Teacher Perceptions of Technology in Algebra Classes: A Qualitative Exploratory Case Study

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Abstract

Teacher perceptions are crucial in integrating technology in high school algebra classes. The problem was the limited inclusion of technology in algebra classes because of the traditional approach to teaching algebra. There is a gap in the literature regarding the influences of teachers' fixed or growth mindsets on their perceptions. The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. Self-perception theory (SPT) and the technology acceptance model (TAM) were combined in the current study to analyze teacher mindset influences on their perceptions of integrating technology in high school algebra classes. Research questions sought to answer possible influences of teachers' mindsets on teacher perceptions of the inclusion of technology in high school algebra classes. The research design was a qualitative exploratory case study with a target population comprising 65 math teachers working for a New Jersey school district. Eighteen teachers who taught algebra were selected. NVivo, a qualitative data analysis software, was used to conduct a thematic analysis of data from focus groups and semi-structured interviews. The thematic analysis closely examined common themes, topics, and ideas. The findings revealed the influence of fixed and growth mindsets on teacher perceptions. While teachers with a fixed mindset perceived technology inclusion negatively, teachers with a growth mindset perceived technology inclusion positively. Educational leaders should improve professional developments that address mindsets.

Keywords: teacher perception, fixed mindset, growth mindset, the integration of technology, self-perception theory, technology acceptance model.

Dedications

I dedicate this dissertation to my family, my spouse, and my two sons. In a busy schedule, they have always supported and understood me. I also dedicate this dissertation to my mother. She was a unique person who valued education and helped me to pursue an education career.

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Chapter 1: Introduction

Education has changed with rapid innovations and developments in instructional technology in the last 2 decades (Biber & Biber, 2021). Algebra is mainly an abstract topic where students struggle to grasp concepts (Bouck et al., 2019). Technology can help algebra teachers visualize various abstract mathematical contents with applications in real-life (Bouck et al., 2019). According to DeCoito and Richardson (2018), teachers mainly use presentation technologies with the trend of minimal utilization of web technologies, applications, discussion platforms, and simulation software. The availability of instructional technologies and rapid development can cause challenges and hesitation (DeCoito & Richardson, 2018). Technology integration in algebra classes depends on teachers' perceptions of understanding educational technology (Karchmer-Klein & Konishi, 2021).

A qualitative case study was conducted to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes. Teachers' perceptions of educational integration of technology can change algebra instruction (Xie et al., 2021). However, teachers struggle to overcome some internal and external barriers that can affect the use of technology in the classroom (Xie et al., 2021). Li et al. (2019) discussed the possibility of fixed and growth mindset effects on the integration of technology in algebra classes. Therefore, a study was needed to explore the effects of teachers' mindsets on the perception of the inclusion of technology in algebra classes.

The following sections include the background of the problem, the statement of the problem, the purpose of the study, the significance of the study, and the research questions. Additionally, the theoretical framework, assumptions, scope and delimitations, and limitations has been provided. Finally, a concise summary of the introduction has been provided.

Background of the Problem

Technology has been an essential part of daily instruction. McCulloch et al. (2018), Ardic and Isleyen (2018), Marley-Payne et al. (2019), and Ismajli et al. (2020) found that the integration of technology in math classes improved students' achievement. In the study done by Fabian et al. (2018), a *t*-test of the gain score between groups showed a significant difference, demonstrating that the experimental group had higher gains than the control group. Although instructional technology could improve algebra instruction, some teachers are reluctant to integrate technology (De Freitas & Spangenberg, 2019; McCulloch et al., 2018). Implementation of technology in algebra classes, such as math applications and websites, was limited due to teachers' perceptions (Mireles-Rios et al., 2019).

Some authors discussed several reasons for teachers' concern about using technology in students' teaching and learning (Marley-Payne et al., 2019; McCulloch et al., 2018; Perienen, 2020; Ross, 2020; Satsangi et al., 2019). Teacher training, teaching style, gender-related attitudes, and mandated curriculum are the primary concerns. All these concerns play critical roles in teacher perception. Some researchers explored the inclusion of technology and suggested using computers, iPads, or other smart devices in daily instruction regarding the lessons and activities created using software and applications in algebra classes (McClain & North, 2021). However, math teachers did not consider the inclusion of technology when addressing student-centered math lessons to improve student engagement and interest (Mireles-Rios et al., 2019). Therefore, the inclusion of technology in algebra classes stayed limited.

Statement of the Problem

The problem is the limited integration of technology in algebra classes across New Jersey high schools due to potential teachers' mindsets influencing their own perceptions of the inclusion of technology (Li et al., 2019). The use of technology is limited due to the traditional approach that appears as a mindset. Thiyagu and Joshith (2021) found that 34.7% of teacher participants in the study contact a little anxious, 24% feel somewhat anxious, and only 8% feel very anxious about the integration of technology.

According to Elmahdi et al. (2018), students' performance in technology-based algebra classes is more elevated than in traditional algebra classes. Elmahdi et al. stated that the lack of the inclusion of technology in algebra classes in high school settings impacts students' teaching and learning. The factors and reasons for the integration of technology in math classes have been extensively discussed in the literature, leaving the influence of teachers' mindsets on their perceptions of the integration of technology in high school algebra classes unaddressed (Li et al., 2019).

People's mindsets could affect how they perceive and decipher events and experiences, influencing their reactions and responses in such situations (Li et al., 2019). A fixed mindset refers to believing that learning and teaching abilities are unchangeable and permanent, while a growth mindset refers to believing that students and teachers can enhance their abilities with appropriate methods and providing adequate efforts (Kroeper et al., 2022). Although many math teachers support a growth mindset, students perceive instructors' beliefs regarding teaching styles and approaches in a real classroom environment differently (Kroeper et al., 2022). Because a fixed and growth mindset could affect teaching and learning, teachers' perceptions of technology in algebra classes might depend on their mindsets. Therefore, the proposed study is current, relevant, and essential.

Purpose of the Study

The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. Humble et al. (2020) found that the majority of teachers perceived that technology brings another layer of work to teachers' shoulders, which requires ongoing professional development. However, the lack of time and rapid development in instructional technology cause frustration and overwhelming (Humble et al., 2020).

The teachers' mindsets are interconnected beliefs, approaches, and attitudes that can be shaped at any stage of teaching and learning (Haukås & Mercer, 2021). Math teachers can perceive the integration of technology according to their beliefs, approaches, and attitudes. Researchers have been interested mainly in the fixed and growth mindsets of students, while some have talked about teachers' mindsets on students' ability and learning (Haukås & Mercer, 2021). Therefore, a study was needed to explore the influence of teachers' mindsets on the inclusion of technology in algebra classes.

A qualitative exploratory case study design was appropriate for this study. Peterson (2019) noted that direct personal experience could be shared in qualitative research to gain a more profound knowledge of externally observable behavior and internal states of mind in context. Researchers can utilize the case study approach to conduct a more in-depth investigation of a person or organization (Yin, 2018). Bressanelli et al. (2018) suggested that an exploratory case study can be beneficial for conveying the precise real-world setting. This qualitative exploratory case study was intended to investigate whether teachers' mindsets influence their perceptions of the inclusion of technology in high school algebra. Focus groups and semi-structured interview protocols were utilized to collect data. Research questions sought to explore teachers' mindsets regarding the inclusion of technology in algebra class; therefore, focus groups and one-on-one semi-structured interviews helped reveal teachers' mindsets and perceptions depending on fixed and growth mindsets.

This research was conducted at three high schools managed by a non-profit Charter Management Organization (CMO) in New Jersey. Sixty-five math teachers were the target population, and 18 volunteer high school algebra teachers were selected for the sample population based on algebra teaching experience. Data saturation occurred after 12 participants were in homogeneous groups (Guest et al., 2006). Eighteen participants were enough to explore teachers' mindsets regarding the inclusion of technology in algebra classes.

Significance of the Study

The literature on teachers' mindsets influences teacher perceptions of the inclusion of technology in algebra classes is limited because research typically focuses on students' mindsets (Haukås & Mercer, 2021; Li et al., 2019). Limited integration of technology in algebra classes depends on teachers' perceptions (Marley-Payne et al., 2019; McCulloch et al., 2018; Perienen, 2020; Ross, 2020; Satsangi et al., 2019). Researchers suggested that there is a need for professional development, ongoing technical support, and curriculum revision to change teachers' perceptions of technology (Bozkurt & Ruthven, 2018; Mireles-Rios et al., 2019). There is a gap in the literature regarding the influences of teachers' fixed or growth mindsets.

The proposed study might advance knowledge of teachers' mindsets on the inclusion of technology in algebra classes by providing findings that can be used to design professional development regarding mindsets. Administrators in school districts might consider utilizing instructional leaders to focus on more teachers' technology mindset. When teachers have open-minded and start integrating technology into algebra classes, students will benefit from engagement and interest due to the use of interactive math applications (Ismajli et al., 2020).

Findings may lead to changes in algebra instructions regarding instructional technology, which could help to update some policies regarding teacher observations. Parents, administrators, teachers, and students might see positive changes in algebra classes due to increased student satisfaction and outcomes (Marley-Payne et al., 2019).

Research Questions

The lack of the integration of technology in algebra classes depends on teacher perceptions (Alkoc Sayan & Ozsoy, 2018). Algebra teachers play a vital role in the integration of technology in algebra classes (Bozkurt & Ruthven, 2018). To explore teacher perceptions regarding teacher mindsets, the following research questions guided the study.

Research Question 1: How do teachers who express a fixed mindset perceive the meaning of the inclusion of technology in high school algebra classes at one school district in New Jersey?

Research Question 2: How do teachers who express a growth mindset perceive the meaning of the inclusion of technology in high school algebra classes at one school district in New Jersey?

Theoretical Framework

The self-perception theory (SPT; Bem, 1972) and the technology acceptance model (TAM; Davis, 1989) were the guiding theories to explore teacher mindset influences on their own perceptions of the inclusion of technology in algebra classes. Atabek (2020) and Cheok et al. (2017) affirmed that the integration of technology relies on teachers' perceptions and technology acceptance regarding ease of use and usefulness. When algebra teachers have a positive attitude toward the integration of technology, actual usage of math applications in daily instruction appears (Dinc, 2019).

According to SPT, people form perspectives and beliefs through monitoring their own behavior (Bem, 1972). Bem asserted that social circumstances impacted behaviors more than free will. According to Mohebi and Bailey (2020), the self-perception theory is the most influential theory describing how self-knowledge is gained. Therefore, teachers' mindsets appear to be affected by SPT.

The technology acceptance model was introduced by Davis (1989) to predict the success of the integration of technology by focusing on perceived ease of use and usefulness. Rafique et al. (2020) expressed that perceived ease of use and usefulness had a powerful impact on technology usage. TAM is crucial for identifying predictors of teacher behavior, such as acceptance or resistance to the use of technology (Granić & Marangunić, 2019).

Because the teachers' mindsets are interconnected beliefs, approaches, and attitudes, the combination of SPT and TAM can be utilized to analyze the influence of teacher mindsets on their own perceptions of the integration of technology in high school algebra classes (Haukås & Mercer, 2021). Self-perception consisting of self-efficacy, perceived enjoyment, and social influence, is a factor that impacts perceived usefulness and ease of use of technology. Research questions explored how the fixed and growth mindsets of teachers influence their own perception of the inclusion of technology in algebra classes. SPT and TAM will help with analyzing data by utilizing focus groups and semi-structured interview protocols. The questions in focus groups and semi-structured interview protocols were designed to reveal teachers' mindsets, whether fixed or growth, depending on SPT and TAM. There will be a further discussion in Chapter 2 regarding the theoretical theories.

Definitions of Terms

Comprehending the meaning of the terms used in a study can increase the understanding of the research findings. Some terms used in this study might not be typical. Definitions of some terms are provided.

Curriculum is defined as algebra topics and skills that are taught in one school year (Wang et al., 2017).

Fixed Mindset is defined as learning and teaching abilities that are unchangeable and fixed (Kroeper et al., 2022).

Growth Mindset is defined as students and teachers can enhance their abilities with appropriate methods and by providing adequate efforts (Kroeper et al., 2022).

Perceived ease of use is defined as math applications and software are user friendly (Rafique et al., 2020).

Perceived usefulness is defined as math applications and software that are beneficial to improve students' outcomes (Rafique et al., 2020).

The inclusion of technology is defined as using math applications and software in daily algebra instruction (McCulloch et al., 2018).

Assumptions

Research assumptions are essential topics, concepts, or views taken for granted and seen as reasonable and commonly accepted from the beginning of the study design through the final report (Theofanidis & Fountouki, 2018). The self-perception theory (Bem, 1972) and the technology acceptance model (Davis, 1989) are assumed to be accurate and suitable to explore teacher mindset influences on their own perceptions of the inclusion of technology in algebra classes. Teachers' perspectives can be shaped by the environment rather than free will, which is the self-perception theory (Bem, 1972). Similarly, teacher perceptions can be identified by the technology acceptance model.

Another assumption of the study was that a teacher's mindset could be revealed by answering the interview and focus group questions. Teachers are expected to answer a set of questions designed by the researcher and modified according to Subject Matter Experts (SME) feedback. The design of the questions in the interview and focus group are assumed to help to identify specifically fixed and growth mindsets of the teachers.

A qualitative exploratory case study design was selected due to the nature of the study focusing on a specific example inside a real-world environment (Yin, 2018). This design was assumed to help answer the research questions. Additionally, the participants' knowledge was assumed to be sufficient to answer interview and focus group questions, and they were willing to share their opinions honestly.

Scope and Delimitations

This study focused on teachers' mindsets that influence their own perceptions of the inclusion of technology in high school algebra classes (Li et al., 2019). Sixty-five math teachers who worked in a school district in New Jersey were invited to participate in the study. The only inclusion criterion was to have algebra teaching experience. Teachers who did not have algebra teaching experience were excluded. A combination of the self-perception theory (Bem, 1972) and the technology acceptance model (Davis, 1989) were the theoretical frameworks for this study. Teachers' mindsets can be shaped and affected by their environment and technology acceptance. Focus groups and one-on-one semi-structured interview protocols were utilized for data collection, which was for a period of 2 weeks. The researcher aimed to explore algebra teachers' mindsets regarding the inclusion of technology in algebra classes.

One of the delimitations of this study was to explore the fixed and growth mindsets of algebra teachers (Haukås & Mercer, 2021). Although mindsets can differ due to beliefs, attitudes, and opinions, such as paradox mindset, global mindset, entrepreneurial mindset, and growth or fixed mindset, this study was bounded by the growth and fixed mindsets of the teachers (Yin, 2021).

Another delimitation was that participants included only algebra teachers in three high schools managed by a charter school organization in New Jersey. Limiting the study to only algebra teachers could potentially affect the transferability of results. Algebra is commonly known as an abstract topic (Bouck et al., 2019). Therefore, algebra teachers might have different approaches to teaching the subject and not consider technology initially.

Limitations

Research limitations refer to potential flaws that are usually beyond the researcher's control and are directly related to the chosen research design, financing constraints, or other issues (Theofanidis & Fountouki, 2018). McGinley et al. (2021) defined dependability as a study design that is reproducible enough to establish future studies. Focus groups and semi-structured interview protocols were specified to ensure the study's dependability. Following a step-by-step data, collection guide helped increase dependability allowing other researchers to replicate the study. Also, transferability was established by providing evidence that the findings of the study could be used in other contexts, circumstances, and populations (Yin, 2018).

The selected study site and the target population could impact the findings of the result. Thomas and Rogers (2020) identified the potential positive impact of the COVID-19 pandemic on technology use in education. Therefore, teachers could have been affected by the pandemic to change their technology mindset. Because the researcher sought to explore how teachers who express a fixed or growth mindset perceive the meaning of the inclusion of technology in high school algebra classes, the results of focus groups and interviews could have been impacted by the COVID-19 pandemic. Therefore, the findings might be misleading in exploring actual teacher perceptions.

Although some resources were utilized to develop data instruments and the questions in the focus group and semi-structured interview protocols (Jeffs et al., 2021; Limeri et al., 2020; Selbach-Allen et al., 2020), the content was a limitation of this study. Although questions were designed to reduce leading answers, wording, and order biases (DeJonckheere & Vaughn, 2019), the number of questions and content coverage was still limited.

Another bias was the relationship between the researcher and participants. The researcher and the potential participants worked in the same educational institution where the study was conducted. As an instructional coach, the researcher might influence some of the teachers. However, due to the nature of instructional coaching, teachers feel comfortable when expressing their opinions. Teachers were asked to answer the interview and focus group questions comfortably and naturally, which helped reduce any biases.

Chapter Summary

Instructional technology has been changing education (Biber & Biber, 2021). According to the research, teachers use technology more or less to boost student learning. However, technology implementation in algebra classes, such as math applications and websites, has been limited because of teachers’ perceptions (Mireles-Rios et al., 2019). Because research often focuses on students' attitudes, there is a paucity of literature on how instructors' mindsets influence teacher impressions of the inclusion of technology in algebra classes (Haukås & Mercer, 2021; Li et al., 2019).

People's mindsets could affect how they perceive and decipher events and experiences, influencing their reactions and responses in such situations (Li et al., 2019). A qualitative exploratory case study was conducted to explore how teachers' mindsets influence their own attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. Two theories, the self-perception theory (SPT) (Bem, 1972) and the technology acceptance model (TAM) (Davis, 1989), combined guided the study.

Chapter 2 reviews the literature regarding teacher perceptions of the integration of technology in math classes. The literature search strategy, theoretical framework, and comprehensive literature synthesis are provided. Finally, a concise summary of major themes in the literature is reviewed.

Chapter 2: Literature Review

Although the integration of technology regarding lessons and activities created using software and applications in algebra classes has recently been a critical topic of discussion among math educators, some researchers explored the effects of technology in general and suggested the inclusion of technology (McClain & North, 2021). Math teachers did not consider the inclusion of technology when addressing student engagement and interest (Mireles-Rios et al., 2019). The problem is the limited integration of technology in algebra classes across high schools in New Jersey due to potential mindset influences of teacher perceptions (Li et al., 2019). According to Damick (2015), technology helped create student-centered, differentiated lessons, increasing student engagement. The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. Although mindset refers to attitudes, beliefs, and opinions in general, this study focused on fixed and growth mindsets.

The background of the problem constitutes the investigation of teachers' beliefs regarding traditional algebra teaching methods (Alsaeed, 2017). Several authors demonstrated how the integration of technology impacts and improves student learning. Alkoc Sayan and Ozsoy (2018), Bozkurt and Ruthven (2018), Lavicza et al. (2020), Leem and Sung (2019), and Ursavas et al. (2019) addressed how teachers' perceptions impacted the integration of technology in education. However, the influence of teachers' mindsets on their perceptions of the integration of technology in high school algebra classes appeared to be a gap in the literature. Li et al. (2019) suggested future research investigate how teacher mindset influences their own perceptions, practice, and performance regarding the integration of technology.

The following sections include the literature search strategy, theoretical framework, a comprehensive synthesis of the literature, and a summary of the literature review. The literature search strategy includes the databases and search terms utilized. Two guiding theories have been identified in the theoretical framework section. A comprehensive synthesis of the literature is presented in the research literature review. Finally, a concise summary of major themes in the literature is provided.

Literature Search Strategy

The review of the literature consisted of peer-reviewed journal articles, books, and limited dissertations. The American College of Education (ACE) Library, ProQuest, and Google Scholar were used to conduct an initial literature search. Peer-reviewed articles and dissertations were from no earlier than 2018. The following terms and sentences were used in the initial literature search: *technology inclusion, technology or not in education, teachers' perceptions of technology, teachers' perceptions of the use of technology, math classrooms with technology, the inclusion of technology in algebra, teachers' perception of the inclusion of technology in algebra, teachers' mindset.*

Theoretical Framework

The self-perception theory (Bem, 1972) and the technology acceptance model (Davis, 1989) were utilized as guiding theories to explore teacher mindset influences on their own perceptions of the integration of technology in high school algebra classes. Integrating technology depends on teachers' perceptions and acceptance (Atabek, 2020; Cheok et al., 2017). Actually, the integration of technology into the curriculum occurs when teachers have a positive attitude toward technology use (Dinc, 2019).

The Self-Perception Theory

The self-perception theory (SPT) asserts that people cultivate perspectives and beliefs by observing their own behavior (Bem, 1972). According to Bem, actions were influenced by social circumstances rather than free will. People comprehend perceptions, beliefs, and attitudes by analyzing behavior and its causes (Mohebi & Bailey, 2020). Self-perception was built on the premise of defining other people by their actions (Mohebi & Bailey, 2020). According to Nazari et al. (2020), people have to decipher ambiguous inner clues by analyzing attributive methods in the context of their own behaviors. In SPT, attitudes do not evolve; instead, people understand why the various attitudes occur by observing their own behaviors (Nazari et al., 2020).

According to Mohebi and Bailey (2020), the self-perception theory is the most influential theory describing how self-knowledge is gained. The SPT explained how new self-knowledge emerged from behavior consistent with previous self-beliefs (Mohebi & Bailey, 2020). Self-observation and reflection played a critical role in the self-perception theory (Bem, 1972). According to Bem, individuals could reflect on behavior after observing action to understand how attitude changes. The application of self-perception theory can change teacher attitudes toward technology (Yee & Bailenson, 2007). Also, the application of self-perception theory supported the objective of the current study, which is to explore how teachers interpreted the inclusion of technology and the effects of adding technology components in high school algebra classes. The inclusion of technology in high school algebra classes depended upon teachers' perceptions and teaching styles (De Freitas & Spangenberg, 2019). For instance, experienced teachers were reluctant to use technology in algebra teaching and learning due to a lack of confidence in handling the technology (Cheok et al., 2017).

The Technology Acceptance Model (TAM)

The technology acceptance model was introduced by Davis (1989) to predict the success of the integration of technology by focusing on perceived ease of use and usefulness. According to Rafique et al. (2020), perceived ease of use and usefulness had a powerful impact on technology usage. These central values proved to be precursor factors influencing the perception of learning by technology (Granić & Marangunić, 2019).

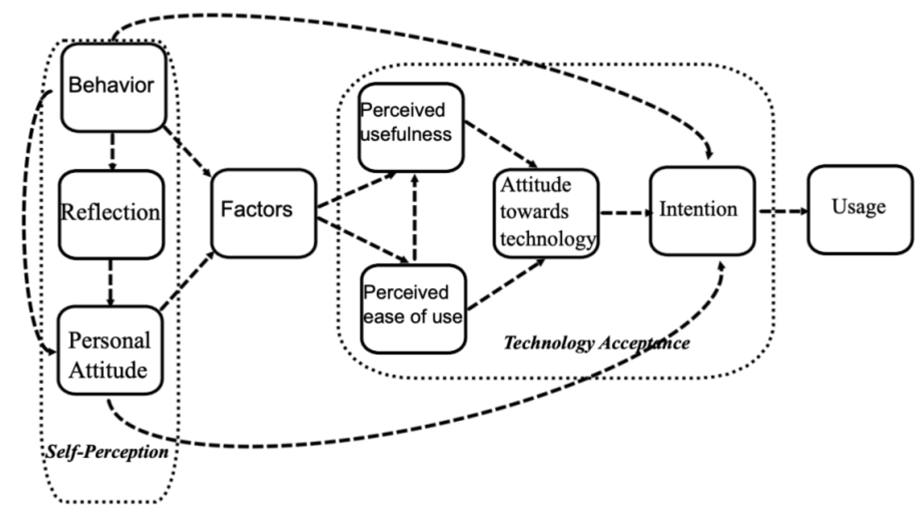
Salloum et al. (2019) demonstrated that TAM was an effective model for educational technology acceptance. According to Salloum et al., perceived ease of use and usefulness were influenced by external factors which impacted attitudes towards the integration of technology in education. Al Kurdi et al. (2020) identified external factors as self-efficacy, perceived enjoyment, and social influence. While self-efficacy refers to a degree of technological competency for use in specific tasks, perceived enjoyment refers to technology usage recognized to be pleasant (Al Kurdi et al., 2020). Social influence was defined as the degree of others' impact on decisions regarding technology usage (Al Kurdi et al., 2020). TAM was critical to understanding predictors of teacher behavior, including reception or resistance to the use of technology (Granić & Marangunić, 2019). The application of TAM supported the purpose of the current study, which was to explore how teachers interpreted the inclusion of technology and the effects of adding technology components in high school algebra classes.

Combining Theories

SPT and TAM were combined as the theoretical framework in the current study to analyze the influence of teacher mindset influences on their own perceptions of the integration of technology in high school algebra classes. One of the factors related to the acceptance of the technology was self-perception (Perienen, 2020). Perceptions, beliefs, and attitudes might be explored by analyzing teacher behavior and intent to adopt educational technology by focusing on perceived ease of use and usefulness. Figure 1 depicts how the two theories may combine. Self-perception, consisting of self-efficacy, perceived enjoyment, and social influence, was a factor that impacted perceived usefulness and ease of use. The intent to use technology depends on attitude and behavior; however, perceived usefulness and ease of use primarily impact attitude. The actual usage of technology occurs when attitude and intention change (Dinc, 2019).

Figure 1

SPT and TAM Frameworks Combined



Note. This figure identifies how two theories connect factors to the use of technology in algebra classes.

Literature Review

The role of technology in education has long been a critical topic for exploration and a point of investigation for a myriad of researchers such as Marley-Payne et al. (2019), McCulloch et al. (2018), Perienen (2020), Ross (2020), and Satsangi et al. (2019). There was no doubt that instructional technology had greatly impacted teaching and student learning in general. The current literature review topics include (a) educational technology, (b) teacher training, (c) teacher perception, (d) teaching style, (e) teacher mindsets, (f) years of experience, (g) gender-related attitudes, (h) curriculum, and (i) student engagement and achievement. Each topic will be addressed in turn.

Educational Technology

According to Marley-Payne et al. (2019), technology was an integral part of high-quality math education. The researchers discussed how Excel spreadsheets helped deepen their understanding of algebra. Besides using graphing calculators as technology in algebra classes, students felt more comfortable using spreadsheets due to their existing computer skills (Marley-Payne et al., 2019). According to Perienen (2020), technology could help address low achievement in math classes. McCulloch et al. (2018) conducted a qualitative study involving 21 high school math teachers. The study revealed that teachers felt more comfortable with technology tools having collaboration, exploration, and assessment features. Given this consideration, technology tools might vary from lesson to lesson.

Satsangi et al. (2019) and Perienen (2020) discussed how technology could support students with special needs. Similar to the study by McCulloch et al. (2018), Satsangi et al. (2019) stated that teachers played a crucial role in selecting appropriate tools for students with disabilities. Even though the approach was the same in both studies, McCulloch et al. (2018) focused on teachers, and Satsangi et al. (2019) focused on students when selecting instructional technology. Ross (2020) stated that educational technologies should be selected systematically by checking teacher and student input. There would be no point in using technology if student achievement did not change. For instance, Osborne et al. (2020) investigated the implementation of geospatial technologies such as geofencing, remote sensing, and global positioning systems

(GPS) in geography classes. In the study by Osborne et al., student achievement did not change due to the poor implementation of geospatial technologies. Therefore, besides selecting appropriate technology tools, implementation was critical. The implementation of technology requires professional development and teacher training (Osborne et al., 2020).

Cheok et al. (2017) studied teachers' perceptions of e-learning by examining an online learning space known as the FROG VLE. The purpose of the qualitative study was to explore the beliefs and practices of 60 secondary school teachers concerning the implementation of FROG VLE (Cheok et al., 2017). According to the results of the study, teachers and students were excited by and benefited from FROG VLE. Students were especially interested in the flexibility of online learning. In addition, FROG VLE helped teachers make their jobs easier by organizing teaching and learning materials (Cheok et al., 2017). However, based on the findings, implementation was an issue due to a lack of teacher training, insufficient administrator support, and a larger class size of 30-40 students (Cheok et al., 2017). A study by Khan (2021) was similar to that by Cheok et al. (2017) regarding the excitement and the benefits of educational technology.

Khan (2021) investigated student teachers' perceptions surrounding the use of Computer Assisted Language Learning (CALL). The findings regarding the use of the CALL application were similar to those of Cheok et al. (2017). Khan (2021) stated that the results indicated a significant increase in overall technological pedagogical content knowledge (TPACK) and the self-efficacy of student teachers of English after participating in CALL. According to Mohebi and Bailey (2020), self-perception was the origin of developing self-efficacy. Self-perception theory (Bem, 1972) confirmed that self-perception was the cause of positive change towards the integration of technology. TAM (Davis, 1989) was also a valuable framework addressing teachers' perceptions and acceptance of technology. Khan (2021) also pointed out that the implementation of CALL required training and support. Khan (2021) and Cheok et al. (2017) agreed that teacher training and constant support were needed to implement technology efficiently and effectively.

Teacher Training

Because technology has been rapidly evolving, teachers should be trained and provided professional development opportunities to keep up with how instructional technology tools can best serve student learning (McCulloch et al., 2018). According to McCulloch et al., professional development activities were crucial in finding and implementing appropriate instructional technologies to meet learning goals in math. Therefore, teachers should have professional development activities addressing technological pedagogical content knowledge (TPACK) and adaptable ways of thinking about utilizing technology for teaching and learning (McCulloch et al., 2018).

Research done by Perienen (2020) supported the suggestion of McCulloch et al. (2018) regarding providing professional development activities to increase the integration of technology. Perienen (2020) conducted a mixed-method study involving 155 math teachers. One of the findings was that teachers emphasized the need to receive proper training in the pedagogical integration of technology in the classroom. Another finding was a direct correlation between computer skills development and frequency of computer use, percentage of teaching involving technology, and teaching experience. In a study by Bozkurt and Ruthven (2018), the same topic was taught by three teachers with different levels of expertise in technology (using dynamic math software). Comparisons among teachers revealed disparities in their practices, including the types of activity used, how their activity formats functioned pedagogically, and the emergent variants of the same activity formats (Bozkurt & Ruthven, 2018).

Schmid et al. (2021) conducted research involving 173 math, science, language, and social studies pre-service teachers. The findings matched previous studies (McCulloch et al., 2018; Perienen, 2020) in showing a correlation between the degree of technical skills and the degree of technology implementation in math classes. Bozkurt and Ruthven (2018), McCulloch et al. (2018), and Perienen (2020) agreed with Alkoc Sayan and Ozsoy (2018) regarding the importance of teacher training. One of the findings in the study by Bozkurt and Ruthven (2018) was that most of the participants emphasized the importance of teacher training for implementing technology adequately and effectively in math classes. The teachers wanted to use technology efficiently but struggled with rapid development and implementation (Bozkurt & Ruthven, 2018).

Huda (2019) shared a common assertion with Stein et al. (2020) regarding the importance of teacher training in integrating technology efficiently in math classes. The findings revealed that a teacher with limited pedagogical knowledge of technology and competence in math software struggled to utilize a graphing calculator. A lack of interest in using technology due to insufficient training provided by the school was evident in the results. The findings of Stein et al. (2020) were consistent with the results of Huda (2019) regarding the lack of support and technology training at the school level. Stein et al. (2020) found that novice teachers claimed to receive insufficient support from their school administrators regarding technology implementation. Due to a lack of support and technical training, novice teachers reported the integration of technology in teaching and learning was challenging (Stein et al., 2020).

Dele-Ajayi et al. (2021) suggested targeted professional development activities in technology implementation to address issues and barriers to empowering indifferent and unaware teachers in the effective utilization of instructional technology. A study by Osborne et al. (2020) involving 66 geography teachers led to similar findings regarding professional development activities. Ninety percent of the participants reported that geospatial technologies were challenging to integrate within the classroom. According to the findings of Osborne et al., more than 65% of participants declared that a lack of effective professional development caused challenges in implementing geospatial technologies in daily instruction.

According to De Freitas and Spangenberg (2019), math teachers were reluctant to integrate technology throughout daily instruction due to insufficient professional development. Participants claimed that the lack of professional development was a significant barrier to efficient technology implementation. Ozudogru and Ozudogru (2019) stated that math teacher training programs were essential for developing TPACK. The study consisted of 202 middle and high school math teachers. The findings of the study revealed positive outcomes with regard to explicitly using the TPACK framework to enhance math teachers' experiences. Since TPACK refers to the intersection of content, pedagogical, and technological knowledge, a teacher can evaluate instruction and lesson plans using TPACK (Ozudogru & Ozudogru, 2019). A specific lesson could be evaluated if the teacher delivered content with appropriate technology and pedagogy. Ozudogru and Ozudogru (2019) claimed that technical knowledge was imperative in addition to content knowledge to ensure effective math teaching and learning. Training on the most appropriate technology tools, such as Geogebra, Desmos, dynamic software programs, and smartboards or interactive boards, should primarily be provided to enhance and embrace teacher TPACK levels (Ozudogru & Ozudogru, 2019).

A study by Ursavas et al. (2019), consisting of 324 pre-service and 517 in-service teachers, aligned with the research by Ozudogru and Ozudogru (2019). The results of the study by Ursavas et al. (2019) provided empirical evidence regarding how professional development increased the positive perceptions of pre-service and in-service teachers regarding the use of technology. To enhance the efficiency and effectiveness of technology in the classroom, schools and school districts should provide technology training (Ursavas et al., 2019).

Nantschev et al. (2020) suggested ongoing instructional technology training to increase teacher TPACK levels as well. Professional development activities should support math teacher awareness of technology and pedagogy (Nantschev et al., 2020). Li et al. (2019) argued that technology training alone, without proper pedagogy, would not be as practical as expected. Professional development should involve technology training with pedagogy while addressing teacher mindset and school culture (Li et al., 2019).

According to Ismajli et al. (2020), options for training teachers included professional development activities and coaching to integrate technology into daily instruction. Ismajli et al. conducted a study consisting of four teachers and 132 students in a primary school. The findings were consistent with Nantschev et al. (2020), in which 29 high school math teachers offered one-on-one coaching to teachers. Although experimental and control groups were provided with the same technological tools in the study by Ismajli et al. (2020), significant differences in student achievement resulted from coaching teachers to integrate technology. Because of one-on-one and individualized coaching, the integration of technology was effective and efficient (Ismajli et al., 2020).

A study by Dinc (2019) involving 76 pre-service teachers showed funding and budgets as barriers to the utilization of technology. However, the findings were not clear regarding what pre-service teachers meant by funding and budgets. A budget might or might not include technology training or workshops. In a large-scale study involving 117 teachers, Atabek (2020) investigated how experienced teachers might help solve the integration of technology challenges. Atabek suggested that teachers needed support with technology supplies and funding. The findings of Atabek (2020) were consistent with the results of Dinc (2019) and Osborne et al. (2020).

Ng and Park (2021) reported findings regarding the use of enhanced video-based professional development to support STEM teachers. Twenty pre-service math teachers participated in the study by engaging in blended learning activities, including a video lesson on integrating technology in math classes. This study by Ng and Park was an example of how pre-service teachers notice the usefulness of effective integration of technology for improving student learning outcomes. The results were consistent with the findings of Nantschev et al. (2020) in that professional development helped understand the integration of technology and changed teacher perceptions. Therefore, teacher perceptions could be an integral part of the use of technology.

Teacher Perceptions

While technology has become an integral part of math education (Lavicza et al., 2020), math teachers play a crucial part in the integration of technology in math classes (Bozkurt & Ruthven, 2018). Alkoc Sayan and Ozsoy (2018) conducted a study involving 299 primary math teachers to analyze teacher perceptions of the use of technology in math classes. The results indicated that although teachers positively approached the necessity and advantages of technology inclusion, the majority of them negatively approached calculators in math classes. In a study by Leem and Sung (2019) with 768 primary teachers, the findings showed positive teacher perceptions with regard to using smart mobile technologies such as smartphones, smart pads, and tablet computers in classrooms. Similarly, teachers expressed negative perspectives regarding the instability and inconvenience of technology (Leem & Sung, 2019). Alkoc Sayan and Ozsoy (2018) and Leem and Sung (2019) agreed that the use of technology depends on teacher perception.

Ursavas et al. (2019) demonstrated that pre-service and in-service teacher attitudes toward computer use were the most influential predictors of behavioral intent. The authors discussed how teacher motivation, knowledge, and abilities significantly influenced instructional technology utilization in schools. Eight hundred seventeen pre-service and in-service teachers participated in the study. The findings were similar to the results of Alkoc Sayan and Ozsoy (2018) and Bozkurt and Ruthven (2018) regarding teachers' positive attitudes toward the integration of technology. Alkoc Sayan and Ozsoy (2018) demonstrated that all participants had a positive attitude toward utilizing technology in class; however, Ursavas et al. (2019) revealed that a positive attitude was more important for developing intent to use technology in pre-service teachers. The findings in a study conducted by Zipke et al. (2019) were similar to the findings of Ursavas et al. (2019) with regard to the use of technology by pre-service teachers. According to Zipke et al. (2019), the pre-service teachers were eager to try out the new educational technology, although they had less experience in college. The results revealed that the pre-service teachers needed someone to model how to use technology in the classroom (Zipke et al., 2019).

In contrast, Mitchell (2019) stated that the pre-service teachers appeared to take risks and felt at ease using digital apps and tools and viewed the use of technology in the classroom as valuable and significant. Although the pre-service teachers wanted to take risks, the findings revealed the importance of teacher training programs regarding pre-service teachers' technology adoption and beliefs (Mitchell, 2019). De Freitas and Spangenberg (2019) focused on math teacher beliefs and teaching styles. Their findings revealed that math teachers were hesitant to implement technology due to embedded teaching approaches. The pedagogical choices by which math teachers were most influenced and shaped were related to how they learned math years ago (De Freitas & Spangenberg, 2019). The integration of technology required changes in pedagogical approach and teaching style. However, math teachers were unwilling to change their teaching style (De Freitas & Spangenberg, 2019).

Teaching Styles

According to Marbán and Mulenga (2019), teaching styles play a critical role in implementing technology in math classes. A set of characteristics, needs, attitudes, and perceptions shape a teacher's teaching style (Marbán & Mulenga, 2019). The study by Marbán and Mulenga, involving 163 primary math teachers, illustrated a positive linear relationship between attitude and teaching styles regarding the inclusion of technology in math education. Research done by Nantschev et al. (2020) with 29 math teachers in higher education supported the study by Marbán and Mulenga (2019) by showing that teachers who followed student-centered instruction were using more technology in math teaching when compared with teachers who followed teacher-centered instruction. The results did not necessarily show that student-centered instruction was better than teacher-centered instruction. However, teachers who adopted student-centered instruction as a teaching style were eager to use technology actively due to interactivity and engagement (Nantschev et al., 2020). Teachers who adopted a teacher-centered approach primarily used technology to keep records and share documents but seldom for interactive, self-exploration, or discovery activities (Nantschev et al., 2020).

A study by Tanas et al. (2020) involving 150 middle and high school math teachers was slightly different from that of Marbán and Mulenga (2019) and Nantschev et al. (2020). Technology has become a permanent job requirement in education regardless of teaching style (Tanas et al., 2020). According to Tanas et al., incorporating technology into math education brought some challenges because of ongoing updates to math software. Tanas et al. also discussed and differentiated between intention and actual behavior regarding the use of technology. Although teachers intended to utilize technology in math classes, usage was limited due to a perceived lack of ease of use and usefulness (Tanas et al., 2020). Davis (1989) identified perceived ease of use and usefulness as the two principles of TAM.

Ibili et al. (2019) conducted a study involving 148 math teachers to examine the factors influencing the intentions of primary school math teacher acceptance and will to implement the Augmented Reality Geometry Tutorial System (ARGTS) and mobile Augmented Reality application produced to improve learners' 3D geometric thinking skills. According to the findings, perceived ease of use and usefulness were direct indicators of intention and acceptance to implement new technology. Tanas et al. (2020) agreed with Ibili et al. (2019) that perceived ease of use and usefulness correlated to intention and acceptance. Also, the findings of Ibili et al. revealed a correlation between teacher attitude and intent to use ARGTS technology. Teachers who used ARGTS technology reported satisfaction in reaching learning goals in geometry class (Ibili et al., 2019). The findings revealed that colleagues' beliefs concerning the use of the system directly influenced the teachers' perceptions of usefulness and ease of use. According to Davis (1989), self-perception and self-efficacy impact attitudes toward the integration of technology. The TAM framework may help evaluate teacher attitudes toward and intention to use technology.

Li et al. (2019) conducted a large-scale study comprising 968 high school teachers to explore factors of technology usage in different settings, such as student-centered and traditional instruction. According to the results, teacher instructional styles and openness to technology positively impacted the use of technology in class. These results were similar to results found by Marbán and Mulenga (2019) and Nantschev et al. (2020) regarding how teacher instructional styles impacted the integration of technology. The findings of Li et al. (2019) were that teachers who utilized student-centered instruction were most likely to implement technology in teaching and learning. Li et al. stated that the influence of teacher teaching styles was independent of teacher perceptions of their self-efficacy with regard to technology. TAM could be used to assess teacher self-efficacy with technology usage (Davis, 1989). Two components of TAM, perceived usefulness and ease of use, can impact teacher self-efficacy regarding technology usage. Although the study by Li et al. (2019) revealed, one of the predictors of the use of technology was teacher openness toward technology, how the teacher mindset influenced teacher perceptions, practice, and performance regarding instructional the inclusion of technology in education was not addressed.

Teacher Mindset

A study by Hong and Soleas (2020) involving 855 pre-service teachers revealed that mindsets were mainly shaped by observing veteran teachers. However, teachers' in-class experience also affected mindset changes. According to Hong and Soleas (2020), teachers' mindsets play a critical role in teaching and student learning. The authors stated that teachers could change and improve teaching styles and strategies according to their mindsets and beliefs. Thus, teachers' mindsets were primarily developed in teacher training before starting to teach professionally. In a similar study, Cementina (2019) explored teachers' digital mindsets on how teachers approached technology in their personal and professional lives. The findings showed that the teachers' hesitation to investigate developing technologies and their technology-related beliefs and experiences influenced their mindset with regard to teaching practice. Both studies, Hong and Soleas (2020) and Cementina (2019) addressed how teachers' mindsets impacted students' mindsets and could change the student experience positively.

Thiyagu and Joshith (2021) investigated the level of stress and anxiety of 150 teacher educators at the college level. According to the findings, 31.3% of teachers had high stress due to the fear of damage or loss of materials (Thiyagu & Joshith, 2021). Also, 28% of teachers had high stress due to anxiety about losing internet data (Thiyagu & Joshith, 2021). Additionally, 23.3% of teachers had high stress due to the fear of viruses or threats (Thiyagu & Joshith, 2021). The results demonstrated that teachers' mindsets toward technology were negatively impacted by these anxieties. De Ruiter et al. (2020) addressed how the teacher and student mindsets influenced teaching experiences. The authors compared fixed and growth mindsets within science, technology, engineering, and mathematics (STEM) contexts in high school settings. According to Tenemaza Kramaley and Wishart (2020), a fixed mindset (talent and intelligence) would not evolve; however, a growth mindset could evolve over time. Although the technology was involved in STEM teaching, the mindset towards technology use changed depending upon the verbal feedback teachers gave to students. De Ruiter et al. (2020) stated that teacher and student mindset improvement was related to verbalization from moment to moment. In this case, the research by De Ruiter et al. (2020) differed from the study by Thiyagu and Joshith (2021). While De Ruiter et al. (2020) found a positive impact of technology on teacher mindsets; Thiyagu and Joshith (2021) discussed a negative impact of technology on teacher mindsets.

Zeng et al. (2019) investigated the relationships between a growth mindset, well-being, perseverance, and work engagement. According to Zeng et al., teacher mindset was imperative to influencing students' beliefs about their abilities. The results also demonstrated that having a growth mindset predicted a higher degree of well-being and perseverance, positively influencing teacher work engagement. Zeng et al. (2020) agreed with De Ruiter et al. (2020) regarding the importance of a growth mindset in influencing student achievement. Cementina (2019) addressed how years of teaching experience influenced a teacher's growth mindset.

Years of Experience

Ozudogru and Ozudogru (2019) conducted a study comprised of 202 middle and high school math teachers to explore the technological pedagogical content knowledge (TPACK) levels to identify if math teacher TPACK levels differed by teaching experience and gender. The findings indicated that there was no significant effect on TPACK levels due to teaching experience. These results contradicted the study by Perienen (2020), which indicated that computers were more common among individuals with less teaching experience and younger teachers. Perienen demonstrated that teachers who have been in education for a longer period of time, considered veteran teachers, had used technology less as compared to novice teachers. Although the TPACK levels of novice and veteran teachers were similar, the intention to use technology in the classroom was different.

Ursavas et al. (2019) demonstrated similar findings regarding pre-service teachers and in-service teachers. However, pre-service teachers' intention to implement technology in education was higher than the in-service teachers' intention (Ursavas et al., 2019). The authors stated that in-service teachers implemented some technology only when it helped to improve learning goals and empower teacher performance. A study by Dinc (2019) involving 76 pre-service teachers revealed that 80.2% of pre-service teachers intended to add technology to improve teaching and student learning. The study coincided with the research done by Ursavas et al. (2019) and Ozudogru and Ozudogru (2019) regarding pre-service teachers' intent to integrate technology in the classroom. Ní Fhloinn et al. (2018) supported Ursavas et al. (2019) and Dinc (2019) regarding student-centered instructions adopted by novice teachers. According to Ní Fhloinn et al. (2018), pre-service teachers' technology usage was more than in-service teachers due to the implementation of a student-centered approach being higher when instruction was provided by pre-service teachers.

Xie and Cai (2021) found inconsistent results as compared to Ozudogru and Ozudogru (2019). According to Xie and Cai (2021), high school math teachers with 6-10 years of teaching experience were open-minded and adopted a constructive approach in math classes. In contrast, teachers with 21 or more years of teaching experience used relatively static, conventional, and pragmatic methods. These concerns were consistent with the findings of Dele-Ajayi et al. (2021) regarding the use of technology, which indicated that the number of years of teaching experience correlated to notable differences in attitude towards the integration of technology. Novice teachers with 1-5 years of teaching experience were less likely to have fully determined and established their own teaching style yet (Xie & Cai, 2021). A study by Stein et al. (2020) slightly differed from Xie and Cai (2021), indicating that novice math teachers were willing to integrate technology to enhance and embrace student learning. Novice teachers believed that using dynamic math software, such as Geogebra and Desmos, improved students' conceptual understanding of algebra.

Atabek (2020) differed slightly from Xie and Cai (2021) and Stein et al. (2020) while investigating how experienced teachers can support the integration of technology. One hundred eighty-seven experienced mixed-level educators, including 85 school administrators, participated in a workshop to explore how instructional technology implementation challenges could be eliminated. Although teacher training, time, and funding for technical support emerged as key findings, in contrast to Xie and Cai (2021) and Stein et al. (2020), Atabek (2020) found experienced teachers helped increase the integration of technology by supporting novice teachers.

The study by Atabek (2020) was consistent with the research done by Pape and Prosser (2018) regarding time constraints. Pape and Prosser stated that one of the main reasons for the lack of integration of technology was a lack of time. Eight math teachers said there was no time for different activities promoting self-discovery and critical thinking due to the need to follow a state-mandated curriculum. The participants in the study by Atabek (2020) suggested reducing the number of classes to create time for planning the integration of technology efficiently and effectively. However, regardless of time constraints, Ozudogru and Ozudogru (2019) addressed how gender impacted teacher mindsets.

Gender-Related Attitudes

According to the results by Perienen (2020) involving 155 female and male high school math teachers, male teachers were more interested in utilizing instructional technology tools, reporting a higher rating for perceived usefulness. However, there was no statistically significant difference between male and female teachers regarding the integration of technology in math classes. Similarly, Schmid et al. (2021) study consisting of 173 high school pre-service teachers, of which 93 were female and 80 were male, found that gender had no impact on attitudinal dimensions. Findings showed no differences in gender regarding the use of technology (Schmid et al., 2021).

Marbán and Mulenga (2019) differed slightly from Schmid et al. (2021) regarding gender-related attitudes. The study by Marbán and Mulenga (2019) consisted of 163 primary math teachers, of which 45 were male, and 118 were female teachers. Teachers completed a survey consisting of 25 positively worded statements relating to the successful integration of technology with rate each item on a 5-point Likert scale. The results by Marbán and Mulenga (2019) implied that, at a 95% confidence level, gender influenced teachers' attitudes towards the use of technology, with males having lower attitude values (Mean = 82.127, Std error = 2.327) than females (Mean = 91.747, Std error = 1.404) (Marbán & Mulenga, 2019). Female teachers with higher scores had positive attitudes toward the integration of technology. The results contradicted the findings of Perienen (2020). Marbán and Mulenga (2019) concluded that, as a result, gender variations in pre-service teachers' views about technology usage might be ascribed.

Ozudogru and Ozudogru (2019) conducted a study involving 202 middle and high school math teachers, of which 88 were female, and 114 were male. The findings supported the findings of the studies by Perienen (2020) and Marbán and Mulenga (2019). According to Ozudogru and Ozudogru, the technology knowledge perceptions of male teachers (M = 25.50, SD = 2.07) were significantly higher than that of female teachers (M = 19.00, SD = 6.04). In contrast, Dele-Ajayi et al. (2021) stated that gender made no statistically significant difference in their study regarding technology and communication technologies in education. Perienen (2020) and Marbán and Mulenga (2019) studies revealed different gender-related attitudes toward using technology in different cultures and curriculum settings.

Curriculum

Wang et al. (2017) researched a new algebra curriculum with the integration of technology. The modified curriculum consisted of unique teaching and learning practices, instructional strategies, and new e-textbooks. Unique teaching, learning practices, and instructional strategies consisted of self-exploration, classroom discussions, and completing real-life projects. Wang et al. stated that algebra teaching and learning should address 21st-century skills, such as critical thinking, problem-solving, and technical skills. Haviz and Maris (2020) agreed with Wang et al. regarding the need for critical thinking and problem-solving as 21st-century skills. Ismajli et al. (2020) stated that designing a curriculum considering critical thinking is essential to improve open-minded teaching and student learning. The research done by Ismajli et al. (2020) showed that the integration of technology promoted critical thinking and improved overall knowledge.

According to Pape and Prosser (2018), algebra is essential for advanced math, college readiness, and career success. Pape and Prosser conducted a three-year, long-term study involving eight community college instructors. The researchers sought information regarding how the eight instructors approached technology and math teaching and learning in general. One of the reasons the teachers gave for using technology in math classes was to improve critical thinking and advance the overall discourse level in class. However, Haviz and Maris (2020) showed that teachers were having difficulties teaching.

The integration of technology requires various pedagogical approaches, such as class discourse and debates. In this regard, Pape and Prosser (2018) found that math instructors claimed emphasis was placed on English or language skills over math instruction in class discussions. Therefore, according to Pape and Prosser, the instructors focused on math education concerns and the math content rather than class discourse or debates that helped improve language skills. According to Pape and Prosser (2018), an instructor believed that math education should stick to traditional teaching with the same curriculum. Although one instructor wanted to implement new technology into instructional practice, planning and time due to the mandated curriculum by the state made it challenging (Pape & Prosser, 2018). The study by McCulloch et al. (2018) showed similar findings regarding the math curriculum. All participants in McCulloch et al.'s study wanted the integration of technology in math lessons if technology was appropriate for the topic. However, since the teachers were to complete a curriculum, they did not have time to search for and implement new instructional technology tools into the lesson (McCulloch et al., 2018). According to Pape and Prosser (2018) and McCulloch et al. (2018), math instructors were forced to complete a state-mandated curriculum; therefore, instructors felt the integration of technology wasted time.

In a similar study regarding geospatial technologies in geography classes, Osborne et al. (2020) stated that half of the teachers who participated in the research thought geospatial technologies were unnecessary for teaching geography curricula. A long-term four-year study revealed that 90% of teachers did not implement geospatial technologies throughout daily instruction due to a lack of technical knowledge, and the perception was that there was no benefit to students learning (Osborne et al., 2020). These findings were similar to the results of McCulloch et al. (2018) and Pape and Prosser (2018), in which the integration of technology depended on curriculum. Teachers wanted to integrate technology; however, the existing curriculum did not involve technology.

Ní Fhloinn et al. (2018) conducted a study involving 34 middle school math teachers to explore their opinions about curriculum reform. The idea behind the curriculum reform was to move toward a more student-centered approach in math classes (Ní Fhloinn et al., 2018). The findings showed similarities with Pape and Prosser (2018) regarding teachers' mindsets. Teachers who participated in the study by Ní Fhloinn et al. (2018) struggled with implementing a new curriculum and new pedagogical strategies. Ní Fhloinn et al. suggested an ongoing training process and support at the school and state levels. According to Thiyagu and Joshith (2021), teachers' mindsets shifted toward becoming facilitators rather than experts. The authors stated that teachers were compelled to integrate technology with new pedagogical methods into the curriculum rather than demonstrating depth of knowledge and expertise in the concepts.

The findings of Prendergast and Treacy (2018) reinforced the results of Ní Fhloinn et al. (2018) regarding new curriculum implementation. Prendergast and Treacy (2018) conducted a long-term study to explore the new math curriculum reform in Irish schools. According to Prendergast and Treacy, students' learning outcomes significantly declined. Prendergast and Treacy stated that teachers agreed that not implementing the new curriculum (wholly or in part) was the primary reason for the decline. The results revealed that expectations of implementation were not satisfied. Teachers were not supported with efficient and proper training to implement the new curriculum as intended (Prendergast & Treacy, 2018). A study by De Freitas and Spangenberg (2019) regarding barriers to the integration of technology pointed to two main factors, which include curriculum-related time constraints and professional development activities supporting the implementation of technology into the curriculum to enhance student engagement and achievement.

Student Engagement and Achievement

McCulloch et al. (2018) emphasized that student interactions and engagement in math classes had shifted due to technological advancements. The authors discussed how teachers chose technology related to learning goals in math, such as reasoning, building understanding, and critical thinking. Using Excel spreadsheets helped students to gain abstract critical thinking and complex problem-solving skills in algebra (Marley-Payne et al., 2019). One of the participants in the study by Marley-Payne et al. shared experiences with colleagues regarding how Excel spreadsheets helped to make connections and deepen their understanding of abstract formulas. According to the results, student achievement and interaction were higher than usual. However, Ní Fhloinn et al. (2018) contradicted Marley-Payne et al. (2019) regarding the use of Excel spreadsheets being a significant factor in student achievement and interaction and pointed to low usage of Excel spreadsheets because most topics did not require it (Ní Fhloinn et al., 2018).

In contrast to Ní Fhloinn et al. (2018), Ismajli et al. (2020) revealed a significant improvement in student achievement when technology was integrated into regular daily instruction. The study was conducted to explore how coaching teachers in the integration of technology impacted student learning outcomes. The findings showed no significant differences between the control group and the experimental group on the pre-test. However, there was a significant difference in the post-test in favor of the experimental group, which utilized technology.

In a similar study, Ardic and Isleyen (2018) found a significant difference between the two groups utilizing computer algebra systems in algebra classes. The researchers claimed that computer algebra systems positively impacted student learning outcomes. One of the reasons for enhanced student achievement was increased interactivity and engagement (Ardic & Isleyen, 2018). These findings agreed with the results of Huda (2019), McCulloch et al. (2018), Marley-Payne et al. (2019), and Ismajli et al. (2020) regarding how computer applications impact student achievement. The integration of technology provided student-centered instruction where students were at the center of teaching and learning and where self-exploration and discovery were promoted (Ismajli et al., 2020). In addition, the integration of technology-enabled critical thinking and problem-solving with engaged students (Ismajli et al., 2020). Some of the indicators of student engagement included students asking more questions, participating more than usual, and active collaboration between students and teachers (Ismajli et al., 2020).

In another study, Fabian et al. (2018) investigated the impact of mobile technologies on student attitudes and engagement. While the experimental group utilized mobile technologies and related activities, the control group followed the traditional curriculum. According to Fabian et al., student engagement was reportedly higher in the experimental group because activities on mobile devices were enjoyable. In addition, students developed positive attitudes towards technology in math class. However, positive attitudes toward technology did not reflect on student achievement. Thus, the findings of Fabian et al. (2018) did not support the study by McCulloch et al. (2018) regarding positive changes in student achievements. However, the findings of Thiyagu and Joshith (2021) were similar to the results of Fabian et al. (2018) regarding excitement and engagement when technology was involved. Teachers made classrooms more exciting and joyful, hence increasing student engagement with technology. Similarly, a systematic meta-analysis (Higgins et al., 2019) indicated the significant overall positive impact of technology on student achievement, motivation, and attitudes.

Huda (2019), McCulloch et al. (2018), and Marley-Payne et al. (2019) found similarities with regard to the positive impact of technology on student learning outcomes in math. Huda (2019) conducted a study to explore the pedagogical knowledge of junior high school teachers with regard to incorporating technology in math teaching. Although only three junior high school teachers participated in this study, the findings revealed that technological pedagogy, teacher motivation, and school culture were crucial factors in determining the success of the integration of technology in math (Huda, 2019). In the findings of a study by Stein et al. (2020), novice teachers with three years or fewer of teaching experience realized that the integration of technology with visual tools, different representations, and interactivity enabled self-learning and autonomy. Additionally, Stein et al. (2020) stated that novice teachers believed students' conceptual understanding increased when technology was involved. Interestingly, novice teachers claimed that technology was helpful for classroom management (Stein et al., 2020).

Dinc (2019) investigated the meaning of technology and barriers to using technology in education by asking two open-ended questions. Out of the 76 pre-service teachers involved, 38 participants agreed on the importance of technology to student engagement. Teachers experienced an improvement in student engagement when technology was integrated. Sixty-four teachers were concerned about whether or not technology helped enhance student achievement (Dinc, 2019). Also, the findings revealed that 61 pre-service teachers used technology in all of their classes, while the others used technology only with core subjects (Dinc, 2019). At this point, the study by Pape and Prosser (2018) was an example of the integration of technology to enhance student engagement. The researchers discussed the effects of the Texas Instruments (TI) TI-Nspire graphing calculator and the TI-Nspire Navigator system. The TI system's dynamic changes and updates included several features, such as visualizations and conceptual understanding, impacting student engagement and student achievement (Pape & Prosser, 2018). Dinc's (2019) point regarding whether or not technology was helping enhance student achievement was addressed in the study by Pape and Prosser (2018) by showing how TI technology could help to enhance student success in algebra. According to Pape and Prosser, since TI technology provided visualization and deeper conceptual understanding, students' academic levels improved.

Although technology appeared to be one of the vital factors for increasing student engagement, there were concerns regarding learner autonomy, individual choices, and the societal relationships associated with specific technology tools (Satsangi et al., 2019). According to Ilin (2020), technology would not change student engagement and outcomes as expected. Stakeholders needed to test and assess technological tools to address advantages and disadvantages (Ilin, 2020). The author identified that technology perception might change according to each individual. Classroom management could be another concern regarding the use of technology.

Classroom Management

Dele-Ajayi et al. (2021) found that experienced teachers claimed their most significant concern was with regard to classroom management processes and tasks involving the use of technology. In this study, Dele-Ajayi et al. (2021) identified different concerns regarding technology, including classroom management; however, the researchers did not discuss how technology impacted classroom management. In contrast to Stein et al. (2020), De Freitas and Spangenberg (2019) stated that teachers had concerns about classroom management and additional disciplinary procedures with regard to utilizing technology in daily instruction. The study findings showed that the integration of technology added a layer of disciplinary issues within the classroom management process. Teachers believed that technology was a distraction.

Ng and Park (2021) agreed with the one by De Freitas and Spangenberg (2019) regarding student distraction and classroom management. The participants in the study (Ng & Park, 2021) later, during professional development sessions, reflected and engaged in blended learning activities while examining a lesson on video. While observing how teachers integrated technology into a daily lesson, participants were most concerned with classroom management issues (Ng & Park, 2021). As a result, the teachers examined various classroom management strategies that could be used to improve the session they witnessed (Ng & Park, 2021).

Chapter Summary

The literature review provided current knowledge of the integration of technology in education, as well as teachers' beliefs, attitudes, and approaches. Technology has been changing education. However, the integration of technology updates and changes, such as the integration of math software, applications, and websites, was not as expected (Mireles-Rios et al., 2019). Overall, instructional technology could impact teaching and student learning positively (McCulloch et al., 2018). Ismajli et al. (2020) and Marley-Payne et al. (2019) addressed how the integration of technology affected education regarding student achievement and learning outcomes. Although the integration of technology helped enhance teaching and student learning, there were still some concerns about the use of technology. While some teachers were reluctant to utilize instructional technologies, some were risk-takers who explored and discovered the benefits of technology (De Freitas & Spangenberg, 2019).

Some researchers addressed and discussed the impacts of the integration of technology and barriers to implementation (Marley-Payne et al., 2019; McCulloch et al., 2018; Perienen, 2020; Ross, 2020; Satsangi et al., 2019). One significant barrier was insufficient professional development opportunities (Bozkurt & Ruthven, 2018). According to McCulloch et al. (2018) and Perienen (2020), teacher training and professional development were essential elements for integrating technology efficiently and effectively. Studies by McCulloch et al. (2018) and Perienen (2020) revealed the positive impact of teacher training on the integration of technology. However, how teacher mindsets influenced their perceptions with regard to the integration of technology was unaddressed (Li et al., 2019). The present study will extend knowledge in the field by exploring and identifying how teachers' fixed and growth mindsets influence teacher perceptions of the inclusion of technology and the effects of adding instructional technology components to high school algebra classes.

Chapter 3 details the qualitative research method and exploratory case study design. Data collection methods and instruments are detailed, as well as information about the targeted population. Additionally, data analysis methods and software are reviewed.

Chapter 3: Methodology

Math educators have discussed the inclusion of technology using software and applications in teaching and learning math (McClain & North, 2021). However, Mireles-Rios et al. (2019) found that teachers do not consider the integration of technology a priority when addressing student engagement and enthusiasm in math. Mehta et al. (2019) discussed how teachers should be trained to change the integration of technology in education.

The problem is limited to the integration of technology in algebra classes across high schools in New Jersey due to potential teachers' mindsets influencing their own perceptions of the inclusion of technology (Li et al., 2019). The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. To explore teachers' perceptions of technology, the following research questions guided the study.

Research Question 1: How do teachers who express a fixed mindset perceive the meaning of the inclusion of technology in high school algebra classes at one school district in New Jersey?

Research Question 2: How do teachers who express a growth mindset perceive the meaning of the inclusion of technology in high school algebra classes at one school district in New Jersey?

The following sections include research design, the role of the researcher, population and sample selection, instruments, data collection, and analysis process. Additionally, ethical concerns, reliability, and validity have been discussed. Finally, a concise summary of the methodology has been provided.

Research Design and Rationale

An exploratory case study design was appropriate to the purpose of this study. Direct personal experience is shared in qualitative research to gain a more profound knowledge of externally observable behavior and internal states of mind in context (Peterson, 2019). Qualitative studies help provide detailed descriptions of complex phenomena and responses to unique or unexpected events. Initial explorations to develop theories, design, experiment with ideas, and progress toward explanations of specific phenomena could be conducted in qualitative research (Sofaer, 1999). The influences of fixed and growth mindsets on teachers' perceptions could be viewed as complex phenomena; therefore, the qualitative research method seemed appropriate for this study.

Research Design

This qualitative exploratory case study investigated whether teachers' mindsets influence their perceptions of the inclusion of technology in high school algebra. According to Yin (2018), the case study research design allows researchers to focus on a specific example inside a real-world environment. Researchers can use the case study method to investigate a person or a group in greater depth (Yin, 2018). Guetterman and Fetters (2018) stated that the goal of a case study was to do research and gain a comprehensive understanding of the case in a real-world setting. An exploratory case study could be invaluable for describing the detailed real-world context (Bressanelli et al., 2018). Researchers use exploratory qualitative case studies widely to analyze scenarios in which the intervention does not yield a single set of results (Menon, 2019).

Yin (2018) classified case studies as explanatory, exploratory, descriptive, instrumental, multiple-case, or collective. While multiple-case or collective studies compare cases, a descriptive case study is utilized to define an intervention or phenomenon (Baxter & Jack, 2008).

Baxter and Jack noted that an instrumental case study gives insight into a problem or aid in the refinement of a theory.

Flexibility and time consideration are some advantages of the exploratory case study as compared to other designs. Smaller groups and unstructured processes give freedom to the researcher. Baxter and Jack (2008) identified the exploratory case study as less structured than grounded theory and phenomenological research design, giving flexibility and the opportunity to tailor questions and processes. The study was bound by time and resources due to potential participants having limited time to participate in this research. Professional Learning Committee (PLC) weekly meetings and teachers' coaching time once a week are limited for this study.

One of the benefits of an exploratory case study is forming a basis for future research. Because qualitative exploratory case studies can produce simple conclusions, researchers can employ some conclusions as tools for model validation in the future (Yin, 2018). Another benefit of exploratory case studies is the flexibility in capturing insights from experiences in real life (Baxter & Jack, 2008).

Some qualitative study designs are phenomenological, ethnographic, and grounded theory studies (Aspers & Corte, 2019). Because a phenomenological study investigates people's experiences through the lived experiences provided by the individuals involved, a phenomenological qualitative study design was not suitable for this study (Aspers & Corte, 2019). An ethnographic study involves culture and is similar to anthropology; therefore, the study design was inappropriate for this research (Aspers & Corte, 2019). A grounded theory design was not suitable because a grounded theory is suitable for generating theories from data. No theories were generated in this study.

Role of the Researcher

Participants in this study came from my district. All teachers know the role of an instructional coach in the school district. As a math instructional coach at the first coaching meeting, I intend to state that I am neither a supervisor nor evaluator nor do I have power over the teachers (Jacobs et al., 2018). Instead, I provide recommendations and friendly feedback to improve instruction quality (Reddy et al., 2019). Additionally, the participants were voluntary, eliminating a conflict of interest. I coach only 10 teachers in the district and have no control over their participation in this study. Fifteen to 20 participants were selected for this study. Some of the participants could have been teachers and I do not know them professionally or personally. Therefore, there was no conflict of interest working with my colleagues.

Research Procedures

Research procedures include the step-by-step process of how the study occurred. The following subsections identify the target population, the selection process for participants, and the instruments for data collection. Subject Matter Experts (SME) feedback regarding instrument design is also addressed.

Population and Sample Selection

This research occurred in three high schools managed by a non-profit Charter Management Organization (CMO) in New Jersey. The charter school district has approximately 600 teachers, including 65 math teachers who make up the target population. Eighteen volunteer high school algebra teachers comprised the sample population. The sample size was reasonable for organizing participants, collecting data promptly, transcribing, and analyzing data conveniently and efficiently (Guest et al., 2006). In a case study, data saturation may occur after 12 participants in homogeneous groups (Guest et al., 2006). A smaller sampling might result in unreliable findings, and a larger sampling might be too time-consuming. Convenience sampling was used to select participants from the target population. Convenience sampling is the process of selecting members of a sample based on their ease of access (Bhardwaj, 2019).

Sixty-five math teachers accessible by email were invited to participate in the study. Teachers' email information is available through a database system in the school districts and accessible by the researcher. The math department in the school district also has a group email that can be used for sending mass emails to all math teachers. Fifteen to 20 responders were selected based on their experience in teaching algebra courses. The inclusion criterion for this study was either current or previous algebra teaching experience. The exclusion criterion was having no experience in teaching algebra.

An email (see Appendix A) including brief information about the study, procedure, participants, and privacy was sent to the organization's Chief Executive Officer (CEO). Additionally, the informed consent form (see Appendix B) that participants signed was attached to the email. Potential participants received an email including the recruitment letter and a brief survey regarding demographic questions (see Appendix C). Demographic information was recorded on a password-protected laptop. Fifteen to 20 teachers who currently teach or previously taught algebra were selected. Then another email was sent along with the Informed Consent (see Appendix B). Finally, the last email (see Appendix D) regarding thanking responders who were not selected for the study was sent out.

Taylor et al. (2021) mentioned that delivering informed consent makes the study understandable, given that permission is obtained during the initial phase of research. Participants received enough information about the study and timeline to consider all options regarding being part of the study. Any question was answered promptly to ensure participants' understanding of the study. The primary goal was to obtain the participants' voluntary agreement and provide information as required.

Data Instruments

Yin (2018) stated that data collection for the qualitative study could be collected through interviews, including focus groups, various observations, surveys, and documentation or artifacts. The data collection procedures help explore a phenomenon regarding teachers' mindsets on the inclusion of technology in algebra classes. The Chief Executive Officer (CEO) granted permission (see Appendix E) to conduct the study at high schools in the district. Approval from the Institutional Review Board (IRB) of the American College of Education (ACE) was necessary to collect data. After IRB approval, data were collected using focus groups and semi-structured interview protocols to answer research questions. Focus groups and semi-structured interview protocols aligned with answering research questions. Research questions sought to explore teachers' mindsets regarding the inclusion of technology in algebra class; therefore, focus groups and one-on-one semi-structured interviews revealed teachers' mindsets and perceptions depending on fixed and growth mindsets.

Focus groups (see Appendix F) and semi-structured interviews (see Appendix G) occurred in person for all participants at the central office or teachers' classrooms. Semi-structured interviews in teachers' classrooms occurred before participating in focus groups. The PLC, which meets every week, was utilized for focus groups. A password-protected laptop was used to record the interviews and the focus groups. After data collection, data were coded and interpreted using software to identify themes and patterns.

Semi-Structured Interview Protocol

Semi-structured interviews are one of the primary methods utilized to collect data in qualitative research. Yin (2018) suggested that interviews are an excellent way to solicit information regarding participants' real-life experiences and should take less than an hour. The interviews happened one-on-one and in-person while recording took place using a password-protected laptop (Yin, 2018). An online meeting option was also available for teachers who could not join in person for any reason. After each semi-structured interview, the recording was transcribed promptly to ensure data was not lost.

The questions were framed to identify and analyze teachers' mindsets regarding the perception of the integration of technology (Li et al., 2019). Although how and why type questions are the primary questions, asking what and yes/no questions were added according to participants' answers due to the nature of the semi-structured interviews (Magaldi & Berler, 2020). As an instrument, the semi-structured interview is aligned with the research questions to collect data for exploring and analyzing the case (Yin, 2018). Nine questions were available for semi-structured interviews. Questions were designed to reveal teachers' mindsets regarding the inclusion of technology in algebra classes. All questions were related to the focus group protocol. For instance, the first three questions sought the meaning of technology in algebra. The fourth and fifth questions asked how teachers felt when using technology in algebra classes to understand how they perceived the integration of technology. Although a set of questions were available, additional questions were there due to the nature of semi-structured interviews. The primary goal of this process was to reveal teachers' mindsets on technology inclusion.

Focus Group Protocol

Richard et al. (2021) say that focus groups have long been used in several fields to investigate and solve problems, such as formulating hypotheses, investigating views and qualities, and developing new product concepts. A focus group of five to eight participants who share homogenous characteristics can be an effective data collection method when discussing a topic (Richard et al., 2021). Three to four focus groups were utilized on the final number of volunteer teachers. A focus group size of fewer than eight is easy to control and keeps the conversation active (Malone & Clifton, 2021). Participants should have enough time to express their thoughts and opinions in a limited time (Malone & Clifton, 2021). Smaller focus groups helped maximize participants' time to be heard.

Six structured questions were used in the focus groups. The first, second, and third questions inquired about the necessity and the meaning of technology in algebra classes. These questions were intended to reveal teachers' mindsets. Questions four and five intended to reveal the extent of the integration of technology in their algebra classes. Finally, the last question requested comments regarding technology inclusion. While teachers answered questions individually, they also listened to others and made comments. Therefore, as an instrument, the focus group aligned with the research questions to collect data and explore and analyze the case (Yin, 2018).

Subject Matter Experts

Data instrument validation is essential for qualitative studies. According to Alghofeli (2022), validity refers to the capacity of the instrument to answer research questions correctly. Reed (2020) explained two phases of content validation. The first is the scale developer's proactive attempts to improve content validity through meticulous conceptualization and domain investigation prior to item development (Reed, 2020). Another step involves after-the-fact efforts to analyze scale content using subject matter experts (SME) assessment (Reed, 2020).

Focus groups and semi-structured interview protocols were shared with four SMEs to maximize the content validity of research instruments. Three experts have Ph.D. degrees and work for educational institutions as an administrator, and one of the experts who has a master's degree works as a guidance counselor. Four SMEs made various suggestions and commented on changing, modifying, or rephrasing some questions (see Appendix H). All comments and suggestions were considered in developing the final focus groups and semi-structured interview protocols.

Three SMEs pointed out some questions to be modified due to the nature of the interviews and focus groups. Some questions in the focus groups and semi-structured interviews, originally “Yes” or “No” short answers, were modified to be open-ended by following suggestions and feedback. One of the SMEs recommended adding a couple of descriptive questions to identify the technology used in algebra classes. Descriptive questions were added to capture teachers' knowledge of software and applications that can be utilized in algebra classes.

Data Collection

Focus group discussions took place in person at the central office for 30 to 60 minutes. An online meeting option was available in case an in-person meeting could not be held due to unavoidable circumstances. However, according to Richard et al. (2021), in-person meetings for focus groups are more effective compared to online meetings. Voice recording on a password-protected laptop was part of the focus group process. Four basic steps to start the discussion were utilized and include: (a) welcoming the participants, (b) reviewing the topic, (c) discussing the ground rules, and (d) asking the first open-ended question (Krueger & Casey, 2002).

Semi-structured interviews were intended to be conducted in person in the teachers' classrooms or at the central office. An online interview option was available in case an in-person meeting could not be held for any reason. Because a semi-structured interview is a verbal interchange and an informal discussion (Magaldi & Berler, 2020), the interview was intended to last no more than 60 minutes. Open-ended, probing and follow-up questions were utilized. Voice recording on a password-protected laptop was part of the semi-structured interviews.

After completing each focus group and semi-structured interview, the participants were thanked and given information on how data would be transcribed and used. Additionally, the participants will be free to contact the researcher via email in case of additional comments or feedback. Recordings were transcribed using Happy Scribe software word by word (Streefkerk, 2019). Transcriptions of the interviews and focus groups were shared with the participants to ensure accuracy for member checking. The review process was followed with participants to correct or remove irrelevant and inaccurate information. Without pre-determined themes or codes, clean data were coded using computer software, Nvivo, to prepare for data analysis.

Data Analysis

NVivo, a qualitative data analysis software, was utilized to conduct a thematic analysis of data from focus groups and semi-structured interviews. In thematic analysis, a researcher closely examines the data to identify repeating common themes, topics, ideas, and patterns of meaning (Caulfield, 2019). A six-step process developed by Virginia Braun and Victoria Clarke (2006) was utilized. The six steps identify as follows:

(1) Familiarization to get to know the data,

(2) Coding to highlight and describe the content,

(3) Generating themes by identifying patterns among codes,

(4) Reviewing themes by ensuring that the themes are helpful and reliable representations of the data,

(5) Defining and naming themes by formulating each theme precisely to analyze data accurately, and

(6) Writing up the data analysis.

To identify repeating common themes, topics, ideas, and patterns of meaning, the researcher closely examines the data in thematic analysis (Caulfield, 2019). I read the transcripts multiple times and took notes to develop an initial understanding of the data. Second, I initiated a thematic analysis by creating initial codes while considering research questions. After creating codes, I identified themes and patterns. Multiple reviews of the data were intended to ensure that the themes were helpful and reliable for data representation. Finally, all information was gathered for analysis, and the emergent themes were defined and named.

The findings and results of the study were displayed in a coherent narrative by explaining and discussing themes and patterns. Quotes and statements from focus groups and semi-structured interviews were utilized to illustrate the common themes. The researcher used tables and diagrams to visualize qualitative data. Thematic analysis was the suitable method of analyzing data from focus groups and semi-structured interviews. To identify repeating common themes, topics, ideas, and patterns of meaning, the researcher closely examined the data in the thematic analysis (Caulfield, 2019).

Reliability and Validity

The trustworthiness of qualitative study refers to internal validation, external validation, reliability, and objectivity (Lemon & Hayes, 2020). Credibility, dependability, and transferability help increase trustworthiness in a qualitative study. Data analysis and logic play a crucial role in designing credible, dependable, and transferable studies.

Credibility

Triangulation and member checks establish credibility and contribute to trustworthiness (Devault, 2019). Qualitative data was collected from focus groups and semi-structured interviews. These two data sources were utilized to support a case study for triangulation by comparing common themes and patterns and cross-checking between answers (Yin, 2018). Implementation of member checking confirms what participants state accurately in the data collection process (Lemon & Hayes, 2020). After the transcription of focus groups and semi-structured interviews, an email was sent to the participants to review their own transcripts.

Dependability

McGinley et al. (2021) expressed that dependability refers to a study design that is repeatable and sufficient to establish future studies. Consistency is one of the aspects of dependability (Korstjens & Moser, 2018). The procedures of focus groups and semi-structured interviews were detailed to establish the consistency and dependability of the study. Dependability was addressed by following a step-by-step guide for data collection so that other researchers might replicate the study.

Transferability

Verbatim transcripts and thick descriptions were utilized in data analysis to ensure transferability. Thick description is concerned with describing a phenomenon in sufficient depth so that it may be used to assess the extent to which the conclusions can be applied to other times or settings (McGinley et al., 2021). Transferability was established by providing evidence that the findings of the study could be used in other contexts, circumstances, and populations (Yin, 2018).

Trustworthiness

According to Cloutier and Ravasi (2021), trustworthiness in a qualitative study means the degree to which the reader can assess whether the researchers have been honest and reasonable in their findings and conclusions. In order to ensure trustworthiness, there was comparing of two data sources, organizing data clearly for quick access, and providing rich contextual information (Cloutier & Ravasi, 2021). Additionally, the design of the focus group and semi-structured interview questions is to reduce bias regarding leading answers, wording, and order biases. There was no comment or attitude after an answer to any of the questions.

Lemon and Hayes (2020) suggested that reliability and validity in a qualitative study can be addressed with trustworthiness. The transcripts of focus groups and semi-structured interviews were shared with the participants. Additionally, the findings were shared with them. Data triangulation was established by using two data instruments and comparing data. Credibility, dependability, and transferability were addressed to maximize reliability and validity.

Ethical Procedures

The Institutional Review Board (IRB) guidelines were followed to ensure the code of ethics in research. After IRB approval, potential participants received a recruitment letter (see Appendix C), and the process began. Email responses were collected in 2 weeks. The demographic survey was evaluated carefully to select participants who taught or had taught algebra. Selected participants received another email containing informed consent (see Appendix B). A detailed presentation was utilized to explain the purpose of the study to make sure participants had a clear understanding of the study. One of the reasons for having a presentation was to maximize informed decisions. The audio recording was part of the presentation in case potential participants wanted to listen and check the information about the study and process before deciding. After the presentation, participants were asked to sign the informed consent form to start the data collection process. Although the researcher had a relationship with potential participants as an instructional coach, Jacobs et al. (2018) say that instructional coaches have no authority and power over teachers. Additionally, the researcher has only 10 teachers to coach 65 math teachers. Some potential participants were the teachers whom the researcher coached. Therefore, there were no conflicts of interest and authority differentials.

Because participation in the study was voluntary, autonomy was in place to address respect for persons as the first principle of The Belmont Report. An autonomous person can deliberate about personal goals and act under the direction of such deliberation (The Belmont Report, 1979). All participants in the study had free choice to be part of it. No one was forced or manipulated to participate in this study. The second principle of The Belmont Report stated respecting participants' choices, keeping participants safe, and taking steps to ensure participants' well-being. Addressing Justice, the third principle in The Belmont Report (1979), requires all teachers should be treated equally. Three principles of The Belmont Report (1979) were addressed by providing autonomy, free choice to be part of the study, keeping all participants safe, and treating them equally.

The confidentiality of the participants was protected by using pseudonyms. Pseudonyms and the real names of participants were kept in a codebook locked in the researcher's office. A password-protected laptop accessible only by the researcher helped keep research data confidential. No other personnel or staff had access to the office and the laptop. All data will be deleted, and all documents related to data will be shredded after 3 years. The Institutional Review Board (IRB) process was critical for ensuring the researcher followed the Belmont Report principles and complied with the ethical procedures required for the study.

Chapter Summary

The methodology chapter presented the research method and the design of the study. As a researcher, the author utilized a qualitative exploratory case study to analyze teachers' mindsets that influence the inclusion of technology in algebra classes. An exploratory case study design was appropriate to the purpose of this study. Direct personal experience was shared in qualitative research to gain a more profound knowledge of externally observable behavior and internal states in context (Peterson, 2019).

A charter school district with approximately 600 teachers, including 65 math teachers, was the research site. Written approval to conduct the research from the CEO of the school district was obtained. Permission from the IRB was obtained to conduct the study. Focus groups and semi-structured interviews were the instruments for data collection. SMEs in field-testing processes validated the instruments' content that helped answer research questions. Fifteen to 20 participants were selected according to their experience of teaching algebra to participate in focus groups and semi-structured interviews.

Data analysis took place by identifying common themes and patterns to create codes. This study was free of pre-determined themes or codes. NVivo, a qualitative data analysis software, was utilized to analyze data. Triangulation and member checks were established for trustworthiness (Devault, 2019). Qualitative data were collected from focus groups and semi-structured interviews, and multiple data sources to support a case study for triangulation (Yin, 2018).

Chapter 4 details the findings and results of this qualitative exploratory case study. Data from focus groups and semi-structured interviews will be shared and displayed. Emerging themes and patterns with coding will be shared and reviewed.

Chapter 4: Research Findings and Data Analysis Results

Instructional technologies have played an increasingly significant role in enhancing students' teaching and learning processes for the last two decades (Fernández-Batanero et al., 2021). Students have struggled with conceptual understanding since algebra consists of abstract topics (Veith et al., 2022). Algebra teachers can use technology to visualize various abstract mathematical concepts with real-world applications (Ziatdinov & Valles Jr, 2022). However, rapid growth and the availability of instructional tools might provide difficulties and generate hesitancy (DeCoito & Richardson, 2018). Although researchers showed the benefits of technology integration in math classes, math teachers have distinct perceptions related to technology inclusion (Dinc, 2019). Teachers' perceptions of technology inclusion in algebra classes play a crucial role in integrating instructional software and applications (Karchmer-Klein & Konishi, 2021).

The problem was the limited integration of technology in algebra classes across New Jersey high schools due to potential teachers' mindsets influences on their own perceptions of the inclusion of technology (Li et al., 2019). The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey.

The following sections include the data collection process and instruments. Additionally, data analysis and findings have been discussed in detail. After addressing reliability and validity, a concise summary of the introduction has been provided.

Data Collection

This research was conducted at three high schools managed by a non-profit Charter Management Organization (CMO) in New Jersey. The charter school district had approximately

600 teachers, including 65 math teachers, who made up the target population. After Institutional Review Board (IRB) approval was secured, 65 teachers were invited by email on June 10, 2022, including the recruitment letter and a brief survey regarding demographic questions. An informed consent form was attached to the email. Nineteen math teachers replied to the email by completing the demographic survey. The only inclusion criterion was to have algebra teaching experience. Table 1 shows the demographics of the participants. Eighteen teachers participated in the study by signing the informed consent form before the one-on-one semi-structured interview in person, which occurred between June 13 and June 20, 2022. The data collection was completed in 2 weeks, between June 10 and June 24, 2022.

Table 1

Demographics of Participants

Participants	Gender	Age	Years of Experience	Ethnicity
Participant 1	Male	31-40	Between 2 and 5	Caucasian
Participant 2	Male	31-40	Between 2 and 5	Caucasian
Participant 3	Female	21-30	Between 2 and 5	Latino or Hispanic
Participant 4	Male	21-30	Between 2 and 5	Latino or Hispanic
Participant 5	Female	61 and up	More than 5	Caucasian
Participant 6	Male	31-40	More than 5	Other/Unknown
Participant 7	Female	31-40	Between 2 and 5	Asian
Participant 8	Female	31-40	More than 5	Asian
Participant 9	Male	51-60	More than 5	Caucasian
Participant 10	Male	41-50	More than 5	Caucasian
Participant 11	Female	51-60	More than 5	Caucasian
Participant 12	Female	31-40	Between 2 and 5	Asian
Participant 13	Female	31-40	More than 5	Caucasian
Participant 14	Female	31-40	More than 5	Latino or Hispanic
Participant 15	Female	31-40	More than 5	Other/Unknown
Participant 16	Female	31-40	More than 5	Other/Unknown
Participant 17	Female	31-40	More than 5	Other/Unknown
Participant 18	Male	21-30	More than 5	Caucasian

Semi-structured interviews and focus groups were used for data collection. Eighteen participants had the semi-structured interview before they participated in one of three focus groups. The average time of the semi-structured interview was 23 minutes. Table 2 shows the actual minutes of the semi-structured interview for each participant.

Table 2

Semi-Structured Interview Timeframe

Participants	Time	Participants	Time	Participants	Time
Participant 1	31 minutes	Participant 7	23 minutes	Participant 13	16 minutes
Participant 2	16 minutes	Participant 8	27 minutes	Participant 14	22 minutes
Participant 3	14 minutes	Participant 9	24 minutes	Participant 15	17 minutes
Participant 4	32 minutes	Participant 10	28 minutes	Participant 16	20 minutes
Participant 5	32 minutes	Participant 11	21 minutes	Participant 17	16 minutes
Participant 6	18 minutes	Participant 12	30 minutes	Participant 18	24 minutes

Participants were invited to the focus groups after semi-structured interviews. Teachers' weekly meetings called Professional Learning Committee (PLC) were utilized for focus groups. Algebra teachers had regular PLC meetings on Tuesday, Wednesday, and Thursday after school. Three focus groups were conducted: (a) the first, with 7 participants, lasted for 35 minutes; (b) the second, with 6 people, took 28 minutes; and (c) the third, with 5 participants, was for 22 minutes. Although the participant's classroom was the location for semi-structured interviews, the central office was the location for focus groups. Because weekly PLC meetings were held at the central office and participants knew each other, privacy was not an expectation. Focus groups were recorded and transcribed verbatim using Happy Scribe software. All transcripts were shared with the participants for member checking by email. The data collection process went smoothly without deviating from the data collection plan.

Data Analysis and Results

Two data collection instruments were focus groups and semi-structured interviews that were audio recorded on a password-protected laptop. Recordings were transcribed verbatim using Happy Scribe software. Transcripts were uploaded on NVivo, a qualitative data analysis software, to execute a thematic analysis of data from focus groups and semi-structured interviews. In thematic analysis, the researcher closely analyzed the data to determine repeating common themes, topics, ideas, and patterns of meaning (Braun & Clarke, 2019).

A six-step process developed by Virginia Braun and Victoria Clarke (2006) was utilized. The six steps were: (a) familiarization to get to know the data, (b) coding to highlight and describe the content, (c) generating themes by identifying patterns among codes, (d) reviewing themes by ensuring that the themes are helpful and reliable representations of the data, (e) defining and naming themes by formulating each theme precisely to analyze data accurately, and (f) writing up the data analysis. In the thematic analysis, codes and themes emerged from data without any pre-determined ones. Therefore, no discrepancy or non-confirming data were observed.

An initial understanding of the data was established by reading transcripts of the interviews and focus groups multiple times. Twenty-five codes were created initially to explore teachers' mindsets and perceptions. Eight themes emerged to represent data from the initial codes. Multiple data reviews were established to ensure the themes are reliable as data representations. Finally, the emergent themes were named and defined. Table 3 shows the initial codes and merging themes.

Table 3

Codes and Themes

Initial Codes	Themes	Definitions
Balance Paperwork Math editor Without technology	Balanced Use of Technology	Using technology and paper-pencil work together in a balance
Comfort zone Fixed mindset Growth mindset	Comfort Zone	Feeling comfortable when using technology or paper-pencil work
Concerns Training	Concerns of Technology	Using technology brings several concerns to learning, including cheating and distractions.
Curriculum	Curriculum	The skills/standards that need to be taught
Time saver	Time-Saver	Teachers have more time to teach instead of copying, manual grading, or delayed feedback
Engagement 21st century Technology generation Conceptual understanding Feedback Practicing math Software-platforms Learning management system Teacher-centered Visualization-Desmos	Student Engagement	Students have ownership of learning
Usefulness Effectiveness	Usefulness	Technology is beneficial for specific topics or skills
User-friendly Influence by others	Ease of Use	Technology is easy to learn and use for students and teachers

Themes emerged from data collected using semi-structured interviews and focus groups. Combining and comparing semi-structured interviews and focus group data helped create themes to explore teachers' mindsets and perceptions to answer research questions of the study, which asked, “How do teachers with fixed or growth mindsets perceive technology inclusion in algebra classes?” Teachers with fixed or growth mindsets have similar perceptions of technology integration in algebra classes; therefore, eight emerging themes are relevant to answer both research questions.

Themes

Teacher perception plays a crucial role in integrating technology into education (Karchmer-Klein & Konishi, 2021). Despite evidence showing the advantages of technology inclusion in math education, math teachers have critical perceptions of technology inclusion (Dinc, 2019). Eight themes emerged from data for analyzing teachers' perceptions of their mindset.

Balanced Use of Technology

Algebra teachers who participated in the study stated that technology had become essential to algebra teaching. However, 18 out of 18 participants in semi-structured interviews and focus groups agreed on having a balance between paper-pencil work and technology. While Participant 10 suggested, "We have to have a good balance," Participant 11 stated, "I want to alternate both of them because I cannot assign something online to my students." According to the participants' approach, using only technology or using only paper-pencil could bring boredom that impacts student engagement negatively.

One of the reasons participants wanted to have a balanced use of technology was the note-taking requirement in algebra class. Algebra teachers believed students should take notes to learn algebra. Participant 14 said, "I feel that students need to take notes." Many participants agreed that a good balance is half technology and half paper-pencil work. However, Participant 16 said, "70% or 80% technology," Participant 2 stated, "80% technology, 20% taking notes." Algebra teachers' beliefs in the balanced use of technology were evident in semi-structured interviews and focus groups. Participants felt comfortable when using technology and paper-pencil in balance.

Comfort Zone

Algebra teachers expressed their comfort level when using new technology in daily instructions. Ten out of 18 participants expressed their comfort level as high even if they were introduced to new technology. Participant 15 stated, "I am very comfortable because this helped me a lot to use my skills about how to share with the students, how to attract the students." Algebra teachers enjoy bringing new technology into daily instruction to increase engagement and enjoyment of math. Additionally, participants want students to have the same comfort level.

Some participants were hesitant to use or utilize a new technology because of their low comfort level. Using a new technology requires intense training to be effective; therefore, participants want to stay in their comfort zone. A comment from Participant 2 was:

> People tend to do like a comfortable things [sic] because we have years of experience and then we know that those days worked in the past before and then we want to keep the things that work and we are looking for something uncomfortable, something new.

Algebra teachers relied on their experiences. When the teachers worked and used some strategies to teach algebra and saw strategies worked throughout the years, they did not change the instructions. Therefore, teachers were bounded by their comfort zone.

Another reason for the low comfort level was that some algebra teachers still wanted to be experts in the class. Participant 5 stated, "Because I am the kind of teacher that when it comes to the classroom, I like to be the one who knows more than everybody else." Teachers who want to be experts require more training or support if technology is to be used in daily instruction. If technology awareness and knowledge are increased by teacher training and ongoing support, algebra teachers will utilize technology more in daily instructions. Proper training and ongoing support could also eliminate algebra teachers' concerns.

Technology Concerns

All participants mentioned some concerns about technology integration; however, some were proactive or open-minded about addressing those concerns. In general, cheating was the biggest concern due to the availability of websites that can directly solve algebra questions.

Participant 9 said, "Technology is great until you get to Photo Math, and then you get to Mathway, and then you get to whatever other programs they use to cheat." Instead of using technology as a learning tool, students utilized some platforms for quick answers to complete assignments. Because students figure out how to complete algebra questions without actually solving them with the help of technology, conceptual understanding would be limited.

Another concern was that technology could be a distraction. Students have Chromebooks to use in daily instructions. Sometimes teachers cannot control all students in case they are on task or not. Participant 10 remarked, "If not used cautiously, it can hurt them if you let them use it all the time for every single thing without asking them to do certain things; I think that can be harmful." Teachers wanted to control students using technology appropriately to complete the assignments on time. However, participants agreed that it is almost impossible to eliminate distractions without students taking responsibility for learning. Participant 16 opinion was, "But still, they have Chromes in front of them, right? They can just open another tab." According to participants, one of the reasons students might cheat easily in algebra classes was the curriculum.

Curriculum

Algebra 1 is a required course in the first year of high school and is a standardized test subject. Many states follow Common Core State Standards (CCSS); therefore, the Algebra 1 curriculum is intensive. The algebra curriculum design depends mainly on computation and algebraic topics, which can be done quickly by an advanced calculator or any similar software. Participant 13 noted, "I believe the curriculum should move away more from computation or calculation and move towards application." Real-life application and project-based tasks could be beneficial if the curriculum is designed accordingly.

A curriculum that makes technology integration easier and eliminates cheating or copying answers from some websites could be beneficial and efficient for technology inclusion. The agreement on curriculum updates from Participant 8 was, "Maybe our curriculum should be updated to have more technology in the lesson." The traditional algebra curriculum consisted of calculation and computation, which could be done by technology. Therefore, algebra teachers thought cheating was more accessible when using technology in the algebra curriculum. Since the curriculum plays a crucial role when integrating technology, a new algebra curriculum should be designed and presented. Connecting with real life for meaningful learning and addressing 21st-century skills could increase student engagement in algebra classes.

Student Engagement

One of the goals of teaching and learning is to increase student engagement, which can impact their outcomes. All participants agreed that student engagement was higher when technology was involved. Participants mentioned Desmos, a web-based graphing calculator, 42 times when discussing visualization and conceptual understanding.

In focus group 2, Participant 17 declared, "Actually, if they use maybe Desmos or maybe GeoGebra, they can immediately see the graph, or they can immediately see the results, and then they get actually happy. It is really more engaging to use technology." Desmos and GeoGebra can provide instant graphing, which increases conceptual understanding. Visualization provides deeper learning and excitement. Differentiation could be effective with technology integration by providing visualization. In focus group 1, Participant 18 remarked, "You make these abstract problems come to life, they visualize, and students are then more comfortable, they understand better." Students must retain knowledge and information, which could be possible with conceptual understanding. Algebra teachers believed using a graphing calculator helped students gain self-confidence and be willing to learn due to visualization.

Technology helped algebra teachers to design and create more student-centered instructions that promote student engagement. Participant 15 said, "To use technology for the teacher to teach algebra is very important because we have more time, and we have student center teaching because it is better than teacher center." As indicated by Participant 18, "Now, with technology, it can be a lot more student-centered. Without technology, the class is a lot more teacher-centered." Technology was needed to increase student engagement and enhance their outcomes in algebra classes. Teachers utilize technology to design student-centered instructions that also help teachers to have more time to teach deeply.

Time Saver

Although participants of this study wanted to balance technology and paper-pencil work, they admitted that technology was a time saver. Specifically, grading, giving instant feedback, and distributing or collecting paperwork required more time. Technology helped teachers to grade, provide instant feedback, and keep all work in a folder or file as records. As a result, teachers have more time to plan, design, and teach student-centered and more engaging instructions. Participant 2 commented, “Without technology, it is very raw, very slow-paced. With the technologies, the teachers save so much time so they could do other things to help the students.”

According to Participant 6, "With technology, in maybe 10 minutes, 15 minutes, they can understand, and we have more time to do some skills activities." Many topics and skills in algebra could be completed at a faster pace when technology was utilized. Participants agreed that technology helped them find pre-made lesson plans, activities, tests, or quizzes; therefore, they did not spend time creating brand-new materials for instructions. Algebra teachers liked utilizing technology in instructions where they could have more time to teach topics and skills deeply.

Usefulness

Many software, platforms, and applications are available for algebra teachers. However, some platforms might not be beneficial as expected. One of the primary reasons algebra teachers use technology was its usefulness. Algebra teachers mentioned how they picked platforms that can be utilized in daily instructions. First, some paid platforms and applications were provided by the school district; however, algebra teachers were not forced or mandated to use those platforms. In focus group 1, Participant 6 commented, "Students know the value of technology, how to use it for our benefit, for their benefit, and implement their real life." Students believed that technology should be part of the instructions. The benefits of technology integration in algebra classes were valued. Algebra teachers believe technology benefits daily instructions if it is used effectively. All participants did not want to use technology for the sake of technology usage. If the benefits and outcomes were not as expected, algebra teachers preferred not to use technology in daily instructions. The point made by Participant 18 was well taken:

> Yeah, so I guess I'm always skeptical of new technology because I know that there's always like a salesman behind it who's trying to promote it, so my ultimate question is always like, all right, is this useful, and is it beneficial?

Although some technologies might be free for teachers and students, many online platforms require subscriptions or fees. Therefore, some teachers might think some instructional technologies are just for business, making money, not for education.

Participant 2 remarked, "So the other platform depends on how well it matches with the learning standard, how well that will help students to learn." Algebra teachers wanted to integrate technology if it is helpful for teachers and students. Usefulness was insufficient; being user-friendly was another requirement for technology inclusion, according to the participants.

Ease of Use

Because technology brings another layer of skills that should be learned, the platforms or applications should be user-friendly to implement into daily instruction. Participant 1 explained how to pick a platform, "Well, I guess one thing I look for is, like, how user-friendly it is if it is intuitive." Algebra teachers looked for ease of use besides the efficiency of online platforms such as Desmos and GeoGebra. Participant 14, when asked about using an online platform, said, "My criteria is whether it is friendly for the students to use, whether it is friendly for the teacher to use."

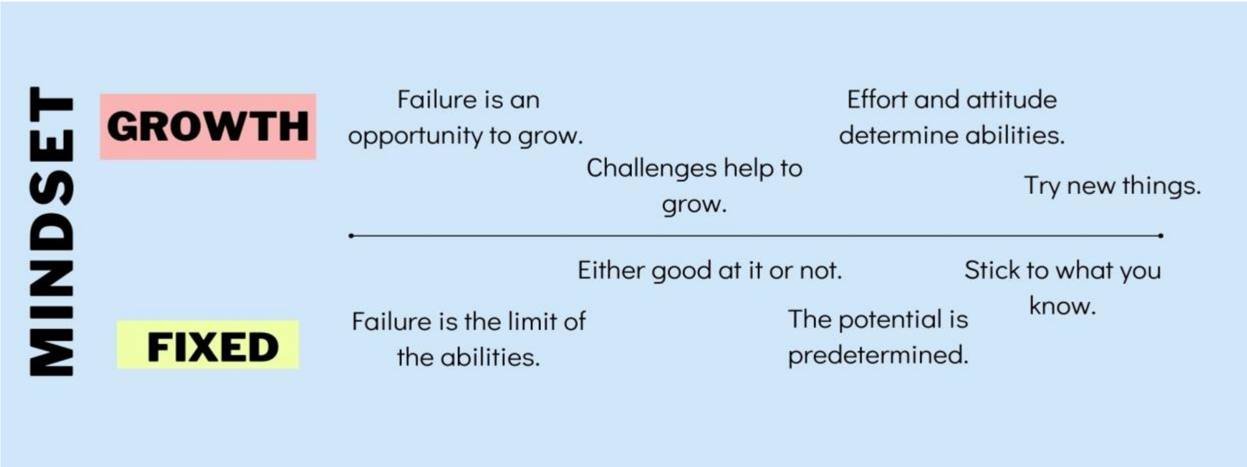
Algebra teachers wanted to feel comfortable when they used technology in classes. Being comfortable could be possible with user-friendly technology in algebra classes. Participants 4, 9, and 17 stated that technology should be user-friendly for students and teachers. Being user-friendly was one of the aspects that teachers were looking for to use technology in algebra classes.

Mindsets of Teachers

A fixed mindset refers to believing that learning and teaching abilities are unchangeable and permanent, while a growth mindset refers to believing that students and teachers can enhance their abilities with appropriate methods and providing adequate efforts (Kroeper et al., 2022). Candy (2019) explained how an individual could reveal a mindset by using some words or sentences. Figure 1 shows some examples of growth and fixed mindsets.

Figure 2

Growth Mindset vs. Fixed Mindset



Participants used specific words or sentences that could reveal their mindsets. Table 4 indicates participants' mindsets with evidence statements. According to the findings, seven teachers expressed a fixed mindset, and 11 teachers expressed a growth mindset.

Table 4

Participants' Mindsets

Participants	Mindset	Evidence
Participant 1	Fixed	It's helpful for the students who maybe aren't so interested or talented at like doing the math analysis by hand on paper.
Participant 2	Growth	So just like pushing that mentality and then changing that mindset and then trying new things and seeing it works will help.
Participant 3	Growth	I love learning new things. Like even as a teacher, I learned still to this day different applications, and I enjoy it.
Participant 4	Growth	The information is accessible; you just got to get it. You don't have to be a certain role in order to figure out whatever you're doing.
Participant 5	Growth	I'm pretty much open to learning all kinds of technology.
Participant 6	Growth	I tried to search new technology and new application development about Algebra and PLC.
Participant 7	Fixed	I might hesitate to get some other information.
Participant 8	Fixed	I feel like I'm stuck on certain technology.
Participant 9	Fixed	I am the expert in the room, and I want to act like the expert.
Participant 10	Fixed	I'm not very keen on using technology for that.
Participant 11	Growth	I never give up because of technology, but I just ask myself to do the best.
Participant 12	Fixed	Because math is not their thing.
Participant 13	Growth	I think being more flexible, being more open-minded to new technology.
Participant 14	Growth	I am for change. I am for new education. I'm for new technology.
Participant 15	Growth	I am open to do everything about new things.
Participant 16	Growth	I never hesitate to put myself back.
Participant 17	Fixed	We don't have time to sit down and to investigate, for example, like Ti-Nspire, for example, calculator or maybe GeoGebra.
Participant 18	Growth	I just try to be persistent to make sure something like, I'm going to really push and try to get it to work well before I give up on it.

Mindset Influence on Teachers' Perceptions

The findings revealed that algebra teachers' mindsets influenced their perceptions of technology inclusion. While teachers with a growth mindset were excited about using instructional technologies in their classes, those with a fixed mindset were hesitant and felt mandated technology usage. Although teachers with fixed and growth mindsets showed similar perceptions, the approaches differ in being negative or positive to the instructional technology.

Fixed Mindset. Algebra teachers with fixed and growth mindsets have similar perceptions of technology inclusion in algebra classes, such as curriculum, student engagement, time saver, usefulness, and ease of use. However, the comfort zone, balanced use of technology, and technology concerns influenced teachers with a fixed mindset negatively. Participant 17 stated, "I am not comfortable because imagine you use, let us say, tools like Pear Deck or GeoGebra." A teacher with a fixed mindset did not want to try a new technology due to challenges. The fixed mindset was the main reason for staying in the comfort zone and hesitating to adopt new technologies in algebra classes. Technology concerns led algebra teachers with a fixed mindset to utilize paper-pencil work without considering the balance of technology.

Algebra teachers with a fixed mindset preferred teaching algebra with only paper and pencil if they had a chance. Fixed mindset teachers felt they had to use technology because of the 21st century, strong encouragement by the administrators, and the students' technology perceptions. Participant 5 stated, "I believe in students bringing a notebook and a pencil to the classroom because they have to take notes at some level." Taking notes on computers because typing math symbols was a challenge for students, and some teachers wanted to have paper and pencils back for daily instructions. Similar to the traditional approach in math classes, Participant

9 declared, "In math, we need to see the work. The reason is that it is understanding the procedure from one step to the other that will get you to the next concept and understand it well without showing work." One of the students showed their work using paper and pencil.

The answer to research question 1 was that algebra teachers with a fixed mindset perceived technology inclusion negatively. If the school district did not require or strongly encourage technology integration, teachers who expressed fixed mindsets wanted to minimize technology inclusion. In that case, fixed mindset algebra teachers differ from growth mindset ones.

Growth Mindset. On the other hand, growth mindset teachers were ready and willing to adopt any new technology. Teachers with a growth mindset were up to challenges and ready to leave their comfort zone. A statement from Participant 11 was, "I am excited to learn something new and work on them. I never give up because of technology, but I ask myself to do my best." Algebra teachers who expressed growth mindsets wanted to utilize technology in a balance of more than 70% of the instructions, even if they needed to leave their comfort zone. Although participants who expressed a growth mindset considered the balance of technology in daily instructions, algebra teachers were ready for challenges and willing to adopt new technologies without hesitations.

Participant 13 noted, "I think being more flexible, being more open-minded to new technology, getting the proper training, so I am ready when I present it in the classroom." Flexibility and open-mindedness were the characteristics of teachers with a growth mindset regarding technology inclusion in algebra classes. Technology concerns were limited for algebra teachers with a growth mindset due to flexibility. Algebra teachers with a growth mindset had positive perceptions of curriculum, student engagement, time saver, usefulness, and ease of use.

The answer to research question 2 was that algebra teachers with a growth mindset perceived technology inclusion positively. A strong belief and approach to technology integration in algebra classes were evident in the perceptions of teachers who expressed growth mindsets.

Reliability and Validity

Internal and external validation, dependability, and objectivity are all aspects of a qualitative study that should be considered trustworthy (Lemon & Hayes, 2020). In this exploratory qualitative study, reliability, dependability, and transferability contributed to increased trustworthiness. Data analysis and logic were crucial in designing credible, dependable, and transferable studies.

Credibility

Triangulation was established by using and comparing two data instruments, semi-structured interviews, and focus groups. Focus groups and semi-structured interviews as data sources were utilized to support a case study for triangulation by comparing common themes and patterns and cross-checking between answers. All recordings were transcribed and shared with the participants for member checks, increasing credibility and contributing to trustworthiness. The implementation of member checking confirmed what the participants stated accurately in data collection.

Dependability

Dependability, according to McGinley et al. (2021), was defined as a study design that is sufficient for future studies and repeatable. Consistency was one of the aspects of dependability (Korstjens & Moser, 2018). The focus group and semi-structured interview processes were described in detail to ensure the consistency and dependability of the study. Dependability was addressed by providing a clear audit trail to permit the replicability of the study.

Transferability

Verbatim transcripts and thick descriptions were utilized in data analysis to ensure transferability. The thick description was concerned with describing a phenomenon in sufficient depth so that it may be used to assess the extent to which the conclusions can be applied to other times or settings (McGinley et al., 2021). Transferability was established by providing evidence that the study's findings could be used in other contexts, circumstances, and populations.

Trustworthiness

Trustworthiness in a qualitative study, according to Cloutier and Ravasi (2021), refers to the extent to which the reader can judge if the researchers were truthful and reasonable in their results and conclusions. To ensure trustworthiness, comparing two data sources, organizing data clearly for quick access, and providing rich contextual information occurred in the study (Cloutier & Ravasi, 2021). Additionally, the focus group and semi-structured interview questions were designed to reduce bias regarding leading answers, wording, and order. No comment or attitude was shown after an answer to any question to eliminate influences on participants. According to Lemon and Hayes (2020), trustworthiness can be used to address reliability and validity in qualitative research. The transcripts of focus groups and semi-structured interviews were shared with the participants by email for member checking. Credibility, dependability, and transferability were addressed to maximize reliability and validity.

Chapter Summary

A qualitative exploratory case study was conducted to explore mindset influences on teacher perception of technology inclusion in algebra classes. Two research questions guided the study. Research Question 1 asked: how do teachers who express a fixed mindset perceive technology inclusion in algebra classes? Research Question 2 asked: how do teachers who express a growth mindset perceive technology inclusion in algebra classes? According to interview data, participants were categorized as having a fixed or growth mindset.

The findings revealed the influence of mindsets on teachers' perceptions of technology inclusion in algebra classes. Algebra teachers who expressed a fixed mindset perceived technology inclusion in algebra classes utilize technology and non-technology in a balance while wanting to feel comfortable and eliminate concerns when they use technology. The perceptions of algebra teachers with fixed mindsets also included the benefits of technology for student engagement and time-saving for teachers. Algebra teachers who expressed a growth mindset perceived technology inclusion in algebra classes utilize technology more often to engage students in daily instructions while eliminating concerns. The perceptions of algebra teachers with growth mindsets also included how technology is useful and user-friendly for students and teachers.

On the one hand, algebra teachers with a fixed and growth mindset had similar perceptions; however, fixed mindset teachers perceived technology inclusion negatively. On the other hand, growth mindset teachers perceived technology inclusion positively. While teachers who expressed a fixed mindset wanted to stay in their comfort zone without any challenges, growth mindset ones were ready and willing to adopt any new technology.

Chapter 5 provides a discussion of the findings and conclusion. Findings are discussed according to the theoretical frameworks, and interpretations are provided. Limitations and recommendations for future studies are discussed in detail. Finally, a concise conclusion is provided after discussing leadership's implications.

Chapter 5: Discussion and Conclusions

The purpose of this qualitative exploratory case study was to explore how teachers' mindsets influence their attitudes toward the inclusion of technology in high school algebra classes at one school district in New Jersey. A qualitative exploratory case study design was selected to focus on a specific example inside a real-world environment due to the nature of the study. Past literature only included mindset studies focusing on the students; thus, a need occurred to explore teachers' mindsets. The results showed that teachers' perceptions of the use of technology in algebra classes were influenced by their mindsets.

Research Question 1 explored how teachers with a fixed mindset perceive technology inclusion in algebra classes. Fixed-minded algebra teachers perceived technology integration as balancing the use of technology and non-technology while also wanting to feel at ease and having no concerns when using technology. The perceptions of algebra teachers with fixed mindsets also included the benefits of technology for student engagement and time-saving for teachers. Research Question 2 explored how teachers with a growth mindset perceive technology inclusion in algebra classes. Teachers in these classes perceived technology integration in algebra classes as using technology more often to engage students in daily instructions while eliminating concerns. The perceptions of algebra teachers with growth mindsets also included how technology is useful and user-friendly for students and teachers.

On one hand, algebra teachers with a fixed and growth mindset had similar perceptions; however, fixed mindset teachers perceived technology inclusion negatively. On the other hand, growth mindset teachers perceived technology inclusion positively. While teachers who expressed a fixed mindset wanted to stay in their comfort zone without any challenges, growth mindset educators were ready and willing to adopt any new technology.

The following sections include findings, interpretations, and conclusions. Additionally, limitations and recommendations are provided. A conclusion of the study is drawn, after discussing the implications for leadership.

Findings, Interpretations, and Conclusions

Technology integration depends on teacher perceptions (Leem & Sung, 2019). The literature showed several factors impacting technology usage in algebra classes, including concerns, curriculum, and student engagement. According to the results of this study, algebra teachers' mindsets influenced their attitudes toward the inclusion of technology. De Freitas and Spangenberg (2019) stated that while some instructors were hesitant to use instructional technologies, others took risks to investigate and learn about the advantages of technology. Although school districts encourage technology inclusion in algebra classes, teachers with fixed mindsets wanted to minimize technology inclusion in this study's findings. Similarly, this study showed that some risk-takers teachers expressed a growth mindset by adopting new technologies to challenge their comfort zone.

Results revealed that algebra teachers with fixed and growth mindsets have similar perceptions of technology inclusion in algebra classes such as curriculum and student engagement. These findings have similarities with the results of Haviz and Maris (2020) and Wang et al. (2017) regarding a modified curriculum for technology integration. Similarly, findings confirmed the results of McCulloch et al. (2018) and Marley-Payne et al. (2019) regarding the increase in student engagement. Technology inclusion provides easy access to student-centered instruction. All participants in this study agreed that instructional technology helped design more student-centered lessons. The findings of Ismajli et al. (2020) were confirmed by the results regarding student-centered instruction, where students were at the center of teaching and learning and as a result, self-exploration and discovery were promoted. Although the inclusion of technology increased student engagement, algebra teachers with fixed and growth mindsets had some concerns, distractions, and cheating, similar to the findings of Satsangi et al. (2019).

Distraction and cheating were two primary concerns regarding technology integration in algebra classes. Ng and Park (2021) and De Freitas and Spangenberg (2019) had similar findings regarding student distraction and classroom management. Participants in this study wanted to control students using technology appropriately; however, eliminating distractions was almost impossible without students taking responsibility for learning. Therefore, teachers needed additional disciplinary procedures concerning utilizing technology in daily instruction (De Freitas & Spangenberg, 2019).

Authors in the literature showed some gender-related approaches to technology usage in instructions (Marbán & Mulenga, 2019; Perinen, 2020). However, gender was not evident as a factor for the mindset in this study. Having a growth or fixed mindset did not relate to gender. Years of experience impacted attitudes toward technology inclusion in the literature by stating that new teachers were more willing to integrate instructional technologies than veteran teachers (Ozudogru & Ozudogru, 2019; Ursavas et al., 2019). Veteran teachers were expected to change or improve their mindset due to training or professional development. This study's findings showed that years of experience had no impact on teachers' mindsets toward technology inclusion.

This study extended the knowledge of teacher perception of technology inclusion in algebra classes by exploring teacher mindset influences on their own attitude toward technology inclusion in algebra classes. Although algebra teachers believed that instructional technology is beneficial and has advantages in teaching and learning, their mindset impacted the actual usage of technology either negatively or positively. Therefore, without addressing the mindsets of algebra teachers, technology inclusion could not be effective as expected.

As guiding theories, the self-perception theory (Bem, 1972) and the technology acceptance model (Davis, 1989) were used to investigate teacher mindset influences on their own perceptions of the integration of technology in algebra classes. The self-perception theory (SPT) claims that people develop attitudes and beliefs by observing their own behavior (Bem, 1972). According to Bem, actions were influenced by social circumstances rather than free will. Participants in this study stated that administrators and instructional leaders strongly encouraged technology integration; therefore, social environments have influenced algebra teachers to utilize technology rather than their own free will.

On one hand, findings in this study showed that algebra teachers who expressed a fixed mindset were stuck in a circle observing their behavior toward technology negatively. On the other hand, algebra teachers who expressed a growth mindset expanded their beliefs and attitudes positively. Although teachers with a fixed mindset wanted to limit technology usage in algebra classes due to the strong culture in the school district, they felt pressure to utilize instructional technology. Similarly, algebra teachers with a growth mindset were influenced by the school culture and the environment hence encouraging them to utilize technology effectively.

Davis (1989) developed the technology acceptance model (TAM) to predict the success of the integration of technology by focusing on perceived ease of use and usefulness. Participants in this study stated that ease of use and usefulness were two primary factors in utilizing technology in algebra classes. Fixed and growth mindset teachers expressed that they could use technology if it is user-friendly and beneficial to students. According to Dinc (2019), technology inclusion in daily instruction occurred when teachers had a positive attitude toward technology usage.

While algebra teachers with a fixed mindset accepted limited usefulness which led to a negative attitude toward technology usage, teachers with a growth mindset were determined to search and find user-friendly and useful technology resources due to a positive attitude. On one hand, the study's findings and results revealed that teachers' fixed mindsets negatively influenced technology inclusion in algebra classes. On the other hand, teachers' growth mindsets positively influenced technology inclusion in algebra classes. Since interpretations, inferences, and conclusions discussed fixed and growth-minded teachers' perceptions of technology inclusion, the study's data, findings, and scope were not exceeded.

The actual technology usage depends on teachers' positive attitudes toward instructional technology. One of the factors that might impact the attitudes positively or negatively is the mindset. Fixed and growth mindsets influence teachers’ attitudes toward technology inclusion in algebra classes. While algebra teachers with a fixed mindset have a limitation when integrating technology, growth-minded teachers face challenges regarding technology inclusion. Although fixed and growth mindset teachers have similar perceptions of technology inclusion, the attitudes and usage differ according to mindset.

Limitations

The sample size of this study was 18 participants, which was one of the limitations. Eighteen high school algebra teachers participated in this study to explore teachers' mindset that influences technology inclusion. Therefore, the findings could represent only high school teachers and might not be transferable to middle and elementary schools. Another limitation is the participants' experience; 12 teachers have more than 5 years of algebra teaching and the remaining 6 are between 2 and 5 years. Because 66% of the participants are veteran, experienced teachers, the findings could be biased that not represent novice teachers. Although member checks were used to establish credibility and contribute to trustworthiness, only some participants confirmed data by replying to the email that was sent. Therefore, a third limitation occurred in confirming the data. Since no co-researcher or peer was a part of the data analysis, a limitation might occur regarding dependability. Similarly, an audit trail was not established to support confirmability, and thus it might be another limitation of this study.

This study's results can be applied to other standardized tested disciplines and high school-level courses such as other math classes, science, social studies, and English Language Arts (ELA). High school teachers have common planning time and grade-level meetings with colleagues to share their experiences and best practices. The impact of the social environment could change the initial perception and attitude toward technology usage.

Recommendations

Although technology could benefit student engagement and outcomes in math classes, teachers' perceptions, attitudes, and beliefs could lead to limited or ineffective use of technology in daily instruction. Administrators and instructional leaders want teachers to utilize technology effectively. This study focused on the influence of teachers' mindsets on technology inclusion in algebra classes. The mindset of teachers influenced their perceptions of technology integration. Teachers need to shift from a fixed mindset to a growth mindset to maximize technology integration and experience its benefits.

Because this study involved mainly experienced teachers, future researchers should focus on pre-service and novice teachers' mindsets about technology inclusion. The new generation that will include future educators grows with many technologies; therefore, the impact of a fixed or growth mindset on technology integration should be minimal for future teacher candidates or new teachers. Future research should explore how teachers' mindsets can be shaped. The findings revealed that technology perceptions depend on teachers' mindsets. Also, researchers could explore teacher training and professional development toward teachers' mindsets.

Professional developments play a crucial role in improving teachers' effectiveness. Administrators and instructional leaders should design professional developments to improve teachers' mindsets. Changing a fixed mindset to a growth one is challenging. Therefore, ongoing job-embedded training provided by instructional coaches should be in place. Technology experts and coordinators should also provide specific training to eliminate teachers' concerns regarding unwanted technology usage. Official teacher observation is one of the critical aspects of teachers showing instructional effectiveness and getting feedback to improve student teaching and learning. To evaluate teacher effectiveness, stakeholders should update the checklist and rubrics according to technology inclusion, specifically in math instructions.

Implications for Leadership

The findings of this study revealed that teachers' mindsets influenced teacher perception toward technology inclusion in algebra classes, potentially enhancing student engagement and outcomes. If the teachers’ mindset shifts from fixed to growth, they may utilize technology to improve algebra instruction, helping student outcomes. Students and families may benefit from instructional technology, and school districts may develop policies to maximize the benefits of instructional technologies. The ultimate goal of education is to prepare students for the future workforce; therefore, technology inclusion will positively impact student success in occupations.

The findings of this study revealed that the algebra curriculum should be updated to maximize technology inclusion. Math educators and curriculum designers may update or create a brand-new algebra relevant to 21st-century skills. Technology experts in schools may improve safety and security options to eliminate teachers’ concerns that were evident in the findings. Although technology policies are being updated regularly, there is always a need for new regulations and procedures. School leaders may implement new policies and regulations. Administrators and instructional leaders may implement job-embedded professional developments and ongoing support to improve teachers' mindsets.

Conclusion

Instructional technology could impact student teaching and learning. Teachers' perception plays an imperative role in the actual usage of technology. Although some factors impact teachers' attitudes, beliefs, and approaches toward technology, the mindset influences the actual usage. This study explored teacher mindset influences on their attitude toward technology inclusion in algebra classes. On one hand, algebra teachers with fixed mindsets perceived the meaning of technology inclusion in algebra classes utilizing technology and non-technology in a balance while wanting to feel comfortable and eliminate concerns when they use technology. On the other hand, the growth mindset teachers perceived technology inclusion in algebra classes by utilizing technology more often to engage students in daily instructions while eliminating concerns. The study's results showed that a fixed mindset negatively influenced technology inclusion, while a growth mindset positively influenced it.

Besides the social environment and strong school culture that impact technology integration in algebra classes, teachers utilize technology according to perceived usefulness and ease of use. The intent of technology inclusion depends on the mindset of algebra teachers. Technology inclusion occurs with the combination of the school culture, self-perception theory, and perceived usefulness and ease of use, technology acceptance model.

The findings of this study contributed to the knowledge by adding the influence of teachers' mindsets on technology inclusion in algebra classes. Although teachers are affected by the social environment and the strong encouragement of technology integration in algebra classes, the intent of the actual usage of technology depends on teachers' mindsets. Teachers need to be trained to shift their mindset from fixed to growth to increase instructional technology's effectiveness in algebra classes.

Administrators and instructional leaders need to design professional development to improve teachers' mindsets while addressing technical skills. Without eliminating teachers' concerns, technology inclusion in algebra classes would remain limited. Math educators need to update the high school algebra curriculum to eliminate teachers' concerns and improve student engagement by utilizing 21^{st}-century skills.

This study provided information on how teachers' mindset influenced their attitudes toward technology inclusion in algebra classes. Although teachers feel pressure to utilize technology due to the social environment and the school culture, the intent of technology integration depends on having a fixed or growth mindset. When the intent is clear, the teachers follow the technology acceptance model to check usefulness and ease of use. Technology is a permanent part of education in this era and therefore, all teachers should be trained to use it effectively.

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Appendix A

Permission Request Email

ID Ismail Demirors
Sat 2/5/2022 1:39 PM
[redacted]

Informed Consent form.docx 50 KB
Permission Letter.docx 44 KB

2 attachments (94 KB) Save all to OneDrive - American College of Education Download all

[redacted]

As a doctoral candidate, I want to conduct research at [redacted] regarding technology inclusion in algebra classes. Please find the Permission letter request and consent form explaining the study process in the attachments.

Thank you for paying attention to this matter.

Ismail Demirors

Permission Request Letter

Date: 02/01/2022

[redacted]
Chief Executive Officer (CEO)

[redacted]

My name is Ismail Demirors, and I am a doctoral candidate at the American College of Education (ACE) writing to request permission to interview high school math teachers. This information will be used for my dissertation research related to **"Teacher Perceptions of Technology in Algebra Classes: A Qualitative Exploratory Case Study."** The purpose of the qualitative exploratory case study will be to explore how teachers' mindsets influence their own attitudes toward the inclusion of technology in high school algebra classes. Fifteen high school math teachers including special education teachers will participate in this study.

Important Contacts for this study include:

Principal Investigator: Ismail Demirors
E-mail: [redacted]
Phone: [redacted]

Dissertation Chair: Barry Chametzky, PhD
E-mail: barry.chametzky@ace.edu

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

Regards, Ismail Demirors

Appendix B

Informed Consent Form

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: Teacher Perceptions of Technology in Algebra Classes: A Qualitative Exploratory Case Study

Researcher: Ismail Demirors

Organization: [redacted]

Email: [redacted]

Telephone: [redacted]

Date of IRB Approval: 06/10/2022

Please note that this research study was approved by the American College of Education Institutional Review Board. A copy of the approval letter will be provided upon request.

Researcher's Dissertation Chair: Barry Chametzky, Ph.D.

Organization and Position: American College of Education/Dissertation Team

Email: barry.chametzky@ace.edu

Introduction

I am Ismail Demirors, a math instructional coach at [redacted] I am a doctoral candidate at the American College of Education. I am doing research under the guidance and supervision of my Chair, Dr. Chametzky. I will give you some information about the project and invite you to be part of this research. Before you decide, you can talk to anyone you feel comfortable with about the research. If you have questions, 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 qualitative exploratory case study is to explore how teachers' mindsets influence their own attitudes toward the inclusion of technology in high school algebra classes. You are being asked to participate in a research study that will assist in studying teachers' mindsets. Conducting this qualitative study will help analyze and explore the inclusion of technology in algebra education.

Research Design and Procedures

The study will use a qualitative methodology and exploratory case research design. An invitation will be disseminated to specific participants within [redacted] The study will comprise 15 participants who will participate in interviews and focus groups.

Participant selection

You are being invited to take part in this research because of your experience as an algebra teacher who can contribute much, which meets the criteria for this study.

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. At any time, if 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

I am inviting you to participate in this research study. If you agree, you will be asked to participate in focus groups and one-on-one interviews. The type of questions asked will range from a demographical perspective to direct inquiries about the topic of the inclusion of technology in algebra classes.

Duration

The focus group and interviews portion of the research study will require approximately 30 to 60 minutes to complete. If you are chosen to be a part of the study, the time allotted for the focus group and interview will be 30 to 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 (audio only) 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 question 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 the integration of technology in algebra classes. The potential benefits of this study will aid math educators in considering new pedagogies or development in math education.

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 via email [redacted]. 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 of 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 that 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 that 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 THIS INFORMED CONSENT FORM FOR YOUR RECORDS.

Appendix C

Recruitment Letter and Demographic Survey

Date: 02/14/2022

Dear math teacher,

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 qualitative exploratory case study is to explore how teachers' mindsets influence their own attitudes toward the inclusion of technology in high school algebra classes. You are being asked to participate in a research study that will assist in studying teachers' mindsets. This qualitative study will help analyze and explore the inclusion of technology in algebra education.

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. If you would like additional information about the study, please contact the following

Candidate Contact Information: Ismail Demirors, [redacted]

Chair Contact Information: Barry Chametzky, Ph.D., barry.chametzky@ace.edu

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 these links below to access, review, and accept the informed consent and complete the demographic survey.

[redacted]

Thank you again for considering this dissertation research opportunity.

Demographic Survey

Full name
Your answer

Class/course you teach
Your answer

Have you ever taught Algebra?
Yes
No
Maybe

Gender
Male
Female
Prefer not to say

Age
21-30
31-40
41-50
51-60
61 and up

Years of experience
Less than 2
Between 2 and 5
More than 5

Ethnicity
Caucasian
African-American
Latino or Hispanic
Asian
Native American
Native Hawaiian or Pacific Islander
Two or More
Other/Unknown
I. Prefer not to say

Appendix D

Email for not Selected Participants

Dear teacher,

Thanks for responding to my email regarding my study.

You were not selected to participate in this research due to the criterion of algebra teaching experience.

However, if you want to see the study's findings, please contact me via email, then I can share the results with you.

Thank you and best regards,

Ismail Demirors

Appendix E

Permission Letter

[redacted]

[redacted]

February 8, 2022

Dear Institutional Review Board:

The purpose of this letter is to inform you that I give Ismail Demirors permission to conduct the research titled **"Teacher Perceptions of Technology in Algebra Classes: A Qualitative Exploratory Case Study"** at [redacted] We have agreed to the following study procedures focus group and a semi-structured interview with 15 to 20 math teachers for the research.

I understand that Mr. Demirors will receive consent from all participants. Mr. Demirors has agreed to provide my office a copy of all the American College of Education IRB-approved, stamped consent documents before he recruits participants on site. Any data collected by Mr. Demirors will be kept confidential and will be stored in a locked filing cabinet and a password-protected computer within his office. Mr. Demirors has agreed to provide us with a copy of the aggregate results from his study.

Sincerely,

[redacted]

[redacted]

Appendix F

IRB Approval

June 10, 2022

To : Ismail Demirors
Barry Chametzky, Dissertation Committee Chair

From : Institutional Review Board American College of Education

Re: IRB Approval
"Teacher Perceptions of Technology in Algebra Classes: A Qualitative Exploratory Case Study"

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, June 10, 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,

Erin Maurer
Assistant Chair, Institutional Review Board American College of Education

Appendix G

Focus Groups Protocol

Introduction Text

Hello all. First of all, I want to thank all of you for being here today. My name is Ismail Demirors, and I am conducting a study regarding teachers' mindset influences on the integration of technology in algebra classes. You are invited because you teach algebra and your ideas, beliefs, and approaches are valuable. I will be the moderator for today's focus group. Your opinions and experiences will help me explore and analyze teachers' perceptions of the inclusion of technology regarding teachers' mindsets. I will categorize the information into themes and topics before being shared anonymously. Your personal information will not be connected to the results of this focus group.

You agree to participate in the focus group and keep our discussion confidential by signing the consent and non-disclosure form. For any reason signing these forms if you feel uncomfortable, you are free to leave at any time.

Before we begin, I want to go over a few ground rules for the focus group. These are in place to ensure that you feel comfortable sharing your experiences and opinions.

Ground Rules:

1. *Confidentiality* – As per the non-disclosure form, please respect the confidentiality of your peers. The moderator will only be sharing the information anonymously with relevant staff members.
2. *One Speaker at a Time* – Only one person should speak at a time to make sure that we can all hear what everyone is saying.
3. *Use Respectful Language* – To facilitate an open discussion, please avoid any statements or words that may be offensive to other members of the group.
4. *Open Discussion* – This is a time for everyone to feel free to express their opinions and viewpoints. You will not be asked to reach a consensus on the topics discussed. There will be no right or wrong answers.
5. *Participation is Important* – It is important that everyone's voice is shared and heard in order to make this the most productive focus group possible. Please speak up if you have something to add to the conversation!

Questions

1. What does the inclusion of technology mean in algebra class?
2. What are your thoughts about the necessity of integrating technology to teach and learn algebra?
    a. Follow-Up Question: How can teaching style impact utilizing technology?
3. How does the inclusion of technology change teaching algebra, regarding being easier or harder?
4. What are some of the ways that you can integrate technology into your algebra courses?

5. What concerns do you have regarding the inclusion of technology in algebra class?
    a. Follow-Up Question: What help do you need based on those concerns?
6. Do you have any other additional comments regarding the inclusion of technology in algebra classes?
7. What are the pros and cons of the integration of technology in Algebra class in regard to: students engagement? deep learning?

Conclusion Text

Thank you for participating in the focus group today. As a reminder, I will categorize the information learned during the discussion into themes and topics before being shared anonymously. If you think of any additional thoughts or comments that you would like to share, please contact me via email.

Appendix H

Semi-Structured Interview Protocol

Introductory Script

Thank you for agreeing to help me with my study. I know you've already returned your consent form to me; do you have any questions? I'll be recording this session. Is that still ok with you? [If the participant answers yes - turn on recording]

Ok, I've started recording.

Let me tell you a little about my study. I am conducting a study regarding teachers' perceptions of the inclusion of technology in algebra classes. The purpose of my project is to explore how teachers' mindsets influence their own attitudes toward the inclusion of technology in high school algebra classes.

I have some questions, but the conversation is open. Meaning the follow-up questions depends on your answers. I hope you will answer all of my questions, but I understand if you prefer not to answer some. If there is a question you'd like to skip, just let me know, and I'll move on to my next question. I expect our interview to last approximately 30-45 minutes.

Interview Questions

- Tell me about how you use or do not use instructional technologies as you teach algebra.
- How do you think some instructional technologies might change the ways in which algebra is taught?
- Tell me about difference between teaching algebra with or without technology.
- Thinking about using technology, what do you think you could change to improve teaching and learning algebra?
- How do you feel when using new technology in your algebra class?
- What are your thoughts about using a calculator in your class?
- What is your opinion on no paper, no pencil in algebra class because of technology inclusion?
- What do you think about teacher training to use technology effectively in their classrooms?
- How comfortable are you with your using technology in your classroom?

Sample Follow Up Prompts

- Tell me a bit more about that.
- Would you expand on your answer/ideas/thoughts?
- Would you provide more details about that?

Closing Script

Thank you for taking the time to participate in this interview with me. Before I turn off the recording, do you have any additional information that you think might be helpful to me? Do you have any questions you would like to ask me about the study?

Again, thank you. You have my contact information if you need to reach me later. I will email you a copy of our interview transcript in the next couple of days for your review. You will have the opportunity to correct any errors in the transcript that you see.

Appendix I

Subject Matter Experts' Feedback

[redacted]

Semi-structured... +2

Review and Feedback

[redacted] edu>

21 KB

Please be cautious
This email originated from outside of ACE organization

Thank you! The reason why I asked for the RQs is because your whole research is about answering them. As you collect the data, always think about how you can answer the RQs. That's why it is important to structure the interviews and focus groups in ways that maximize participant input. When you get to the analysis, you will look for as much data as possible to answer the RQs and support your claims. A solid research design is key to draw plausible conclusions.

I added some notes on the interview protocol document (see attached). I think you can use those ideas for the focus group protocol as well.

I hope this helps.
Let me know if I can assist any further.

[redacted]

[redacted]

Introductory Script

Thank you for agreeing to help me with my study. I know you've already returned your consent form to me; do you have any questions? I'll be recording this session. Is that still ok with you? [If the participant answers yes - turn on recording]

Ok, I've started recording.

Let me tell you a little about my study. I am conducting a study regarding teachers' perceptions of technology inclusion in algebra classes. The purpose of my project is to explore how teachers' mindsets influence their own attitudes toward technology inclusion in high school algebra classes.

I have some questions, but the conversation is open. Meaning the follow-up questions depends on your answers. I hope you will answer all of my questions, but I understand if you prefer not to answer some. If there is a question you'd like to skip, just let me know, and I'll move on to my next question. I expect our interview to last approximately 30-45 minutes.

Interview Questions

- How do you define technology in algebra class?
- What do you think about technology's role in algebra class?
- Is there any difference between teaching algebra with or without technology?
- Thinking about using technology, what do you think you could change to improve?
- How do you feel when using new technology in your algebra class?
- Do you want to teach algebra without a calculator if you have a chance? Please explain.
- What is your opinion on no paper, no pencil in algebra class because of technology inclusion?
- Do you think technology skills are needed for teaching algebra?
- Tell me about what you feel when you use technology in your class?

Sample Follow Up Prompts

- Tell me a bit more about that.
- Can you expand on your answer/ideas/thoughts?
- Would you provide more details about that?

Closing Script

Comments

Page 1

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Semi-structured intervie... 20 KB

Focus group protocol.docx 20 KB

2 attachments (40 KB) Save all to OneDrive - American College of Education Download all

Please be cautious
This email originated from outside of ACE organization

Hi Mr. Demirors,

This is such an important study especially at this time and I am glad you are doing it. Attached please see my comments to your documents.

...

Word Semi-structured interview protocol.docx Edit in Browser Download Save to OneDrive

Word Accessibility Mode Print Find Immersive Reader ...

Introductory Script

Thank you for agreeing to help me with my study. I know you've already returned your consent form to me; do you have any questions? I'll be recording this session. Is that still ok with you? [If the participant answers yes - turn on recording]

Ok, I've started recording.

Let me tell you a little about my study. I am conducting a study regarding teachers' perceptions of technology inclusion in algebra classes. The purpose of my project is to explore how teachers' mindsets influence their own attitudes toward technology inclusion in high school algebra classes.

I have some questions, but the conversation is open. Meaning the follow-up questions depends on your answers. I hope you will answer all of my questions, but I understand if you prefer not to answer some. If there is a question you'd like to skip, just let me know, and I'll move on to my next question. I expect our interview to last approximately 30-45 minutes.

Interview Questions

- How do you define technology in algebra class?
- What do you think about technology's role in algebra class?
- Is there any difference between teaching algebra with or without technology?
- Thinking about using technology, what do you think you could change to improve?
- How do you feel when using new technology in your algebra class?
- Do you want to teach algebra without a calculator if you have a chance? Please explain.
- What is your opinion on no paper, no pencil in algebra class because of technology inclusion?
- Do you think technology skills are needed for teaching algebra?
- Tell me about what you feel when you use technology in your class?

Sample Follow Up Prompts

- Tell me a bit more about that.
- Can you expand on your answer/ideas/thoughts?
- Would you provide more details about that?

Comments

[redacted]

Ground Rules:

1. *Confidentiality* – As per the non-disclosure form, please respect the confidentiality of your peers. The moderator will only be sharing the information anonymously with relevant staff members.
2. *One Speaker at a Time* – Only one person should speak at a time to make sure that we can all hear what everyone is saying.
3. *Use Respectful Language* – In order to facilitate an open discussion, please avoid any statements or words that may be offensive to other members of the group.
4. *Open Discussion* – This is a time for everyone to feel free to express their opinions and viewpoints. You will not be asked to reach a consensus on the topics discussed. There will be no right or wrong answers.
5. *Participation is Important* – It is important that everyone's voice is shared and heard in order to make this the most productive focus group possible. Please speak up if you have something to add to the conversation!

Questions

1. What does technology inclusion mean in algebra class?
2. Is it necessary to integrate technology to teach and learn algebra?
   1. Follow-Up Question: Should teaching style change when teachers utilize technology?
3. Does technology inclusion in algebra class make teaching easier or harder?
4. What do you want to change in your class regarding technology integration if you have a chance?
5. Do you have any fears or concerns regarding technology inclusion in algebra class?
   1. Follow-Up Question: What help do you need based on those fears or concerns?
6. Do you have any other additional comments regarding technology inclusion in algebra classes?

Page 1

[redacted]

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chnology
hard to: Students

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Filter

Wed 2/9 Inbox

Review and Feeedback

Ismail Demirors
Hello [redacted] Thank you for agreeing to review my research instruments. Please find the documents in the attachment. You ca... Mon 2/7/2022 1:37 PM

[redacted]

E organization

nse. It's been a little hectic.

s to "teacher" or "one" might be better.

Here are my opinions on these two documents;

Review and Feeedback

Filter

Wed 2/9 Inbox

Please be cautious This email origi...

Semi-structured... +1

•How do you define technology in algebra class?
How do you define the use of of technology in class- maybe?
• What do you think about technology's role in algebra class?

• Is there any difference between teaching algebra with or without technology?
Yes or no question. Rewording may help: what might be some of the differences between teaching algebra with tech or no tech?

• Thinking about using technology, what do you think you could change to improve?

• How do you feel when using new technology in your algebra class?

• Do you want to teach algebra without a calculator if you have a chance? Please explain.

• What is your opinion on no paper, no pencil in algebra class because of technology inclusion?

• Do you think technology skills are needed for teaching algebra?
Yes or no question. Questions that start with how are better when seeking for others input.
You can maybe say-
What are some of the tech skills that one should have when teaching an Algebra course?

• Tell me about what you feel when you use technology in your class?

1. What does technology inclusion mean in algebra class?

2. Is it necessary to integrate technology to teach and learn algebra?

a. Follow-Up Question: Should teaching style change when teachers utilize technology?
This can be a separate question rather than a follow up.

3. Does technology inclusion in algebra class make teaching easier or harder?
What kind of an impact would incorporating technology make on the course difficulty?

[redacted]

Mon 2/7/2022 2:12 PM

[redacted] ACE organization

Dear Mr. Demirors,
Thank you for sharing the questions to get feedback. I wrote below some critics from my point of view. I hope these critics could be helpful for you.
If you have any questions, please let me know.

[redacted]

For focus group questions
The 6 questions you are asking are open-ended and very good, but I see that there is no question that is related to a specific technological innovation or equipment that can be used in Algebra.

Second, there is also no question about how technology could be adapted to Algebra, and what kind of procedures and processes should be included through adaptation processes.

Feedback for Introductory Script,
I see the same situation in this part. All questions are open-ended.
There is no question for a specific technology can be used in Algebra.

Second, there is no question for teachers who used which technologies and what kind of experiences they had.

Third, to the teachers, the best practices with technologies they experienced in Algebra classes could be asked since It can inspire some others.

Forth, I think, a question can be asked to the teachers It can be about which technologies and methodologies should not be used in Algebra.

...

--

[redacted]