORM FOR YOUR RECORDS.

Appendix D

Original Intel Teacher Interview Protocol

Teacher Interview Protocol

Intel Guide to Monitoring eLearning Programs

Teacher Interview Protocol

Instructions

The purpose of this interview is to gather information from teachers about the implementation of the Intel technology-based solution. This interview should take approximately 1 hour.

For each part of the interview, begin with the initial open-ended question. The topics listed on the left-hand column are intended to guide your discussion. For each topic, the sample probes listed on the right are intended to initiate conversation and elicit information. Please note that the probes included here are suggestions to help you obtain information about the topic. You are not required to ask every question listed; you are also welcome to make up other probes as might be appropriate and relevant.

Questions

Part 1: Rapport Building and Background Information	
Please tell us a little about yourself as a teacher.	
Current Experience	1. What grade levels and subjects do you teach? 2. How long have you been teaching at this school? 3. Do you have any other roles at the school (like departmental head or instructional coach) in addition to being a classroom teacher?
Background	4. How long have you been teaching? 5. How much experience do you have with using technology in the classroom to support your teaching?

Part 2: Classroom and School Context	
Please tell us a little about your school and how you teach.	
Classroom Practice	6. Can you describe a typical lesson in your classroom? 7. What resources do you use while planning your lessons? 8. How do you gauge your students' progress?

Part 2: Classroom and School Context—continued	
School Reform Context	9. What are the expectations that your school administration or higher level administrators have of you? 10. Right now, are you actively trying to change the ways teaching and learning happen in your classroom? What are you doing that is new or different? 11. Is this a change that others in your school or community are also working on, or are you doing this on your own?

Part 3: Intel Technology Solution	
Please tell us a little about your experience with using the Intel educational technology.	
Integration with Classroom Practice	12. Please describe one lesson or activity in which you have used the technology. (Probes: What was the activity? What did you do? What did students do? What sorts of resources did students use? What kinds of products, if any, did students produce? How did you assess what students were learning?) 13. How did you plan and prepare for this lesson? What resources did you use? 14. What kinds of lessons and activities have you been able to use it with, in general? 15. How have your students' responded to the use of the technology?
Perceptions/Buy-in	16. How do you think this program could benefit your students? 17. How do you think this program could benefit you as a teacher?
Challenges	18. What kinds of challenges and barriers have you encountered with using the technology in the classroom? 19. How have you addressed these challenges?
Prior Technology Experience	20. Did you use technology in your classroom previously? If so, how?

Part 4: Professional Development	
Please tell me a little about the professional development that you have received as part of the Intel technology solution.	
Professional Development Participation	21. Have you participated in professional development specific to the technology solution and related programs? 22. If yes, what did your professional development activities consist of? 23. What did you find most valuable about this professional development? 24. In what ways do you think the professional development could be improved?

Part 5: Support	
Please tell us about the various kinds of support you have received to help you implement the technology (support for implementation, support from the school administration, technical support, support from colleagues, etc.). Please also tell us about any difficulties you may have encountered and how they were addressed.	
Support for Implementation	25. How was the Intel technology solution explained to you at the start? 26. What support were you offered to help you learn about and start using the technology in the classroom? Have you received all the support you were offered? 27. Has the implementation been carried out in a way that reflects the initial plan? If not, what are some of the major differences?
Technical Support	28. Have you encountered any technical difficulties in using the technology? 29. To what extent do you receive support to help address these difficulties? (Probes: Who provides the support? How often do you need the support? How often do you receive it? What is the nature of the support you receive? Is the support you receive always in response to a problem or is it also proactive?)
Support from School Administration	30. To what extent do you feel support from school leadership/administration for the integration of technology into instruction?
Support from Colleagues	31. To what extent have you been able to share your experiences with the technology with your colleagues? Have your colleagues shared their experiences with you? 32. Has interacting with your colleagues helped prepare you to use technology in class?

Part 6: Wrap-up

Finally, is there anything else you would like to tell me about your experience with this program?

Thank you so much for participating! If we have some follow-up questions or a follow-up interview in a couple of months or so, would you be willing to participate again? If yes, how could we contact you then?

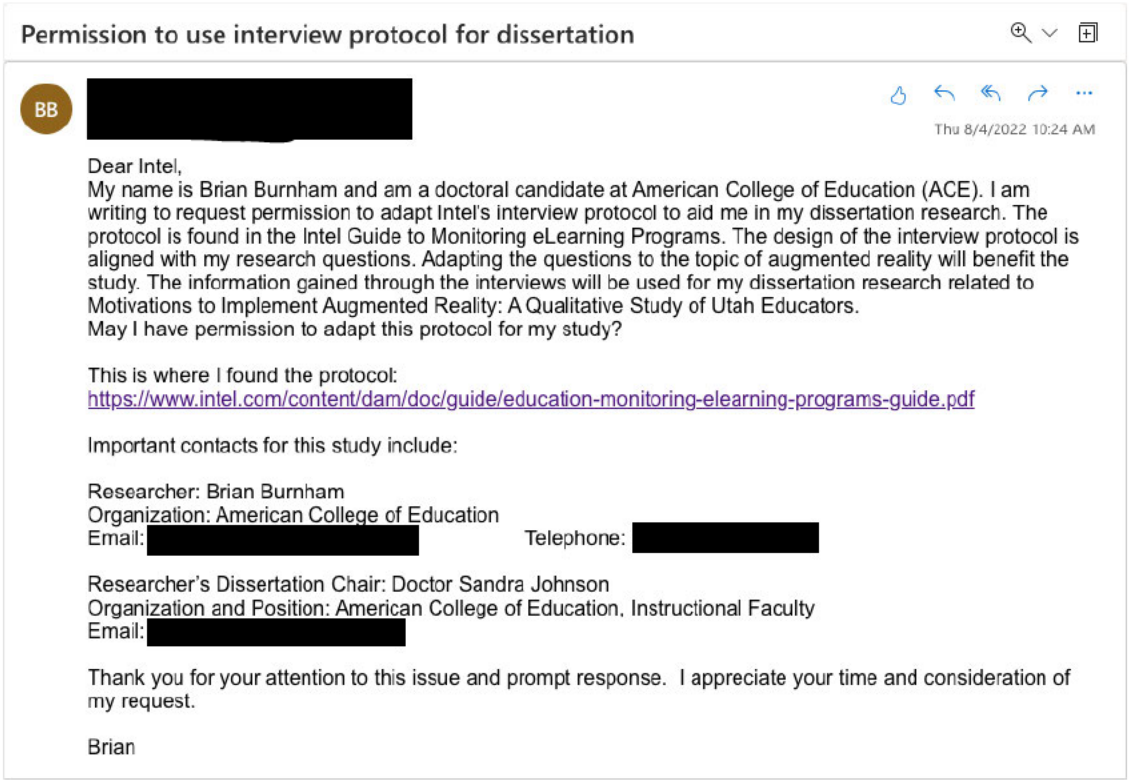
Follow-up

If the integration research design calls for multiple rounds of data collection, this protocol can also be used for the follow-up interview. In these cases, it will be appropriate to focus on observed change since the original research took place. More specific guidelines for customization are as follows:

Section	Suggested Modification
Part 1	Omit.
Part 2	Omit questions 6-8. Modify questions 9-11 to focus on changes, if any, since the previous interview.
Part 3	Questions 12-15 may be used without modification. Focus questions 16-19 on changes, if any, since the previous interview, modifying phrasing as appropriate. Omit question 20.
Part 4	Focus questions on changes since the previous interview.
Part 5	Omit questions 25-27. Focus questions 28-32 on changes, if any, since the previous visit, modifying the phrasing as appropriate.
Part 6	Wrap up.

Appendix E

Permission to Adapt the Intel Teacher Interview Protocol



Permission to use interview protocol for dissertation

BB [redacted]

Thu 8/4/2022 10:24 AM

Dear Intel,
My name is Brian Burnham and am a doctoral candidate at American College of Education (ACE). I am writing to request permission to adapt Intel's interview protocol to aid me in my dissertation research. The protocol is found in the Intel Guide to Monitoring eLearning Programs. The design of the interview protocol is aligned with my research questions. Adapting the questions to the topic of augmented reality will benefit the study. The information gained through the interviews will be used for my dissertation research related to Motivations to Implement Augmented Reality: A Qualitative Study of Utah Educators.
May I have permission to adapt this protocol for my study?

This is where I found the protocol:
https://www.intel.com/content/dam/doc/guide/education-monitoring-elearning-programs-guide.pdf

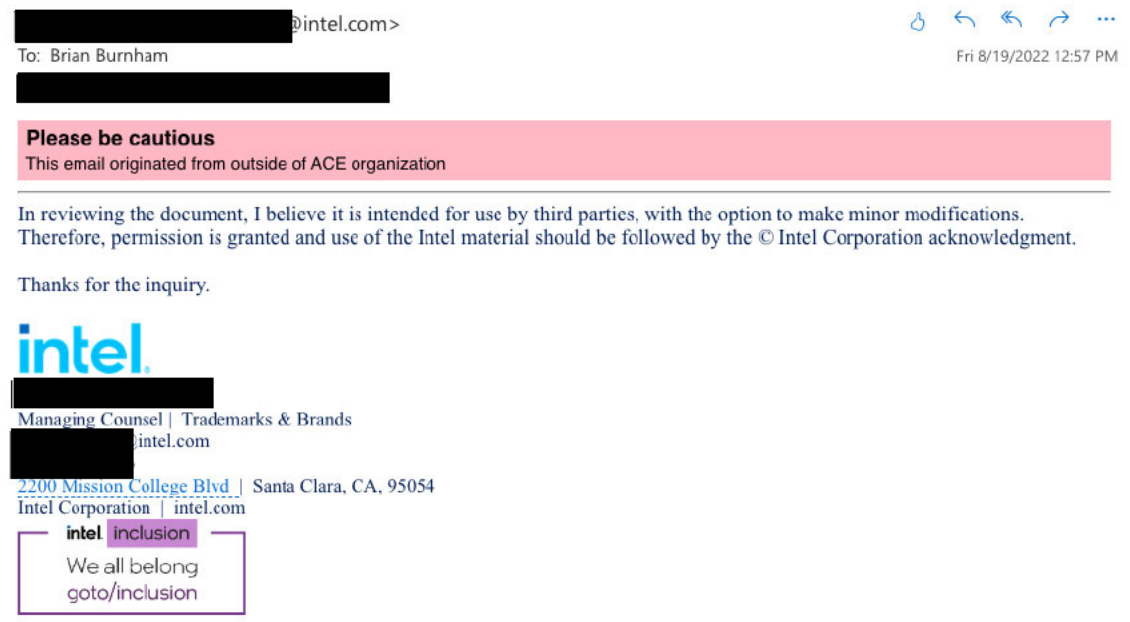
Important contacts for this study include:

Researcher: Brian Burnham
Organization: American College of Education
Email: [redacted] Telephone: [redacted]

Researcher's Dissertation Chair: Doctor Sandra Johnson
Organization and Position: American College of Education, Instructional Faculty
Email: [redacted]

Thank you for your attention to this issue and prompt response. I appreciate your time and consideration of my request.

Brian



[redacted]@intel.com>

To: Brian Burnham

[redacted]

Fri 8/19/2022 12:57 PM

Please be cautious
This email originated from outside of ACE organization

In reviewing the document, I believe it is intended for use by third parties, with the option to make minor modifications. Therefore, permission is granted and use of the Intel material should be followed by the © Intel Corporation acknowledgment.

Thanks for the inquiry.

intel

[redacted]
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2200 Mission College Blvd | Santa Clara, CA, 95054
Intel Corporation | intel.com

intel inclusion
We all belong
goto/inclusion

Appendix F

Requests for Input From Subject Matter Experts

Interview protocol validation

Brian Burnham [redacted]
To: [redacted]

Saturday, August 6, 2022 at 3:44 PM

Interview Protocol_A...
1.3 MB

Download All • Preview All

Internal Use\Not Encrypted Learn more

Dear [redacted]

I am a doctoral candidate at American College of Education (ACE). I am writing to request your assistance in validating an interview protocol. I am working to adapt an existing protocol that was developed by Intel to evaluate teachers' implementation of specific technology. I believe the design of this protocol aligns well with my research questions and can be adapted for my study. Please find attached my adapted interview questions.
The information gained through the interviews will be used for my dissertation research related to Motivations to Implement Augmented Reality: A Qualitative Study of Utah Educators. The purpose of this basic qualitative study will be to explore what factors motivate teachers at Layton High School in Davis County, Utah, USA to implement augmented reality in their teaching and what support is needed by a motivated teacher to effectively apply AR in their classrooms.
Your review of the protocol and suggestions for improvement will be greatly appreciated. Please feel free to invite other qualified researchers to contribute to the review of this protocol.

Important contacts for this study include:

Researcher: Brian Burnham
Organization: American College of Education
Email: [redacted] **Telephone:** [redacted]

Researcher's Dissertation Chair: Doctor Sandra Johnson
Organization and Position: American College of Education, Instructional Faculty
Email: [redacted]@ace.edu

Thank you for your attention to this issue and prompt response. I appreciate your time and consideration of my request.

Regards,

Brian Burnham

interview protocol

[redacted]

Brian Burnham [redacted]
To: [redacted]

Monday, August 22, 2022 at 10:48 AM

Interview Protocol_a...
1.3 MB

Download All • Preview All

Internal Use\Not Encrypted Learn more

[redacted] suggested I reach out to you for help in evaluating my interview protocol for my dissertation research. I have adapted the protocol from one developed by Intel. My protocol will evaluate teachers' motivations to use augmented reality and potential needs. The protocol does not intend for an interviewer to ask all questions, just as needed. Would you be willing to look over the protocol again and offer feedback that might help me improve the instrument and the interview outcomes? It would be ideal to have your feedback by Tuesday if possible. It is not a problem if you are not able or interested in offering feedback. Just let me know and I will make other arrangements. Thanks!

Appendix G

Feedback From Subject Matter Experts

RE: Interview protocol review

[redacted]

Monday, August 22, 2022 at 10:14 AM

To: Brian Burnham; Cc: [redacted]

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Brian,

I have listed various elements of an effective interview and protocol that I considered in my review of your document. Some of the recommendations listed would not be included in your formal protocol but should be considered nevertheless. Below those general recommendations, I've included some specific considerations for your protocol.

- Establish suffiencient rapport (confidence, cooperation, friendliness).
- Explicitly explain the purposes of the interview.
- Ensure that each question relates to a specific study objective.
- Use open-ended questions that encourage subjects to answer in their own words with depth of response.
- Avoid leading questions.
- Evaluate the sincerity and insight of the interviewee (ask questions in different ways to get at same point to verify accuracy).
- Stimulate the subject's insight into their own experience and explore areas not anticipated in the original plan.
- Follow up on what participants say, and ask questions when you don't understand.
- Listen more; talk less. Listening is the most important part of interviewing.
- Don't interrupt. Learn how to wait.
- Tolerate silence. It means the participant is thinking.
- Keep participants focused and ask for concrete details.
- Retain actual wording (notes, recording).
- Don't be judgmental about participants' views or beliefs; keep a neutral demeanor. Your purpose is to learn about others' perspectives, whether you agree with them or not.
- Don't debate with participants over their responses. You are a recorder, not a debater.

Mills, G., & Gay, L. (2018). *Educational Research: Competencies for Analysis and Applications* (12th ed.). Pearson.

Considerations

- Q5 How will subjects interpret "digital technology"?
- Q13 How representative will the "one lesson or activity" be of the teacher's overall experience? They may pick the best or worst because they stand out. Perhaps Q14 addresses this?
- Q15 What does "responded" mean?
- Q18 "challenges and barriers" or "challenges or barriers"? Maybe just use "challenges"?
- Q25 How much "training" vs. "explanation"?
- Is teacher perception of student interest in the use of AR in the classroom an important factor in teacher motivation? Is student interest relevant to your research questions?

Best of success!

[redacted]

Re: Research Interview Protocol Suggestions

[redacted] Brian Burnham [redacted] Wednesday, August 24, 2022 at 10:47 AM

To: [redacted]

Internal Use\Not Encrypted Learn more

[redacted]

Thank you for your time and expertise in reviewing this document. I also appreciate the time you spent with me yesterday discussing it. You are a valuable asset!

Thanks,
Brian

From: [redacted]
Date: Tuesday, August 23, 2022 at 3:22 PM
To: Brian Burnham <[redacted]
Cc: [redacted]
Subject: Research Interview Protocol Suggestions

Brian,
Here are my suggestions for your Interview Protocol.
Please let me know if you have any questions.
[redacted]

Teacher Interview Protocol

Teachers and Motivation to use AR in the Classroom

Teacher Interview Protocol

Instructions

The purpose of this interview is to gather information from teachers about what motivates them to use augmented reality in their classrooms. This interview should take approximately 1 hour.

For each part of the interview, begin with the initial open-ended question. The topics listed in the left-hand column are intended to guide your discussion. For each topic, the sample probes listed on the right are intended to initiate conversation and elicit information. Please note that the probes included here are suggestions to help you obtain information about the topic. You are not required to ask every question listed; you are also welcome to make up other probes as might be appropriate and relevant.

Questions

Part 1: Awareness about AR, Rapport Building, and Background Information	
Research Objective 1: Awareness about AR	1. Are you aware of digital technology in the classroom? 2. Are you aware of the technology called Augmented Reality (AR)? If yes, who or how did you learn about it?
~~Please tell me a little about yourself as a teacher.~~	
Research Objective 2: Current and past Teaching Experience	3. Would you please tell me about your current teaching experience? Hopefully they will address each of the questions below, if not, the interviewer could ask them. • What grade levels and subjects do you teach? • How long have you been teaching at this school? • Do you have any other roles at the school (like departmental head or instructional coach) in addition to being a classroom teacher? • ~~How long have you been teaching?~~

Part 2: Experience Using Augmented Reality in Teaching --	
~~Please tell me a little about your experience with using augmented reality in your teaching.~~	
Research Objective 2: Experience Teaching with AR	4. Tell me about your experience (with one example) using digital technology in class. • Have you used AR with your students? If yes,

Teacher Interview Protocol

[redacted]

What is the teacher target population? Higher education? High School? Elementary? Identifying your focus group sample is key.

Are these teachers using AR already or are we assuming what things can motivate them to use AR in the future?

There are some questions about what can motivate them to use AR - I am thinking you are addressing these questions to teachers who don't use the technology yet, is this right?

@mention or reply

[redacted]

Generally you develop the interview protocol with the aim of collecting data and supporting each of your research objectives. I am not sure why you mentioned in your email that you do not intend to ask all questions during the interview.

@mention or reply

[redacted]

You are considering asking other questions that are not stated in the focus group protocol? I am thinking you are using an unstructured protocol instead of an structured focus group protocol? You evaluation committee would want to know which of the two you are using.

@mention or reply

	• What subject matter? • What was the content? • What was the activity? • What was the student expected to do? • What was the App? • How did your students respond to the task? ~~If yes, please describe one lesson or activity in which you used AR technology. (Probes: What was the activity? What did you do? What did students do? What sorts of resources did students use? What kinds of products?)~~ ~~What kinds of lessons and activities have you been able to use it with in general? What resources did you use?~~ ~~How much experience do you have using digital technology in the classroom to support your teaching? – expected responses a lot – a little – no experience.~~

Ask this question only to teachers who responded about their experience with one example using digital technology in classroom.

Perceptions of Student Learning when Integrating AR with Classroom Practice	5. Overall, would you say that AR increases student learning? If so, tell us about the achievement of the student learning outcomes in your class. 6. How do you think AR could benefit your students' learning? • Does it improve student learning? • Does it improve student critical thinking skills? • Does it simplify concepts and content? • Does the technology motivate learners? • Does the technology contribute to provide a safe learning environment • Does the technology support peer-to-peer interaction? 7. How have your students responded to the use of AR?
Perceptions of benefits for Teachers/Buy-in	8. How do you think AR could benefit you as a teacher? • Is easier to design activities • Technology is more accessible (Apps are free) • Cost Effective
Perceptions of Challenges/barriers for implementation	9. What are some major barriers you encountered so far, with using AR in the classroom? • Funding? • Administrative support? • Student engagement? • Limited access to technology • Administration is unaware of trends of leading technology. 10. How have you addressed these challenges?

Teachers and Motivation to use AR in the Classroom

Part 3: Motivation of the use of AR

~~Please tell me a little about your motivation to use augmented reality in your teaching.~~

Motivating factors to use AR in your teaching ~~Professional Development Participation~~	11. Please tell me about some key motivating factors for you to use augmented reality in your teaching. • If there is professional development offered on the following: • Learning the basics/intermediate/advance concepts of AR. • Learning basic/intermediate/advance level of implementation of AR in my class. • Peer-to-peer support from colleagues– other teachers who are using AR • ~~Do you feel motivated to use AR in your classroom?~~ • ~~If yes, what makes you feel motivated to use AR in your teaching?~~ • ~~If no, what makes you feel unmotivated you to use AR in your teaching?~~ • ~~What factors increase or decrease your motivation to try using AR in your classroom (or to use it more)?~~

Part 4: Support

~~Please tell me about the kinds of support you would need to implement AR in your classroom (support for implementation, support from the school administration, technical support, support from colleagues, etc.).~~

Perceptions of anticipated difficulties when using AR in class ~~Support for~~	12. What kind of difficulties might you expect when facing using AR in your class? • Technical difficulties

Implementation	• Age difficulties • Currency of Knowledge of AR • Technology savviness • Burden of Cost, Time of learning the technology, etc. • Support from peers • Lack of support from administration • Technology is more for make teacher • Technology is only for younger teachers 13. ~~How much explanation about AR would you need to be able to use AR in your teaching?~~ 14. ~~What support would you need to help you learn enough about AR to start it in the classroom?~~ This is cover under motivating factors
Technical Support	15. ~~What kind of technical difficulties would you face in using AR in your classroom?~~ This is under perceptions of Support 16. ~~What kind of support would you receive to help address these types of difficulties? (Probes: Who would provide the support? How often would you need the support? What is the nature of the support you would need?)~~
Support from School Administration	17. To what extent do you feel your school leadership/administration would support your use of AR in your classroom?
Support from Colleagues	18. To what extent do you feel colleagues would support your use of AR in your classroom? Have your colleagues shared their experiences of using AR with you? 19. Has interacting with your colleagues helped influence your desire to use AR in class?

Part 5: Wrap-up

Finally, is there anything else you would like to tell me about ~~you're~~ your motivations to use AR and the support you would need to use AR in your teaching?

Thank you so much for participating!

Do you know what their research questions were? -

Appendix H

Institutional Review Board Approval Letter

December 12, 2022

To : Brian Burnham
Sandra Johnson, Dissertation Committee Chair

From : Institutional Review Board
American College of Education

Re: IRB Approval

"Motivations to Implement Augmented Reality: A Qualitative Study of Utah Educators"

The American College of Education IRB has reviewed your application, proposal, and any related materials. We have determined that your research provides sufficient protection of human subjects.

Your research is therefore approved to proceed. The expiration date for this IRB approval is one year from the date of review completion, December 12, 2023. If you would like to continue your research beyond this point, including data collection and/or analysis of private data, you must submit a renewal request to the IRB.

Candidates are prohibited from collecting data or interacting with participants if they are not actively enrolled in a dissertation sequence course (RES6521, RES6531, RES6541, RES6551, RES6561, RES6302) and under the supervision of their dissertation chair.

Our best to you as you continue your studies.

Sincerely,

Tiffany Hamlett
Chair, Institutional Review Board
American College of Education

Appendix I

Adapted Interview Protocol

Teachers and Motivation to use AR in the Classroom

Teacher Interview Protocol

Instructions

The purpose of this interview is to gather information from teachers about what motivates them to use augmented reality in their classrooms. This interview should take approximately 1 hour.

For each part of the interview, begin with the initial open-ended question. The topics listed in the left-hand column are intended to guide your discussion. For each topic, the sample probes listed on the right are intended to initiate conversation and elicit information. Please note that the probes included here are suggestions to help you obtain information about the topic. You are not required to ask every question listed; you are also welcome to make up other probes as might be appropriate and relevant.

Introduction

"Thank you for agreeing to help me with my study. I know you've already returned your consent form to me; did you have any questions?
I'll be recording this session, is that still ok with you? [then turn on recording]. Ok, I've started recording, may I ask again so that it's captured on the recording, is it ok that I record this session?
Let me tell you a little about my study…
The purpose of my project is to…
I've developed a list of questions to address my topic. I hope you'll answer all of them, but I do understand if there are some you prefer to not answer.
Before we jump into specific interview questions, can you tell me a little about yourself?"

Questions

Part 1: Awareness about AR, Rapport Building, and Background Information

Research Objective 1: Awareness about AR	1. Are you aware of digital technology in the classroom? 2. Are you aware of the technology called Augmented Reality (AR)? If yes, who or how did you learn about it?
Research Objective 2: Current and past Teaching Experience	3. Would you please tell me about your current teaching experience? • What grade levels and subjects do you teach? • How long have you been teaching at this school? • Do you have any other roles at the school (like departmental head or instructional coach) in addition to being a classroom teacher?

Part 2: Experience Using Augmented Reality in Teaching –

Research Objective 2: Experience Teaching with AR	4. Tell me about your experience (with one example) using digital technology in class. • Have you used AR with your students? If yes, • What subject matter? • What was the content? • What was the activity? • What was the student expected to do? • What was the App? • How did your students respond to the task?-

Ask this question only to teachers who responded about their experience with one example using digital technology in the classroom.

Perceptions of Student Learning when Integrating AR with Classroom Practice	5. Overall, would you say that AR increases student learning? If so, tell us about the achievement of the student learning outcomes in your class. 6. How do you think AR could benefit your students' learning? • Does it improve student learning? • Does it improve student critical thinking skills? • Does it simplify concepts and content? • Does the technology motivate learners? • Does the technology contribute to provide a safe learning environment • Does the technology support peer-to-peer interaction? 7. How have your students responded to the use of AR?
Perceptions of benefits for Teachers/Buy-in	8. How do you think AR could benefit you as a teacher? • Is easier to design activities • Technology is more accessible (Apps are free)

	• Cost Effective
Perceptions of Challenges/barriers for implementation	9. What are some major barriers you encountered so far, with using AR in the classroom? • Funding? • Administrative support? • Student engagement? • Limited access to technology • Administration is unaware of trends of leading technology. 10. How have you addressed these challenges?
Part 3: Motivation for the use of AR	
Motivating factors to use AR in your teaching	11. Please tell me about some key motivating factors for you to use augmented reality in your teaching. • If there is professional development offered on the following: • Learning the basics/intermediate/advance concepts of AR. • Learning basic/intermediate/advance level of implementation of AR in my class. • Peer-to-peer support from colleagues– other teachers who are using AR
Part 4: Support	
Perceptions of anticipated difficulties when using AR in class	12. What kind of difficulties might you expect when facing using AR in your class? • Technical difficulties • Age difficulties • Currency of Knowledge of AR • Technology savviness • Burden of Cost, Time of learning the technology, etc. • Support from peers • Lack of support from administration • Technology is more for male teachers • Technology is only for younger teachers
Support from School Administration	13. To what extent do you feel your school leadership/administration would support your use of AR in your classroom?
Support from Colleagues	14. To what extent do you feel colleagues would support your use of AR in your classroom? Have your colleagues shared their experiences of using AR with you? 15. Has interacting with your colleagues helped influence your desire to use AR in class?
Part 5: Wrap-up	
Finally, is there anything else you would like to tell me about your motivations to use AR and the support you would need to use AR in your teaching? If needed, may I follow up with you via email? Thank you so much for participating!	

Appendix J

Audit Trail of Significant Process Decisions

Purchasing an upgrade to Google Meet

I decided to purchase the upgrade of Google Meet to allow the recording of meetings. The recorded meetings facilitated the creation of interview transcripts used in data analysis.

Making an adjustment to the interview protocol

I decided to move question three on the interview protocol to the top of the interview questions. Since the introduction text and the third question requested similar information, this change created a more natural flow in encouraging participants to describe their work history.

Showing an Example of AR for Education

Many teachers mentioned or demonstrated having no understanding or an incorrect understanding of AR. For participants unfamiliar with AR, I gave a brief explanation of AR and showed a simple online AR app. This allowed teachers to offer more informed opinions about using AR.

Adapting the Nature of Some Interview Questions

All but one teacher reported never using AR in the classroom. Instead of asking questions to such participants about their experience with AR, I asked questions about perceptions of what using AR might be like.

Appendix K

Recordings of Potential Personal Biases

1. I recognized a potential personal bias when interviewing a teacher who teaches auto mechanics. Initially, the subject taught, language, and appearance made me wonder if the teacher's comments would have relevance to the topic of augmented reality. Awareness of the bias motivated me to remain objective in randomly selecting potential participants.
2. I recognized a potential personal bias when randomly selecting participants to interview. I noticed the subjects the teachers taught and wondered if some would be less helpful in collecting data. For instance, I speculated whether those teaching physical education would contribute meaningfully to the study. Being aware of this perspective helped me remain objective in randomly selecting teachers to participate.
3. I recognized a potential bias when I interviewed a younger teacher. I assumed, because of the participant's age, more familiarity with augmented reality. I quickly discovered that I was wrong. Assuming young teachers would be familiar with AR was incorrect several times. My self-awareness of this bias helped me remain objective when interviewing subsequent young participants.