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Middle School Teachers' Use of Technology to Transform Mathematics Instruction

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2020

Abstract

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by

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BS, The University of the West Indies, Mona, 2002

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Incorporating technology into instructional practices is needed to cultivate learners who are digitally competent to function in a society in which technology keeps evolving. The problem that exists at the study site is that although technology is available, it is primarily being used to enhance learning rather than transform learning. Transforming the teaching- learning process, requires the use of technology to modify and redefine learning. Therefore, the purpose of the study was to explore the extent to which middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado use digital technology as a transformative learning tool in mathematics instruction. The substitution, augmentation, modification, and redefinition (SAMR) model of technology was used as the conceptual framework. The research questions focused on middle school mathematics teachers' current use of technology and factors that may be keeping those teachers from using technology to transform instruction in middle school mathematics classrooms. A qualitative case study design was used to gather data from nine middle school mathematics teachers at the study site. Data were collected through interviews, observations, and document analysis. The findings indicated that the middle school mathematics teachers primarily used technology to enhance instructions. The findings indicated that training, distractions, and curriculum integration precluded the use of technology to transform instruction. Findings from the research informed the establishment of a project to address the problem at the study site. Findings from the study may also engender positive social changes by providing recommendations for system-wide changes geared toward empowering students to take ownership of their learning, become actively engaged learners, and become creative thinkers.

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Dedication

I can do all things through Christ who gives me strength – Philippians 4:13. First and foremost, I would like to express my highest gratitude to God for giving me the strength, wisdom, knowledge, and understanding to complete this research study. I would like to thank my parents, siblings, and nieces for their unrelenting support.

This project is dedicated to my mother, Mrs. Sarah James, and my sisters Careen James-Barnett, and Marie Latty. They were with me during sleepless nights and when I felt discouraged. Their words of encouragement and constant fervent prayers strengthened me and impelled me to work harder. Thank you believing in me. I love you.

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Compiling research like this is not an easy task. It is time-consuming and sometimes maddening. My respect for researchers has been heightened, as has my gratitude for those who supported me through the process, both spiritually or emotionally.

For continued assistance and encouragement, I wish to thank my committee chair, Dr. Deborah Focarile, my second members, Drs. Michael Brunn and Celeste Stansberry, who took the time to read my drafts and provide constructive feedback that informed my final study. Special thanks to Dr. Deborah Focarile for taking the time out to speak to me and guide my research. My highest gratitude to Drs. Brunn and Stansberry for their assistance with the conceptualization and the methodology aspects of my research.

I would like to acknowledge the Head of School and the Associate Director of Program at the study site for permitting me to conduct this research at the institution. Special thanks to all the participants who were the cornerstone of this study. Without their cooperation, this project study would not be possible. I would like to thank all the faculty members at Walden University who have guided me through my doctoral journey.

Finally, I acknowledge others who have offered needed emotional support and advice often to the tune of many hours. I am eternally grateful for your unconditional support.

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Section 1: The Problem

The Local Problem

The problem at a PreK–8 independent day school in Denver, Colorado is that although digital-based technology is available, it is not being used to engage students in a transformative learning experience in middle grade mathematics classes. Research has also indicated that the integration of technology in instructional practices has been slow (Laferriere et al., 2013). But the integration of technology into instructional practices, primarily in the early years, can positively influence student learning (Vaughan & Beers, 2017) and transform students' learning outcomes (Laferriere, Hamel, & Searcon, 2013). Further, in this digital age it is important that students are given the opportunity to use technology at higher levels to innovate and create (Bakla, 2019). The effective use of technology can optimize learning experiences for students, creating a transformative learning experience for students (Hamilton et al., 2016; Puentedura, 2014a). Higher-level integration of technology can provide the opportunity for students to collaborate, create, and engage in higher-order thinking (Hamilton et al., 2016; Puentedura, 2014a). Additionally, the integration of technology can motivate and engage learners, help develop critical thinking and problem-solving skills, improve math proficiency, and augment learners' understanding of math concepts (National Council of Mathematics Teachers [NCTM], 2016).

Technology may be integrated into the curriculum at four different levels: substitution, augmentation, modification, and redefinition (Hamilton et al., 2016; Puentedura, 2014a). However, researchers have found that educators primarily use technology to substitute tasks that can be completed without employing digital technology (Nkonki & Ntlabathi, 2016; Romrell, Kidder, & Wood, 2014). Technological advancements and the growth of Internet use has rendered traditional instructional practices obsolete (Jacobs, 2010); therefore, educators must deliberately augment their perspectives on technology and adopt new approaches to effectively engage learners (Jacobs, 2010).

The school leaders at the PreK–8 independent school in Denver, Colorado in which the research was conducted recently earmarked funds to construct a technology and innovation center, and innovation is one of the goals of the school's 5-year strategic plan. According to the director of curriculum, teachers are expected to integrate technology into their practice as outlined in Puentedura's (2009) SAMR model for technology integration to provide a transformative learning experience for students. Using technology to perform tasks that may be accomplished without the use of digital technology falls within the substitution and augmentation tiers of the SAMR model (Puentedura, 2009), which can modify and redefine the teaching-learning process, leading to a shift in technology as an enhancement tool to a transformational learning tool (Puentedura, 2014a). Incorporating technology at the higher levels of the SAMR technology model provide opportunities for learners to engage in 21st-century competencies: critical thinking, collaboration, and communication (Puentedura, 2014a). However, through observations, the instructional leaders have found that most mathematics teachers use technology primarily as a note-taking tool and for assessments, the lower level of the SAMR technology model. Additionally, the math department chair asserted that of the nine middle school mathematics teachers, four did not use technology in mathematics instructions, and five used technology to substitute traditional activities, such as note-taking and assessments, which may enhance learning but does not augment students' learning experiences and promote critical thinking (NCTM, 2016). To support advanced mathematical thinking, reasoning, problem-solving, discourse, and improved performance in mathematics, mathematics teachers must use technological tools such as content-specific applications and web-based digital media to transform the teaching-learning process and increase students' access to information and ideas, enhance collaboration and communication, and foster critical thinking (NCTM, 2016), thereby providing transformational learning experiences for students.

Rationale

For centuries, educational systems have been predicated on how educators autonomously transmit knowledge to passive learners. Educators have unilaterally controlled the learning process by deciding the pace of lessons, the flow of communication, content taught, methodology, and mastery of the content (Weimer, 2013). However, global phenomena such as advancement in technology and access to information has rendered teacher-centered traditional teaching deficient in preparing students for the demands of in the 21st-century workforce (Cullen, Harris, & Hill, 2012). International comparisons such as the Trends in International Mathematics and Science Study and Pisa and national indicators such as the National Assessment of Educational Progress (2016) have shown that students in the United States are performing below average when compared to their peers in other developed nations in mathematics achievement and skills acquisition (Bicer & Capraro, 2017). Similarly, the 2013 Organization for Economic Co-operation and Development report illustrated that the mathematics proficiency and achievement of students in the United States is subpar when compared to other nations (Higgins, Huscroft, & Crawford, 2019). Similar studies have indicated that the students in the United States continue to lag behind their peers worldwide in mathematics achievement, mathematical discourse, and skill acquisition (Siegler et al., 2010; Star et al., 2015; Woodward et al., as cited in Higgins et al., 2019). Thus, for over 2 decades there has been a thrust toward reforming mathematics instructions to improve student performance, and one primary reform effort has been the implementation of digital technology into mathematics instruction (Higgins et al., 2019).

The NCTM technology statement is that “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances student learning” (NCTM, 2016, p. 24). Additionally, the incorporation of technology into mathematics instruction provides the opportunity for mathematics teachers to use a myriad of modes of presentation and assessment, which has the potential to positively influence student engagement, motivation, and student learning (Eyyam & Yaratan, Maccini, Wright, & Miller, 2014; Mulcahy, 2014) as well as achievement and attitude (Higgins et al., 2019). Similar findings have been illustrated in many studies (Cheung & Slavin, 2013; Li & Ma, 2010; Rosen & Salomon, 2007; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Despite the potential positive impact of technology on student learning, technology integration is typically rare (Blackwell, Lauricella, & Wartella, 2014), inert (Laferriere et al., 2013), or used as a substitute for traditional teaching methods (NCTM, 2016).

The administrators and the director of curriculum at the study site noted that in 2012 the school incorporated a 1:1 iPad program for middle school students. Additionally, each classroom was fitted with SmartBoard Technology or Promethean Boards. However, the administrators noticed that the use of technology was limited to note-taking and/or assessments. Another problem that was highlighted by the administrators and the mathematics department chair was that the middle school students were performing relatively low in mathematics when compared to other independent schools in the area. As a result, several families opted to withdraw their children before entering the middle school division. Consequently, a mathematics task force was established to analyze trends in data, highlight underlying issues with students' academic achievement in mathematics, and develop a program to improve students' performance in mathematics. The task force found that technology was being used to substitute traditional methods that may be accomplished without the use of technology (Hamilton et al., 2016; NCTM, 2016), thereby having little or no impact on student engagement (Hamilton et al., 2016). But a shift toward using technology to transform learning rather than enhance learning promotes higher-order thinking, engenders active learning, improves retention, and improves students' academic performance (Kadry & Ghazal, 2019). Additionally, using technology at the modification and redefinition levels of the SAMR model of technology promotes active learning, engenders higher levels of creativity, augments reasoning and critical thinking skills, and improves problem-solving skills, thereby improving student learning outcomes and academic achievement (Ramnarain, 2015).

The purpose of the study was to explore the extent to which middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado used digital technology as a transformative learning tool in mathematics instruction. The study focused on middle school mathematics teachers' current use of technology and factors that may be keeping middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms at the study site.

Definition of Terms

Augmentation: Digital technology acts as a substitute for traditional instructional practices, with functional improvements (Puentedura, 2006).

Bloom's taxonomy: A classification of the six cognitive domain categories (Krathwohl, 2002).

Educational technology: A variety of technology-based programs or applications that help deliver learning materials and support to improve academic learning goals (Cheung & Slavin, 2013).

Modification: digital technology allows for a functional redesign of instructional practices (Puentedura, 2006).

Redefinition: Digital technology allows for the creation of tasks that can only be completed with digital technology (Puentedura, 2006).

Substitution, augmentation, modification, and redefinition (SAMR) model: The SAMR model (Puentedura, 2006) is a four-tiered hierarchical framework for incorporating digital technology. The four tiers—substitution, augmentation, modification, and redefinition—represent the levels at which technology may be incorporated into the teaching-learning process.

Substitution: Digital technology acts as an alternative for teaching and learning with no functional change (Puentedura, 2006).

Technology, pedagogy, and content knowledge (TPACK) framework: A technology integration framework that combines technology, pedagogy, and content knowledge for the successful integration of technology into instructional practices (Koehler & Mishra, 2009).

Significance of the Study

This project study addressed a local problem by focusing on how middle school mathematics teachers use technology-integrated instruction to engage students in a transformative learning experience in mathematics. This study is significant because it addressed an issue that has not been studied in my local setting (director of curriculum, personal communication, March 22, 2019). The study site is invested in incorporating technology in instructional practices; however, teachers do not have adequate knowledge and skills in effectively using technology-integrated instruction (fifth-grade mathematics teachers, personal communication, 2019; sixth-grade mathematics teacher, personal communication, May 15, 2019; seventh-grade mathematics teacher, personal communication, May 22, 2019). The findings from the study provide insight into possible factors that may be hindering mathematics teachers from integrating higher-level technology-integrated instructions to transform learning. This could aid administrators in embarking professional development that supports technology-integrated pedagogy in mathematics. The findings from the study can engender positive social change by equipping teachers with technological skills and knowledge that are essential in engaging 21st-century learners in collaborative and transformative learning experiences in mathematics. Digital-based technology can influence student engagement, enhance collaboration, improve critical thinking, and enhance the learning of mathematics (Evans, Nino, Deater-Deckard, & Chang, 2015), positively impacting students' confidence and development (Sen & Ay, 2017). Thus, the integration of digital-based technology into mathematics instruction could effect positive social change by providing opportunities for students to develop 21st-century competencies such as collaboration, critical thinking, and communication.

Research Questions

The primary goal of qualitative research is to understand, describe, and discover meaning (Burkholder, Cox, & Crawford, 2016). Therefore, research questions are usually designed to describe, discover, or explore a phenomenon (Onwuegbuzie & Leech, as cited in Burkholder et al., 2016). The situation at the study site is that digital-based technology is not being used to engage students in a transformative learning experience in middle grades mathematics classes. To explore this phenomenon two research questions were used to discover a) the extent to which middle school mathematics teachers use of digital technology to transform mathematics instruction and b) factors that may be impeding the use of digital-technology initially and/or completely to transform instruction in middle-grade mathematics classrooms at the study site:

1) How do middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado use digital-based technology as a transformative learning tool in mathematics instruction?
2) What do middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms at a PreK–8 independent school in Denver, Colorado?

Review of the Literature

The literature was collected from the Walden University library databases: ERIC, ProQuest Central, and Education Research Complete. Additionally, a comprehensive search of Google scholar was used to review relevant literature. The search terms that were used to search the literature included *technology and mathematics instruction*, *benefits of technology*, *technology integration*, *middle school mathematics*, *SAMR model of technology integration*, *teacher pedagogy*, *effective instructional practices*, and *teacher perception of technology*. Based on the purpose of the study, the literature was organized into the following categories: teacher perception, technology, and professional development; learner-centered approach and technology; technology and instruction; benefits of technology; the TPACK framework; and mathematics achievement and technology.

The literature review illustrated that teachers' perceptions of technology can influence the use of technology in their instructional practices (Heath, 2017; Smith et al., 2016). The literature on technology and professional development noted that ongoing job-embedded professional development is essential in building teachers' capacity and influencing the use of technology in their pedagogical practices (Kul, 2018; Machado & Laverick, 2015; McKnight et al., 2016). The literature on learner-centered approach and technology illustrated that integration of technology at advanced levels within the classroom engenders more autonomous learners and reduces students' dependence on the teacher as the sole dispenser of knowledge (Longo, 2016; McKnight et al. 2016). The literature on technology and instruction illustrated that the growth in the use of technology and ease of accessing information has created a paradigm shift in the teaching and learning process by providing teachers with alternate ways to engage learners and deepen their understanding (Donnelly & Kyei-Blankson, 2015; Ianos & Oproiu, 2018). Overall, the literature illustrated that there are numerous benefits associated with technology integration such as providing the opportunity to differentiate instruction, enhance student participation, improve student performance, and foster a learner-centered classroom (Cox, 2019; McKnight et al., 2016).

Conceptual Framework

Puentedura's (2009) SAMR model for technology integration provided the conceptual framework for the study. The SAMR model of technology integration is a four-tiered hierarchical model for incorporating digital technology into the teaching-learning process to facilitate optimal learning experiences for students. The SAMR model consists of four tiers at which technology may be incorporated into the classroom: substitution, augmentation, modification, and redefinition (see Figure 1). The tiers are categorized into two groups based on how learning is influenced by the learning activities that are used to engage learners (Puentedura, 2009). Technology that only enhances learning falls within the substitution and augmentation tiers (Puentedura, 2009). Modification and redefinition represent the upper levels of model and the threshold where technology has moved from simply enhancing learning to transforming learning through 21st-century skills such as critical thinking, collaboration, and communication (Puentedura, 2009).

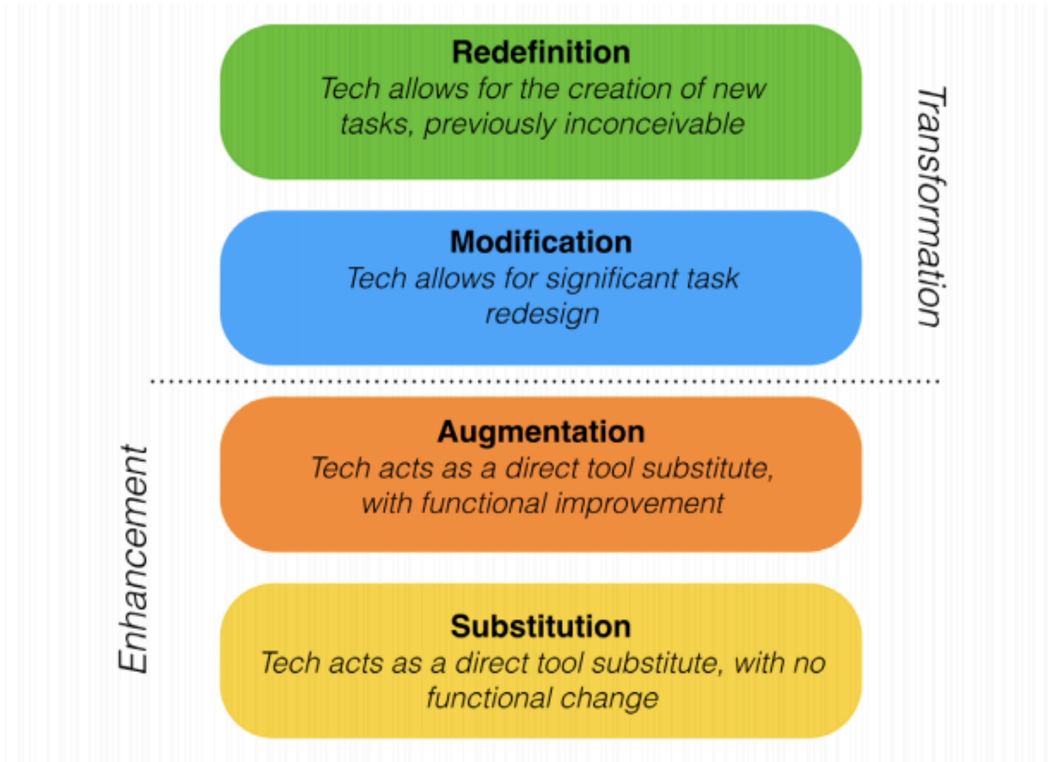

Figure 1. SAMR model of technology integration. From Puentedura (2009).

Technology integration at the substitution and augmentation levels refers to learning activities that may be accomplished without the use of technology, such as using online assessments (Hamilton et al., 2016; NCTM, 2016). The lowest level of the SAMR model of technology, substitution, is the implementation of technology without any functional change to learning activities (Hamilton et al., 2016). The substitution level integration involves replacing traditional instruction and learning activities, such as completing a worksheet online instead of using paper copies. The second level of the SAMR model of technology, augmentation, involves the use of technology with some functionality (Puentedura, 2009). For instance, students may use tools such as spell check and Grammarly to enhance written work. The modification and redefinition tiers of the SAMR model refers to learning activities that are not attainable without the use of digital technology (Hamilton et al., 2016). For example, students use GeoGebra and Desmos technologies to model algebraic and geometric concepts (NCTM, 2016). Modification and redefinition represent the threshold where there is a shift toward using technology to transform learning, promoting higher-order thinking rather than merely using technology to enhance learning. Additionally, the integration of technology at the modification and redefinition levels engenders active learning, which also improves retention (Kadry & Ghazal, 2019) and increases creativity, augments reasoning and critical thinking skills, and improves problem-solving skills, thereby improving student learning outcomes and academic achievement (Ramnarain, 2015).

The SAMR model of technology functioned as a guide to explore the extent to which middle school mathematics teachers at the study site used digital technology as a transformative learning tool in mathematics instruction. The SAMR model of technology delineates technology integration into two major categories based on the functionality of technology in the teaching-learning process. The integration of technology at the substitution and augmentation levels enhances the teaching-learning process but does not provide a transformative learning experience for students. However, learning is transformed when technology is used to modify and redefine the teaching-learning process (Puentedura, 2009). The SAMR model of technology was used as the frame for the research questions, which sought to explore middle school mathematics teachers use digital-based technology as a transformative learning tool in mathematics instruction and what middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. The SAMR model of technology was also used to analyze data to explore the levels of technology integration into mathematics instruction. Figure 2 illustrates more about how the SAMR model of technology and how it fits with two other related frameworks – Bloom's taxonomy and Dale's cone of experiences. There is a correlation between using technology at the transformational level of the SAMR model with higher order thinking skills in Bloom's taxonomy and active learning in the Dale's cone of experiences.

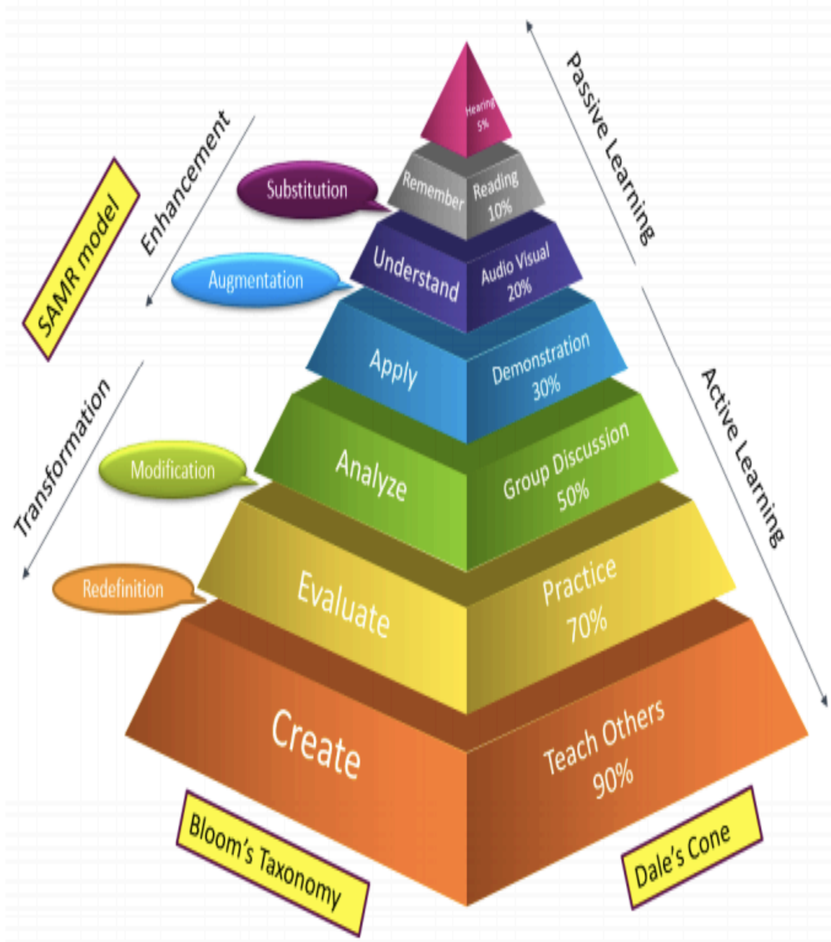

Figure 2. Illustration of how the levels of the SAMR technology model are related to Bloom's taxonomy and Dale's cone of experiences.

Teacher Perception

Researchers have found that teachers' perceptions of technology as an instructional tool influence the integration of technology into their pedagogy (Heath, 2017; Kalonde, 2017; Minshew & Anderson, 2015; Smith, Kim, & McIntyre, 2016) as well as the frequency of use (Machado & Laverick, 2015). Teachers who perceive digital technology as a tool with the potential to enhance and transform learning are more inclined to incorporate technology into instructional practices (Kalonde, 2017; Smith, Kim, & McIntyre, 2016). However, technology is typically used to supplement or enhance learning rather than transform learning (Ertmer & Ottenbreit-Leftwich, 2014). One of the primary variables that impacts the integration of technology is the pedagogical beliefs of teachers (Ertmer & Ottenbreit-Leftwich, 2014). Teachers do not receive extensive training in technology integration into a specific content area that they are being trained to teach (Karatas, Tunc, Yilmaz, & Karaci, 2017). Additionally, professional development in technology integration is infrequent and inconsistent (Hunt-Barron, Tracy, Howell, & Kaminski, 2015). Therefore, teachers' do not feel confident in incorporating technology at a more advanced level (Ertmer & Ottenbreit-Leftwich, 2014).

A paradigm shift in instructional practices will require a change is teachers' mindset about technology integration into pedagogical practices (Ertmer & Ottenbreit-Leftwich, 2014). The probability that teachers will incorporate technology into instructions is increased when teachers perceive technology as a valuable instructional tool (Heath, 2017). Additionally, the convergence of factors such as teachers' attitudes toward the use of technology and teacher agency is paramount to the successful integration of technology in education (Heath, 2017). Hence, teachers' perceptions on the use of technology can influence the use of technology as transform instruction practices (Heath, 2017). Similarly, access to technology and educators' perceptions toward the use of technology are two barriers that educators must overcome to effectively integrate technology into their instructional practices (Smith, Kim, & McIntyre, 2016).

Technology and Professional Development

The need to prepare students for the demands of the 21st century has engendered significant paradigm shifts in educational systems (Jacobs, 2010). Technological advancements, changes in world economies, and the destruction of borders caused by globalization are some world phenomena that have impacted how school systems prepare students to survive in the 21st century (Jacobs, 2010). Curricular practices that were centered around perennialism, idealism, and realism (Wiles & Bondi, 2015) have become obsolete in an era where student learning is not confined to the walls of the classroom. Developing creative, autonomous learners who can function in a world that is changing at warped speed requires a shift from the teacher-centered curriculum and instructional practices toward learner-centered pedagogy (Cullen et al., 2012).

The efficacy of the shift in curricular and pedagogical practices depends on the frequency and consistency of professional development designed to provide teachers with the skills and knowledge needed to equip students with 21st-century skills (Kihoza, Zlotnikova, Bada, & Kalegele, 2016; Vaughan & Beers, 2016). Additionally, to build educators' capacity and confidence in incorporating technology the faculty needs time to learn, explore, and experiment; therefore, ongoing professional development is essential (Jones, as cited in Cullen et al., 2012). Job-embedded professional development has the potential to improve teachers' perceptions of technology integration. For example, in a year-long study on technology integration in K-12 classrooms, teacher engagement in technology-based professional development was found to lead to a shift in pedagogical practices and positively influence student learning (Machado & Laverick, 2015). Findings have also indicated that teachers who engaged in technology-rich, targeted professional development demonstrated enhanced technological skills and improved attitude toward the integration of technology into their pedagogical practices (Kul, 2018; Machado & Laverick, 2015).

Ongoing job-embedded professional development on technology integration at advanced levels is also needed to increase teachers' skill-level and knowledge of how to integrate technology into instruction (McKnight et al., 2016). Job-embedded professional development provides the opportunity for teachers to engage in the process of collaborative inquiry (Carpenter, 2017). The collaborative inquiry process allows educators to collaboratively identify challenges, collect and analyze data, and determine pedagogical shifts and strategies that can optimize student learning (Cantalini-Williams et al., 2015). Additionally, collaborative inquiry fosters collegiality among teachers and create a community in which school leaders and teachers can address issues at the school level (Cantalini-Williams et al., 2015).

Recognizing and understanding that some teachers may not have the skillset for incorporating technology at advanced levels is essential to creating a supportive environment where teachers can develop those skills. Teachers have found that ongoing job-embedded professional development that is tailored to meet the specific needs of a school more effective than school/district-mandated professional development (McKnight et al., 2016). In earlier studies, similar findings have indicated that when teachers engage in school level targeted professional development based on specific needs, they are more likely to buy-into system-level change designed to improve student learning outcome (Glassett & Schrum, 2009; Levin & Schrum, 2013; Ruggiero & Mong, 2015).

Technology integration practices, pedagogy, preparation to incorporate technology, and the implementation of technology at different levels are often misaligned in school systems (Ruggiero & Mong, 2015). This misalignment is a result of external barriers such as limited job-embedded technology training and limited access to technology, which hinders teachers' use of technology within the classroom (Ruggiero & Mong, 2015). Therefore, professional development should be redesigned to focus on the successful implementation of technology in the 21st-century classroom (Ruggiero & Mong, 2015). Findings from a similar study indicated that factors such as lack of technology targeted professional development engendered frustration in teachers which deterred them from effectively integrating technology in their practice (Minshew & Anderson, 2015). Lack of professional development to enhance teachers' technology skills and knowledge and inadequate technology in the classroom affect the successful integration of technology in the teaching and learning process (Kalonde, 2017).

Learner-Centered Approach & Technology

Incorporating technology into instruction requires a shift in the traditional roles of teachers and students. Technology gives students access to a myriad of resources and information that would have been otherwise dispensed by teachers in a relatively passive classroom setting. The integration of technology at advanced levels within the classroom reduces students' dependence on the teacher as the sole dispenser of knowledge (McKnight et al. 2016). This shift in the roles is a characteristic of the transformative use of technology in instructional practices (Glassett & Schrum, 2009 as cited by McKnight et al. 2016). In a mixed-method study to explore the types of technology that teachers use in the classroom and how technology is used to improve student learning (Ruggiero & Mong, 2015). The researchers found that teachers who fostered learner-centered approaches were more likely to incorporate technology into their instructional practices (Ruggiero & Mong, 2015).

The 21^{st}-century has rendered traditional teaching methods of stand and deliver, and paper-pencil, obsolete. This has been propelled by advancement in digital technology and the increased use of the internet to access information. As a result, there needs to be a paradigm shift into how technology is incorporated into the teaching-learning process to effectively spark students' interest and curiosity, engage learners, and meet the overall needs of students in this digital era (Lalima & Dangwal, 2017). Therefore, providing technology integrated learning opportunities for students has the potential to positively influence student learning while cultivating 21^{st}-century skills. One primary 21^{st}-century skill is collaboration which can be cultivated in a learner-centered classroom (McKnight et al. 2016). When technology is incorporated in learner-centered classrooms, students are given opportunities to collaborate with other learners which allows them to construct knowledge through the use of technology (Gyamfi & Gyaase, 2015). Learner-centered approaches such as blended learning and project-based learning facilitates synchronous and asynchronous learning which fosters collaboration, communication, critical-thinking, and synchronous higher-level cognitive activities (Longo, 2016). Additionally, these models provide opportunities for teachers to differentiate instructions to address the diverse learning styles of students to improve student learning outcomes (Longo, 2016). Findings from similar studies indicate that the integration of technology into instructional practices has the potential to enhance student engagement, stimulate student interest, and broaden students understanding of more challenging concepts (Machado & Laverick, 2015; Murphy, 2016; McKnight et al., 2016). Thereby, having a positive influence on student learning outcomes.

Technology and Instruction

The exponential growth of technology and ease of accessing information has created a paradigm shift in the teaching and learning process and has challenged traditional pedagogical practices (Donnelly & Kyei-Blankson, 2015). Also, the use of technology in the classroom has the potential to deepen students' understanding (Ianos & Oproiu, 2018). Technology integration provides teachers with alternative ways to engage learners. According to Ianos and Oproiu (2018), technology "offers the teacher many possibilities to ease teaching, which becomes more attractive and interesting for students" (p. 58).

Though technology integration into the curriculum has gained much traction in the last decade; schools need to streamline instructional strategies for technology integration (McKnight et al., 2016). Thus, developing and adopting an instructional model for integrating technology into instructional practice is essential to a systemwide change (Kihoza et al., 2016; McKnight et al., 2016). Additionally, teachers need to be trained in how to use technology to transform student learning (Ianos & Oproiu, 2018; Minshew & Anderson, 2015). Moving from a didactic approach to teaching is essential in preparing students to meet the demands of the 21st century. Hence, there must be a paradigm shift in how educators engage learners. It is vital that educators purposefully augment their pedagogical perspectives in order to adopt novel instructional approaches that effectively equip learners with 21st-centuty skills (Jacobs, 2010). Thus, educators are obligated to prepare students with skills needed to effectively function in a society where being successful requires the ability to compete and cooperate on a global scale (Jacobs, 2010).

Nganga and Kambutu (2017) provided an international perspective on 21st-century learning and instruction by conducting qualitative research to gain insight into how teachers are prepared to meet the demands of the global society in which technology use and access to technology continue to increase (Nganga & Kambutu, 2017). Global trends and the ubiquity of technology has impelled educational reform worldwide, to incorporate technology as an integral component of instruction (Nganga & Kambutu, 2017). Educators tend to employ a behaviorist approach to teaching, in which teacher-centered pedagogy is used to instruct students (Nganga & Kambutu, 2017). This approach is not valuable in a global era because students need to learn 21st-century skills such as collaboration, critical thinking, and problem-solving which are not mastered in a teacher-centered classroom (Nganga & Kambutu, 2017). Similarly, Smith (2014), noted that, in an era where 21st-century competencies have impelled schools to change the way students are educated, it is vital that educators model using digital technology where students have the opportunity to communicate and collaborate with their peers inside and outside of the classroom.

Using the face-to-face environment as the only mode of collaboration does not provide rich opportunities for students to engage in learning at a deeper level (Smith, 2014). The face-to-face only model of collaboration is far outdated in an era where students are constantly engaging in virtual environments through social media and other technologies. Smith (2014) posited that the growth in technology and the popularity of web-based activities have rendered skill-based learning and activities to become obsolete. Similarly, Dede (2014) found that educators can make an authentic shift towards more in-depth learning by reinventing their teaching tools to create new types of instructional environments in which students have the opportunity to use both online and hybrid educational environments. Therefore, technology must be implemented with efficacy and fidelity to positively influence student learning. The effective implementation of technology is contingent on factors such as educators' knowledge and willingness to incorporate technology as a learning tool, school infrastructure to support the use of technology, and student access to technology outside of school (Lalima & Dangwal, 2017).

Benefits of Technology

Researchers have highlighted several benefits to technology integration. McKnight et al. (2016) noted that incorporating technology has the potential to differentiate and individualize instruction to meet the diverse learning needs of students. In a mixed-method research involving 7 schools, the researchers found that technology provided the opportunity for students to work at their own pace and level on the same activity (McKnight et al., 2016). Findings also indicated that technology increased the likelihood of participation from students who are introverts (McKnight et al., 2016). Similarly, Cox (2019) noted that technology has the potential to enhance student participation. The researcher found that technology integration has the potential to reduce and, in some instances, alleviate the anxiety that may be associated with whole class verbal discussions (Cox, 2019). Incorporating technology into instructional practice cultivates a safe learning environment in which students feel more comfortable participating; thereby, increasing student engagement and transforming student learning (Latulippe, 2016). Additionally, in a study involving 7 schools, the researcher found that technology use in assessment helped students with attention issues to focus when test items were presented individually (McKnight et al., 2016).

Studies have shown that technology integration has the potential to positively influence the engagement and focus of students with learning challenges. Fabian, Topping, and Barron (2018) noted that digital technology supports students with disabilities by providing equal access and opportunity to learn materials at a similar level as their peers. The researcher noted that the use of digital technology such as iPads as assistive technology for students with disabilities has benefits such as easy access to reading and mathematics applications, talk to text features, and communication applications that can improve engagement and focus of students with disabilities (Fabian et al., 2018). Similarly, in a study across seven schools conducted by McKnight et al. (2016), it was found that students on the autism spectrum were able to remain on task for longer when using technology. Findings also indicated that technology allowed teachers to individualize learning for students with learning disabilities (McKnight et al., 2016). Technology integration can modify and redefine the learning experience for students, particularly students with special needs (McKnight et al., 2016).

Technology integration is fostered in a learner-centered classroom where the teacher is not seen as the primary disseminator of information. Allowing students to become more autonomous learners who take control of their learning process is essential in improving student engagement and transforming the learning process (Cullen et al., 2012; McKnight et al., 2016). Technology integration such as the use of blogs, discussion boards, and *Google Docs* provides the opportunity for students to communicate and collaborate with their peers who are studying similar concepts (McKnight et al., 2016). When technology allows for a functional redesign of instructional practices or for the creation of tasks that can only be completed with digital technology (Puentedura, 2006), students are given the unique opportunity to collaborate and interact with peers and receive immediate feedback McKnight et al., 2016). Research indicates that collaboration and immediate feedback improves student learning outcomes (Cox, 2019; Eyyam & Yaratan, 2014; McKnight et al. 2016).

Ekmekci and Gulacar (2015) used a case study methodology to compare the effectiveness of digital-based instructional activities and hands-on learning activities. The researchers found that students who were engaged in hands-on activities were more collaborative than those using digital technology (Ekmekci & Gulacar, 2015). Additionally, the researchers noted that a combination of digital-based instructions and hands-on activities are effective strategies, and should be considered in instructional practices (Ekmekci & Gulacar, 2015).

The Technology and Pedagogical Content Knowledge Framework

The TPACK framework for the use of technology in instructional practice (Mishra & Koehler, 2006), represents a paradigm shift in how educators teach and learn with technology (Wetzel & Marshall, 2012). This framework adds a technology domain to Shulman's (1986) pedagogical content knowledge framework (Swallow & Olofson, 2017). TPACK was developed to help educators with technology integration (Mishra & Koehler, 2006). The framework represents the intersection of pedagogical knowledge, content knowledge, and technological knowledge which are essential to effective technology integration (Mishra & Koehler, 2006). The efficacy of technology integration in the classroom is based on the process of implementation using pedagogical content knowledge (Swallow & Olofson, 2017). The TPACK framework recognizes that technology integration is not a single universal approach but rather educators must gauge how technology integration can transform student engagement and learning (Mishra & Koehler, 2006; Swallow & Olofson, 2017).

Mathematics Achievement and Technology

According to Shieh and Yu (2016), in an era where access to information is growing exponentially the integration of technology into traditional teaching methods can positively influence student learning, achievement, and learning retention. The researchers found that in students who were taught using technology integrated instructions outperformed their peers who were taught using traditional instructional methods such as direct instruction (Shieh & Yu, 2016). Additionally, students with technology integrated instruction had better sensory memory and long-term retention (Shieh & Yu, 2016). In a meta-analysis on the effects of technology in mathematics on achievement, the researchers found that technology integration can maximize student learning (Higgins et al., 2019). Similarly, the technology principle of the National Council of Teachers of Mathematics (NCTM; 2016) states that ‘‘technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances student learning’’ (p. 24). In the meta-analysis, Higgins et al. (2019), highlighted the studies that found that incorporating technology into math instruction fostered engagement, improved student motivation, and improved student achievement and performance in mathematics (Barron, Ivers, Lilavois, & Wells, 2006; Mulcahy, Maccini, Wright, & Miller, 2014). Similarly, in a randomized controlled experiment conducted by Roschelle Feng, Murphy, and Mason (2016), it was found that that there was a strong positive correlation between educational technology intervention and students' standardized mathematics test scores. The researchers noted the correlation was particularly evident among students who previously had low mathematics achievement scores (Roschelle et al., 2016).

The integration of technology into mathematics instruction provides the opportunity for teachers to represent information in different modes (Higgins et al., 2019). For instance, instead of direct instructions, teachers may incorporate mathematics technology tools such as GeoGebra and Desmos to augment learners' understanding of math concepts. Studies have shown that using technology at an advanced level promotes critical thinking, increases retention, and provides the opportunity for students to engage in real-world problem solving (Bitter & Pierson, 2005; Cemal Nat, Walker, Bacon, Dastbaz, & Flynn, 2011; Wiske et al., 2005 as cited by Higgins et al., 2019).

In a quasi-experimental quantitative study on using technology to support mathematical explanation, the researchers used pre-test and post-test data to investigate the impact of technology on students' conceptual and procedural knowledge (Stoyle & Morris, 2017). The researchers found that students who used technology to engage in mathematical discourse via blogs outperformed their peers who did not use technology on post-tests (Stoyle & Morris, 2017). The researchers also found that when students were given a delayed post-test, the students who were exposed to technology showed greater retention of the concepts being assessed (Stoyle & Morris, 2017). Therefore, the students who used technology at an advanced level demonstrated the greatest gains in conceptual knowledge (Stoyle & Morris, 2017). In a similar study, Genlott and Gronlund (2016), found that technology tools that provided the opportunity for students to collaborate and receive real-time feedback improved student learning in literacy and mathematics.

In a cumulative meta-analysis of 30 years of research on the effects of technology on student achievement, Young (2017) found that technology integration into math instruction has the potential to positively influence student achievement. The researcher found that technology provides the opportunity for problem-solving skills and conceptual understanding of mathematics concepts to be strengthened through learner engagement and creativity (Young, 2017). Earlier studies agree with Young's (2017) findings on the effect of technology on mathematics instruction and achievement. Stohl-Lee, Hollenbrands, and Holt-Wilson (2010) noted that technology provides the opportunity for students to reorganize and deepen their conceptual understanding by fostering higher-order thinking. Similarly, Hodges and Conner (2011) asserted that technology integration influences how students reason through math concepts and engage in mathematical discourse. According to Young (2017), deepening conceptual understanding, higher-order thinking, and student engagement are promoted in technology-enhanced mathematics instruction, which improves student math achievement.

Implications

This project examined how middle school mathematics teachers at a PreK- 8 independent school in Denver, Colorado use technology-integrated instruction to engage students in a transformative learning experience in mathematics. The administrators at the school are concerned that teachers are using technology primarily as a substitute for traditional practices. Using technology to modify and redefine instructional practices has the potential to transform student learning (Puentedura, 2014). However, teachers should be trained in how to use technology to transform student learning and increase student-learning outcomes. There must be a paradigm shift in how teachers use technology in the learning environment (Wetzel & Marshall, 2012).

The increasing use of technology and the opportunities that technology provides such as greater access to materials has rendered traditional stand and deliver methods of teaching, obsolete (Cullen, Harris, & Hill, 2012). Therefore, student-centered learning that embraces 21st-century competencies must embark on augmenting student understanding, increase, engagement, and engender critical thinking. This implies that there needs to be a paradigm shift in the traditional roles of the teacher and the student. This research has the potential to engender social changes by providing recommendations for system-wide changes geared towards empowering students to take ownership of their learning, become actively engaged learners, and become creative thinkers.

Though digital technology is used in the classroom, it is frequently used as a tool to enhance rather than optimize learning (Puentedura, 2006). Thus, technology is used at the substitution and augmentation levels of the SAMR technology model (Puentedura, 2006). When technology is used at the lower levels of the SAMR technology model, it acts as an alternative for teaching and learning with little or no functional change (Puentedura, 2006). However, when technology is used to modify and redefine the teaching and learning it harnesses 21st-century skills such as critical thinking, collaboration, and communication. Using technology that allows for the significant redesign of tasks and for the creation of a new task that cannot be done without technology provides the unique opportunity for students to explore mathematical concepts beyond the classroom which increases students' access to information and ideas; enhances collaboration and communication; and fosters critical thinking (NCTM, 2016). This implies that educators must endeavor to use technology at the modification and redefinition levels of the SAMR technology model (Puentedura, 2006) to transform student learning. This change in practice will engender positive social change by providing the opportunity for greater student achievement in mathematics.

Though technology integration has the potential to increase student engagement and motivation (Cox, 2019; Huang, Yang, Chiang, & Su, 2016; McKnight et al., 2016). Technology also has the potential to distract learners (Dietrich & Balli, 2014). Therefore, the onus is on educators to monitor the proper use of technology within the classroom. This implies that school systems that are committed to integrating technology as a tool to transform the teaching and learning process must provide teachers with tools and training to monitor the use of technology. Students should also be provided with training on how to use technology as a learning tool.

The problem that exists at the study site is that while digital-based technology is available, it is not being used to engage students in a transformative learning experience in middle grades mathematics classes. Based on the anticipated findings from the analysis of data from interviews, observations, and document analysis, a project was developed with a plan of implementation. To develop teachers' capacity around the use of technology at the modification and redefinition levels of the SAMR model of technology required the development of a systematic job-embedded professional development. According to Bernhardt (2016), continuous, job-embedded professional development fosters learning in educators and school leaders that is paramount ensuring effective collaboration that can positively influence instructional practices. Additionally, I would recommend creating and/or joining professional learning communities (PLCs) to share ideas with other mathematics teachers both within and outside of the school. PLCs augment collective capacity building and strengthens collaboration (Fullan, 2010).

Summary

In section 1, I examined a local problem that exists at a PreK-8 independent school in Denver, Colorado. The problem is that while digital-based technology is available, it is not being used to engage students in a transformative learning experience in middle grades mathematics classes. The SAMR technology model provided the conceptual framework to ground the project study. Semi-structured interviews, teacher observation, and documents were used to collect data on the level at which digital technology is being used in the classroom, and factors that may be keeping middle school mathematics teachers from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms.

The literature illustrated factors such as teacher perception of technology as an instructional tool and professional development influence the integration of technology-enhanced instruction (Heath, 2017; Kalonde, 2017; Minshew & Anderson, 2015). The literature also highlighted the benefits of incorporating technology into the teaching-learning process and the impact of technology on instruction and math achievement. The literature showed that the incorporation of technology into classrooms promotes a learner-centered environment in which students become active and engaged learners (Cullen et al., 2012; Ertme, & Ottenbreit-Leftwich, 2014).

Section 2 of the study examined the methodology that was used to collect data from the participants and the process of data analysis. Semi-structured interviews, observation, and document analysis were used to collect data from participants. Inductive data analysis was used to analyze the data. To ensure credibility, triangulation, member checking, and using peer debriefers, (Toma, 2011 as cited by Ravitch & Carl, 2016), was used. Section 3 of the study focused on the development of a project to address the problem. The project was developed based on the findings from the data analysis. This section comprised of the rationale for the project, review of the literature, project description, project evaluation plan, and implications. Section 4 of the study- reflections and conclusions- examined the strengths and limitations of the project.

Section 2: The Methodology

Introduction

Across the United States, stakeholders in education are concerned with the condition of the education system (McFarland et al., 2017). International assessments indicators such as Trends in International Mathematics and Science Study and Pisa, and national indicators such as the National Assessment of Educational Progress have reported that students in the United States continue to lag behind other developed nations in core academic areas such as mathematics (Bicer & Capraro, 2017; Siegler et al., 2010; Star et al., 2015; Woodward et al., as cited in Higgins et al., 2019). This state of education has led to a move toward incorporating instructional practices designed to engage students and transform the teaching-learning process (McFarland et al., 2017). The integration of technology into mathematics instructional practices is one such instructional practice (Higgins et al., 2019; KewalRamani et al., 2018). However, the problem at the study site is that although digital-based technology is available, it is not being used to engage students in a transformative learning experience in middle grades mathematics classrooms. Therefore, this study was conducted to provide recommendations for the problem at the study site and also guide the development and implementation of a project designed to address the local problem.

Research Design and Approach

A qualitative case study was used as the research design to investigate middle school teachers' use of technology to transform mathematics instruction. This approach was used to gain insight into how teachers currently use technology and what middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. A qualitative research design emphasizes collecting data on naturally occurring phenomena (Babbie, 2017). Therefore, the focus of qualitative research is on generating meaning and understanding through the rich description (Merriam, 2009). The qualitative approach is particularly useful when studying educational problems that require developing an understanding of complex social environments and the meaning that individuals within those environments bring to the experience (Burkholder et al., 2016). Additionally, the primary goal of qualitative research is to understand, describe, and discover meaning (Onwuegbuzie & Leech, as cited in Burkholder et al., 2016).

Qualitative methodology was suitable for this study because this design provided the opportunity to gain in-depth perspectives from individuals on a specific phenomenon (Burkholder et al., 2016), in this case middle school teachers use of technology to transform mathematics instruction. Qualitative methods also transcend strict compliance to a research method and design in that the fidelity of participants and their experiences provides a more holistic description of a central phenomenon (Creswell, 2015; Ravitch & Carl, 2016). Further, qualitative studies are placed in different strata based on the research designs and the primary uses of the research (Creswell, 2015).

A qualitative case study design was used to explore middle school teachers' use of technology to transform mathematics instruction at a PreK–8 independent school in Denver, Colorado: how digital-based technology is used in mathematics instruction and what may be keeping middle school mathematics teachers from using digital-technology initially and/or completely to transform mathematics instruction. A case study design was selected because case studies provide the opportunity for researchers to investigate a central phenomenon through in-depth open-ended questions (Yin, 2013). Additionally, data were collected through different methods: interviews, classroom observations, and documentation, as varied types of data collection methods are required for qualitative case studies to allow for more in-depth significant data (Creswell, 2015). Case study designs are suitable for qualitative researches in which a variety of perspectives are examined through multiple methods (Burkholder et al., 2016). One distinctive feature of a case study design is also the bounded unit (Merriam, 2009). For this case study, semistructured interviews were used to gain data to answer the research questions:

1) How do middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado use digital-based technology as a transformative learning tool in mathematics instruction?
2) What do middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms at a PreK–8 independent school in Denver, Colorado?

Qualitative research designs differ based on three areas: major purpose, unit of analysis, and primary data collection (Burkholder et al., 2016). The major purpose of a case study is to describe the behavior of a bounded unit with a phenomenon (Burkholder et al., 2016, p. 73). Other qualitative research designs did not match the nature and purpose of the study, which was to explore the extent to which middle school mathematics teachers in a PreK–8 independent day school in Denver, Colorado use digital technology as a transformative learning tool in mathematics instruction. For instance, I did not explore the shared culture of a group (Creswell, 2015); therefore, the ethnographic research design was not suitable. Furthermore, in ethnographic designs data are collected through immersion in a culture for an extended period (Burkholder et al., 2016). The study was also not aimed at developing a new theory based on common experiences of participants (Creswell, 2015); therefore, grounded theory research was not a suitable design. Additionally, in grounded theory designs data are gathered through one data collection method: interviews (Burkholder et al., 2016). Further, the purpose of the study was not designed to describe the lives of participants through the exploration of their individual stories (Creswell, 2015); therefore, a narrative research design was ill-suited for the scope and purpose of the study. Finally, the purpose of the study was not to describe themes and patterns of lived experiences across individuals concerning a phenomenon (Burkholder et al., 2016); therefore, a phenomenology design was not suitable. Furthermore, data were collected from different sources on a bounded unit, which is atypical of phenomenological designs that are focused on common experiences collected through interviews (Burkholder et al., 2016).

Participants

Before obtaining data from participants, permission was sought from the administrators at the study site. Permission was also sought from the Walden University Institutional Review Board to conduct the study (approval no. 05-27-20-0417435). The sample for the study comprised of no more than nine middle school mathematics teachers at a PreK–8 independent school in Denver, Colorado. Participants were selected from all grade levels at the middle school. Participants were eligible to participate in the study if they met the following criteria: middle school mathematics teacher at the study site and at least 3 years of teaching experience in the field of mathematics. Qualitative sampling is based on relevance and depth rather than representativeness and breadth (Burkholder et al., 2016). Hence, a small number of participants was selected to provide in-depth data on the phenomenon being studied.

The participants were selected by applying nonprobability purposeful sampling (Ravitch & Carl, 2016). Purposeful sampling provides comprehensive data and details about the specific population and location under investigation and allows researchers to select participants who had experiences with the phenomenon being studied (Ravitch & Carl, 2016). Using purposeful sampling techniques allowed me to select participants who have experience with the central phenomenon being examined (Ravitch & Carl, 2016).

Gaining Access to Participants

To gain access to the participants, a letter was sent to the administrators at the study site seeking permission to conduct the study within the school. Permission was also sought from the Walden University IRB. Prior to collecting data from potential participants, Walden University's IRB gave permission to conduct the project study. A synopsis of the proposed study was discussed with the administrators of the study site. Based on my review of the research proposal, the administrators at the study site granted permission for data to be collected from middle school mathematics teachers.

After permission was granted, I collaborated with the associate director of programs at the study site via e-mail to gain access to the participants. An e-mail was sent to all teachers who qualified as participants for the study. The e-mail provided information about the study as outlined within the IRB formal review. This included the voluntary nature of the study, confidentiality upon participation, my role as researcher, and the purpose of the study as it is included in the consent form (Burkholder et al., 2016). The consent form also covered the potential risks and benefits of participation, the right to withdraw from the study, and a brief explanation the procedures of data collection, including the time and activities required of participants (Burkholder et al., 2016). This included one 30-minute online classroom observation that was used to collect data on the use digital technology as a transformative learning tool in mathematics instruction, most recent unit and accompanying lesson plans, and one 40-60-minute semistructured online interview about their use of digital technology as a transformative learning tool in mathematics instruction and what may be keeping them from using digital-technology initially and/or completely to transform instruction in their mathematics classes. The participants were asked to reply to the e-mail with "I consent" or to attach an electronic signature to the consent form if they felt that they understood the study well enough to decide to participate.

Procedures for Ethical Protection of Participants

Most educational research deals with human subjects; therefore, researchers must understand the legal and ethical ramifications when conducting research. Anyone who is involved in research must be cognizant of the general agreement shared by researchers as it relates to ethical responsibility (Babbie, 2017). The nature of qualitative research, more specifically the researcher's direct contact with participants, will inevitably cause ethical issues to arise (Ravitch & Carl, 2016). Furthermore, the efficacy of qualitative data collection relies on developing rapport or relationship; thus, relations considerations must be framed as ethical issues (Ravitch & Carl, 2016, p. 346). Participants' observations and having participants open up about controversial and personal issues can be intrusive and may spark ethical concerns (Babbie, 2017; Ravitch & Carl, 2016). Thus, qualitative researchers must anticipate eminent ethical issues to prevent harm to human subjects (Burkholder et al., 2016).

Although ethical issues are inherent in qualitative research design, they may be curtailed by adhering to the basic ethical principles—autonomy, beneficence, and justice—established by the U.S. Department of Health and Human Services (n. d.). The nature of qualitative research lends itself to vulnerability because the interviewer may unearth complex, sensitive issues from the participants (Ravitch & Carl, 2016). Therefore, the researcher must maintain research ethics throughout the research process. One ethical issue in the qualitative research process is disclosure. To address this ethical issue, the participants were informed about all aspects of the research. Securing informed consent gives the participant a choice about whether to participate in the interview process or not (Burkholder et al., 2016). Additionally, to ensure that participants' responses are protected, confidentiality and anonymity were established and maintained throughout the research process (Burkholder et al., 2016).

E-mails were used to arrange times for online class observations and virtual semistructured interviews with individual participants. I explained the details of the project study, confidentiality measures in place for the study, and the risks and benefits of participation. Additionally, I explained that participants' names would be coded in the research study to ensure privacy and protect their identity. Participants were also informed that I would be the only person with access to the coding system that will be stored on my password-protected personal computer. Prior to the meeting, participants received a formal consent form via e-mail. Each participant volunteered to participate in the study by replying "I consent" to the formal consent form that was sent via e-mail. Participants were asked to keep a copy of the consent form for their records.

Interviews were conducted and recorded online via Google Meets using my personal computer. The semistructured interviews were transcribed and coded into a Microsoft Word document on my password-protected personal computer. These codes were used to form broad themes found in the literature review (Merriam, 2009). Member checks were used to confirm draft results for the viability of the setting and accuracy of the researcher's interpretation of their data used in the findings (Creswell, 2012; Merriam, 2009). Draft results were e-mailed to each participant for them to review the viability in the setting and accuracy of their data used in the final data findings. A brief online meeting was available for each participant if they chose to discuss the draft results with me. None of the participants chose to discuss the results in a private meeting. All data were stored in a secure file on my personal computer that was kept in a secure location at the researcher's residence.

Data Collection

The qualitative case study provided the opportunity for individuals to be studied in their natural setting and to understand or interpret phenomena based on the meanings people attach to them (Denzin & Lincoln, 2013). The nature of knowledge, epistemology, makes it essential that qualitative investigations are conducted in individuals' natural settings (Creswell, as cited in Ravitch & Carl, 2016). Additionally, the ontological assumption of qualitative research is that interactions of individuals engender multiple truths, making truth a subjective concept that is based on an individual's experiences (Burkholder et al., 2016). This qualitative study provided the opportunity for the participants to describe the extent to which digital technology was used as a transformative learning tool in mathematics instruction and factors that may be hindering the use of digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms.

Data were collected from nine middle school mathematics teachers (Grades 6–8) at the study site. Data were collected through semistructured interviews, classroom observations, and document analysis such as unit and lesson plans. Collecting data through a variety of methods (i.e., triangulation) establishes the validity and credibility of qualitative research (Ravitch & Carl, 2016). Furthermore, to enhance the credibility of data, case studies require different types of data collection methods which allowed the researcher to gather more meaningful data (Creswell, 2015).

Semistructured Interviews

Interviews are the primary method of collecting in-depth rich qualitative data (Ravitch & Carl, 2016). The main goals of interviewing are to gain in-depth insight into participants' lived experiences, understand how participants perceive the phenomenon being studied, and explore how participants' experiences relate to others (Ravitch & Carl, 2016). Semistructured interviews are one of the most impactful means by which researchers endeavor to understand participants (Fontana & Frey, as cited in Creswell, 2015). Individual semistructured interviews provide a more secure environment in which participants feel comfortable and safe to share (Rubin & Rubin, 2012). Semistructured interviews allow the researcher to get more in-depth information about how respondents feel and think about a phenomenon; therefore, the researcher must establish an atmosphere of trust and respect to obtain accurate information (Ravitch & Carl, 2016). Nine semistructured interviews were conducted using Google Meets. Each interview lasted between 45–60 minutes.

Gaining salient and adequate information from participants requires questioning techniques that can engage participants in discussion (Ravitch & Carl, 2016). Therefore, open-ended questions were used to gain detailed information from participants. Open-ended questions provided the opportunity for interviewees to respond in different ways, expound on answers, and/or bring up new issues (Rubin & Rubin, 2012). In addition to effective questioning techniques and balancing rapport and neutrality, participants were provided with explicit explanations and information on how the interview will proceed (Burkholder et al.,2016). To gain deeper insight into the phenomenon being examined, individual semistructured interviews, containing five anchor questions, were used to collect qualitative data from each middle school mathematics teacher at the study site:

1. How comfortable are you with using technology in your classroom?
2. Can you provide examples of how you incorporate technology into your mathematics instruction?
3. What are your views on digital technology as an instructional tool?
4. What supports and encourages the use of technology inside the classroom?
5. What barriers that may be keeping you from using digital-technology initially and/or completely in classrooms, beyond substituting and/or augmenting traditional methods?

To gain in-depth information from participants in an interview requires establishing a professional rapport and trust (Rubin & Rubin, 2012). The participants were provided with a clear outline of the goals and purpose of the study, specific information about the sample, the interview process, and how the information will be used. The participants were also given adequate information on how the interview will proceed. Providing a space in which participants feel comfortable and safe to share, is key to gaining good qualitative data (Ravitch & Carl, 2016). Thus, the participants were interviewed virtually using an online platform of their choice. The platforms that were offered were Zoom, Google, and Skype. All the participants opted to be interviewed through the Google virtual platform via Google Meets.

Being professional is an essential characteristic of a good qualitative interview. Therefore, preparation before the interview process was essential. To prepare for the interview participants were contacted via telephone to discuss the interview process. An interview guide was used to ensure that the participants were given sufficient time to answer research and the 5 anchor questions. Each interview was conducted in an online setting for 40 – 60 minutes. During the interviews, a guide was used to ensure that as much information as possible was collected. According to Rubin and Rubin (2012), using a guide ensured that the discussion was focused on the phenomenon being studied and that the interviewees provided as much information as possible. After the interviews are completed, the data were secured and coded to protect the participants. To ensure accuracy, each interview was recorded and carefully transcribed (Rubin & Rubin, 2012).

Observation and Fieldnotes

Data were also be collected by observing the nine participants live online *Google* classes. Each observation lasted for no more than 30 minutes. During the observation, detailed field notes were taken to answer the research question on the extent to which middle school mathematics teachers use digital-based technology as a transformative learning tool in mathematics instruction. According to Ravitch and Carl (2016), observations and fieldnotes enable researchers to directly see and record data on participants in their natural setting. Thereby, providing the opportunity for researchers to directly explore and describe attitudes, behaviors, beliefs, and interactions (Ravitch & Carl, 2016). An observation checklist was also used to determine the level at which technology was being used in the lessons based on the SAMR model of technology integration.

Document Analysis

Document analysis was used to collect data to address the research questions. According to Rubin and Rubin (2012), document analysis involves examining documents that may appear in writing form, pictures, and visual recordings. Document analysis is most effective when used in tandem with interviews since the opportunity is provided for participants to expound on how the use and purpose of the documents (Rubin & Rubin, 2012). For this project study, lesson and unit plans were used as documents to collect data on middle school mathematics teachers' use of technology. I collected lesson and unit plans from each of the nine participants. Those documents were shared with me via *Google* and emails.

After all the data were collected from online class observations, virtual semi-structured interviews, and document analysis, the information was coded to identify patterns and themes. The semi-structured interview data were securely stored on the researcher's personal password-protected computer. A coding system was developed to ensure the anonymity of participants. The coding system was stored on the researcher's personal computer that is password protected. Additionally, the coding system can only be accessed by the researcher.

Data Analysis

In qualitative research methodology, data are gathered on naturally occurring phenomena (Ravitch & Carl, 2016). The data that are collected are typically in the form of words rather than numbers. Therefore, the researcher must explore a variety of data collection methods to ensure that the method that is selected is aligned with other components of the study, particularly the research questions (Ravitch & Carl, 2016). Additionally, qualitative researchers must ensure that the selected data collection method will engender participants' engagement and maximize the amount of information that is gathered on the topic being studied (Saldaña, 2016).

Data collected from lesson and unit plans were reviewed to identify patterns and themes (Burkholder et al., 2016). The data were collected through interviews and observations were coded to assign meaning to the qualitative data (Ravitch & Carl, 2016). Coding is the process by which researchers use recognizable patterns to organize qualitative data (Burkholder et al., 2016). The coding of qualitative data involves deriving themes and assigning labels to categories (Benaquisto, 2008 as cited by Burkholder et al., 2016). Once codes were established, thematic clustering was employed to reassemble pieces of data into coding categories (Ravitch & Carl, 2016). Coding is the initial phase of organizing raw qualitative data (Saldaña, 2016). Coding then led to categorizing the data based on common features, attributes, and/or elements (Saldaña, 2016). After placing the coded data into categories, the data were further analyzed to deduce a common theme (Saldaña, 2016). The process of coding the data the "essence of the inductive form of qualitative data analysis, where findings emerge out of the data" (Schoch, 2016 as cited by Burkholder et al., 2016, p. 237). Therefore, inductive analysis was used to analyze data and gain a deeper understanding of the phenomenon being investigated.

In qualitative research methodology, the data collection and analysis process is iterative and recursive (Ravitch & Carl, 2016). Additionally, the process of data analysis requires the triangulation of data (Burkholder et al., 2016), to get a more comprehensive view of the phenomenon being studied (Ravitch & Carl, 2016). Effectively managing and organizing data is essential to the analysis of data in the qualitative case study research process. According to Cope (2014), organizing, managing, and keeping track of data enhances the credibility and trustworthiness of the study. For this research, I used a three-pronged data analysis process (Ravitch & Carl, 2016). This process involved consistently organizing and precoding data, developing written representations of data and engaging in the process of coding the data to generate themes (Ravitch & Carl, 2016).

Semistructured Interviews

Virtual semi-structured interviews were recorded and transcribed after each interview was completed. Additional notes from the interview were also written to ensure that details were captured from each response. I took notes during digitally recorded interviews to ensure that salient information was not missed during the interview. Notes were also taken to provide me with the opportunity to write probing questions that were used as the interview progressed (Rubin & Rubin, 2012).

After data were collected through semi-interviews, the data were coded to assign meaning to the information (Ravitch & Carl, 2016). The coding process gives meaning to the qualitative data that has been collected from different data sources (Saldaña, 2016). The process involves deriving a word or a short phrase that embodies the salient attribute of language or data that have been collected throughout the research process (Saldaña, 2016). Open coding was used to assign labels to categories and derive themes from the raw data that was collected from observations, semi-structured interviews, and document analysis (Benaquisto, 2008 as cited by Burkholder et al., 2016). Once codes were established, thematic coding was done to reorganize segments of qualitative data into coding categories (Miles et al., 2014 as cited by Ravitch & Carl, 2016). The final step in the coding process involved developing common themes based on the findings. Rubin and Rubin (2012) describe themes as "summary statements, causal explanations, or conclusions" (p.194). Themes explain the cause of the occurrence of a phenomenon, the interviewee's perceptions about the phenomenon, and the relationship between concepts (Rubin & Rubin, 2012).

Classroom Observations

Data were collected by observing each participant's online classes for 30 minutes, to determine the level at which participants integrated technology based on the SAMR model of technology integration. The classroom observations were recorded and saved using the *Google* platform. The classroom observations were aimed at answering the research question on middle school mathematics teachers use of digital-based technology as a transformative learning tool in mathematics instruction. Observational fieldnotes were taken to capture information that was relevant to the purpose of the study (Ravitch & Carl, 2016). Jottings were taken while the online classes were being observed. The jottings were transcribed into more cogent written accounts of what was being observed in the classroom (Emerson, Fretz, & Shaw, 2011) in relation to the use of technology.

The observation and field notes were analyzed to determine if the technology was being used to enhance learning or if the technology was being used as a transformational learning tool. Therefore, the data were analyzed based on the enhancement and transformational thresholds of the SAMR model of technology integration. Subsequently, the observation and fieldnotes data were categorized (Merriam, 2009) based on the four levels of the SAMR model of technology integration.

Document Analysis

Lesson plans and unit plans of the nine participants were analyzed to determine if technology was being incorporated into mathematics instructions. If technology was being used, the documents were also analyzed to determine the level at which technology was being used in the teaching-learning process based on the SAMR model of technology integration. The SAMR model of technology was used as the rubric to determine if lessons and units were planned using technology at the substitution, augmentation, modification, or redefinition level. The documents that were collected from the participants were saved in Google documents. The existing participant documents provided insight into the use of digital technology over a period of three months and allowed the researcher to understand the phenomenon being studied (Patton, 2015; Ravitch & Carl, 2016).

The purpose of this qualitative case study was to explore the extent to which middle school mathematics teachers in a PreK – 8 independent day school in Denver, Colorado use digital technology as a transformative learning tool in mathematics instruction. Data were collected from semi-structured interviews, observations and field notes, and document analysis. Each data source was organized and coded to examine mathematics teachers' use of technology as a tool to transform instructions based on the SAMR model of technology integration. Assigning consistent codes to the data from the three sources increased the dependability of the data (Ravitch & Carl, 2016). Data analysis also explored the factors that were impeding participants from using technology at the modification and redefinition levels of the SAMR model, to transform mathematics instruction in the classroom. A three-pronged data analysis process was used to ensure that the emerging themes from the data were aligned to the conceptual framework, SAMR model of technology integration. Inductive analysis was used to transform the raw data into smaller manageable tables (Ravitch & Carl, 2016). Additionally, inductive analysis provided the opportunity for the researcher to establish an explicit connection between the data and the purpose of the study (Creswell, 2015). The culminating data analysis of semi-structured interviews, classroom observations, and document analysis were coded to identify the major themes (Saldaña, 2016). The major themes were reported based on the research questions that grounded the qualitative case study.

Credibility and Validity of Findings

In quantitative research, internal validity affirms that the data that is collected is aligned with the research questions (Burkholder et al., 2016). Credibility in qualitative is similar to internal validity, it refers to the truth of the data or the participant's perspectives and the interpretation and representation of the data by the researcher (Polit & Beck, 2012 as cited by Cope, 2014). To ensure the credibility of a study, the researcher must ensure that the findings of the study are believable based on the data presented (Merriam, 2009). Credibility can be established through triangulation, member checking, presenting a thick description, discussing negative cases, having prolonged engagement in the field, using peer debriefers, and/or having an external auditor (Toma, 2011 as cited by Ravitch & Carl, 2016, p. 189). For this study, credibility was established through triangulation and member checking.

According to Cope (2014), credibility and trustworthiness may be enhanced through methods triangulation to gain a holistic view of the phenomenon being studied. Triangulation refers to the process by which data is collected through a variety of methods: observation, focus group, and individual interviews (Shenton, 2004). Triangulation may also be achieved by using a wide range of participants (Shenton, 2004). Therefore, using different data collection methods: observation and field notes, semi-structured interviews, throughout the process enhanced the credibility of qualitative research (Cope, 2014). Member checking provided the opportunity for participants to review and confirm interview transcripts, examine data, and provide feedback about the data and conclusions (Merriam, 2009).

Qualitative research design emphasizes collecting data on naturally occurring phenomena (Ravitch & Carl, 2016). The unified, flexible, and evolving nature of qualitative research can pose a dilemma when selecting the criteria for evaluating the quality of qualitative research design (Northcote, 2012). Whereas in quantitative research the criteria used to measure quality is based on the validity and reliability instrument construction (Golafshani, 2003); the quality of qualitative research depends on trustworthiness (validity); and reliability which incorporates dependability, transferability, reflexivity, and reliability (Stewart & Hitchcock, 2016 as cited by Burkholder et al., 2016). To ensure trustworthiness of the research process, it is vital that the initial components of the study: the purpose and design of the study, are aligned and supported by relevant sources (Stewart & Hitchcock, 2016 as cited by Burkholder et al., 2016). To ensure the credibility of qualitative research, the researcher must be transparent about the research process, the goals, and expectations (Ravitch & Carl, 2016). Transparency is also vital to establishing validity in qualitative research (Ravitch & Carl, 2016).

Summary

In the methodology section, qualitative case study was identified as the appropriate design to gain insight into middle school mathematics teachers' use of technology to transform mathematics instruction. Prior to collecting data, permission was sought from the administrators at the study site and from the Walden University IRB. Due to state-mandated lockdown stipulations that resulted from the COVID 19 pandemic, data were collected virtually through semi-structured interviews, classroom observations, and document analysis. The credibility of findings was established through triangulation and member checking. Data from interviews, classroom observations, and document analysis were coded to develop overarching themes. The SAMR model of technology was used as the conceptual framework to ground the study and examine the level at which middle school mathematics teachers use technology in their instructional practice. Findings from the study were used to answer the research questions about the level at which teachers use technology and factors that they may be preventing teachers from using technology to transform mathematics instruction. This research has the potential to effect positive social change by providing recommendations for system-wide changes geared towards empowering students to take ownership of their learning, become actively engaged learners, and become creative thinkers.

Data Analysis Results

The qualitative case study examined middle school teachers use of technology to transform mathematics instruction. Two research questions were used to gain insight into middle school mathematics teachers' use of digital-based technology as a transformative learning tool in mathematics instruction, and what middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. The results from the study addressed the two research questions by highlighting the participants' use of technology based on the levels of the SAMR model of technology. The data collected through virtual semi-structured interviews, observations, and document analysis were analyzed through the qualitative case study strategy of inductive analysis. Inductive data analysis allowed the researcher to gain insight into the participants' view of the phenomenon by providing the opportunity for the participants to describe their authentic experience with the phenomenon being investigated (Ravitch & Carl, 2016).

During the virtual classroom observations, the nine participants were observed presenting their lessons through Google Slides in their Google Classroom. The students were observed joining the class while the teacher presented the lesson by using the present function in Google Classroom. The teachers were also observed recording the lesson to upload into their classrooms to facilitate asynchronous learning. It was observed that students participated in the lessons by responding to questions orally or by writing the answers using the chat function in Google Classroom. Teachers also used videos to further enhance student learning. In class, the students were observed playing a game of Kahoot to review for a unit test. All lessons, assignments, and assessments were completed online using the Google platform. Document analysis showed that lesson and unit plans had a technology component. The documents illustrated the participants' list of use of technology which included SmartBoard technology, iPads, laptops, and Google Classroom. The participants did not specify how technology will be used during their lessons.

During virtual semi-structured interviews, the participants described their use of technology as primarily a substitute for traditional teaching methods as a way to enhance the teaching-learning process. The participants noted that their use of technology was limited to assessments, presenting lessons via PowerPoint or keynote, and quick feedback during games such as Kahoot. The participants asserted that challenges to using technology include insufficient technology training, lack of curriculum integration, and classroom management.

Teacher Profiles

I collected data from nine middle school mathematics teachers at a PreK-8 independent school in Denver, Colorado. The participants are all mathematics educators who have been in the classroom for at least five years. All the participants have been employed at the study site for at least four years. Two of the teachers also work as the mathematics interventionist for the middle school. To assist with the development of this qualitative case study, an overview of the participants will be provided. Pseudonyms were used to represent the name of each participant.

Table 1

Teacher Profiles

Participants	Experience Teaching Middle School Math	Years at the Study Site	Technology Training
Aaron	Over 20 years	Over 20 years	One-time technology training.
Becky	10 years	5 years	One-time technology training
Camden	7 years	9 years	Intermediate technology training
Dean	8 years	8 years	One-time technology training
Evelyn	5 years	5 years	Advanced technology training
Francisca	15 years	10 years	One-time technology training
Gloria	25 years	17 years	No formal technology training
Harry	6 years	6 years	Advanced technology training
Janet	5years	18 years	No formal technology training

The participants expressed interest in using digital technology as a transformative learning tool rather than just using technology to enhance their instruction. The participants had a positive view of digital technology as an instructional tool. Most of the participants noted that they were comfortable with using digital technology in their lessons. However, participants claimed that little to no technology training precludes that from using digital technology at a more advanced level based on the SAMR model of technology. Six participants stated that a lack of curricular integration is another factor that prevents them from incorporating technology into their instructional practice. The use of digital technology is perceived as an additional task instead of being connected to what is being taught in the curriculum. A few of the participants feared that the incorporation of digital technology into their instructional practice at a more advanced level based on the SAMR model of technology will result in loss of class control.

The study focused on middle school mathematics teachers' current use of technology and factors that may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. During the data analysis, data that were collected were coded into board themes based on the two research questions. The themes were organized based on the research questions. Two major themes: technology as an enhancement and technology as a transformative instructional tool, emerged from research question #1. Three major themes: professional development/training, distractions, and lack of curriculum integration emerged from research question #2.

Research Question # 1

How do middle school mathematics teachers in a PreK – 8 independent day school in Denver, Colorado use digital-based technology as a transformative learning tool in mathematics instruction? Research question 1 sought to gain insight into middle school mathematics teachers' use of technology based on the hierarchical SAMR model of technology integration to determine the level at which teachers use technology in their instructional practices. Data for research question # 1 were collected from virtual classroom observations, lesson and unit plans, and online semi-structured interviews. The categories of technology integration that emerged from data were that technology was used at the substitution, augmentation, modification, and redefinition levels of the SAMR model of technology (see Figure 3). The categories were then arranged into the major themes of using technology to enhance instruction and using technology to transform instruction.

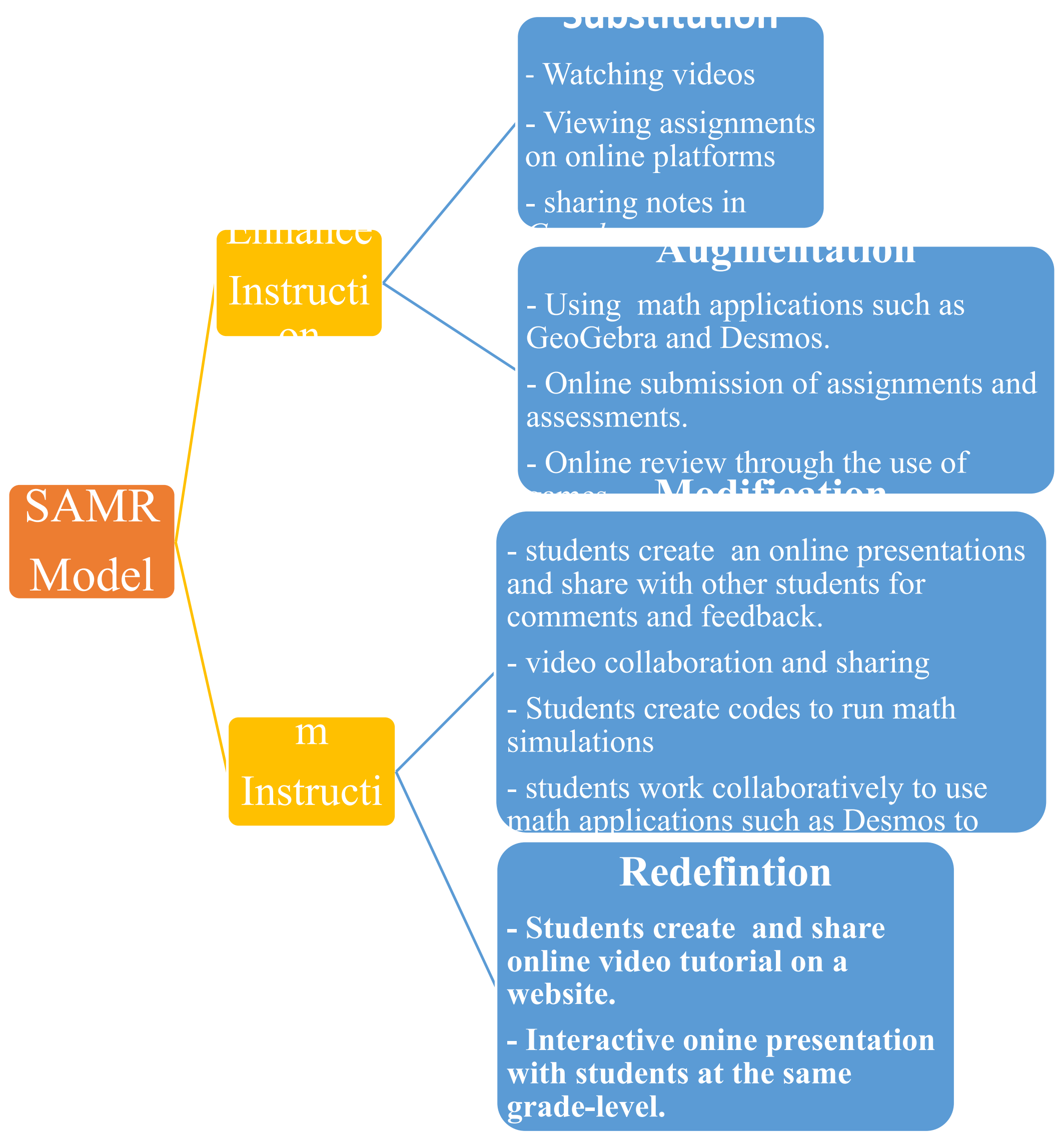

Figure 3. SAMR level of mathematics activities.

Technology as an enhancement tool. The first major theme that emerged from research question #1, which sought to gain insight into the use of technology as a transformative instructional tool, found that all the participants used technology to enhance the teaching-learning process. All the participants were actively engaged in using Google Classroom to provide instruction for their students during remote learning. It was observed that all participants incorporated videos from Khan Academy into their lessons to enhance their instructions. It was also observed that the participants recorded their lessons to facilitate both synchronous and asynchronous learning. The lessons were presented using google slides. Some participants noted that they converted PowerPoint presentations to google slides so that the presentation would be more compatible with google classroom. Camden stated,

> I use digital technology in my classroom in the form of presenting lessons via PowerPoint. During remote learning I continued to present PowerPoint lessons by creating the presentations and using the Google add on, Screencastify, to voice-over the visual presentation as a means of explaining the concept.

Francisca noted that she uses technology to communicate with her students through the school's learning management skills. Francisca stated that she feels more comfortable providing students with paper copies of assignments because it provides her with the opportunity to assess students' thought processes to determine errors in computation. She noted that remote learning was the only time she has used technology consistently to provide instructions for her students. Francisca explained,

> At the start of each week, I use the students' learning management system to help them with executive functioning. Therefore, my use of technology is limited to helping the students organize their materials for each week. After reviewing the students' workload for each week, I allow them to use their paper planners to record due dates for assignments, assessments, and projects. During remote learning, the students used Google Sheets to organize their weekly assignments.

Six participants were observed having review sessions with their students. Most of the participants used games to engage their students in online reviews. Becky, Harry, and Janet were observed using the game Kahoot as a review tool for a unit assessment. While Gloria, Aaron, and Camden used online jeopardy games to review for an end of unit assessment. The researcher was informed that online assessments were completed in a timed manner using the school's learning management system. The system automatically scored the assessments; thereby, allowing students to receive real-time feedback.

Additionally, teachers converted worksheets to google docs to provide the opportunity to share with the students in google classroom. The participants noted that students were asked to complete and upload assignments as google docs in google classroom. One participant, Harry, explained that he uploaded pre-recorded lessons and ask his students to take their notes, screenshot the notes, and share in his google classroom. He also stated that he used math applications such as Desmos to teach the concept of linear and nonlinear functions.

Technology as a transformative instructional tool. The second major theme that emerged from research question 1 was the use of technology as a transformative instructional tool is that technology can be used at the modification and redefinition levels to transform the teaching-learning process. Modification and redefinition are the upper levels of the SAMR model of technology and represent the threshold at which technology moves from enhancing learning to transforming learning through the use of 21st-century skills such as critical thinking, collaboration, and communication (Cox, 2019; Hamilton et al., 2016).

Based on the data collected from semi-structured interviews and classroom observations, three participants: Dean, Harry, and Evelyn, have used technology at the modification and/or redefinition levels of the SAMR model to transform the teaching-learning process. The three participants noted that they inconsistently use technology as a transformative learning tool.

Harry noted that before remote learning his students used mathematics programs such as GeoGebra to create and use graphs, and develop videos that were then posted on GeoGebra Tube and YouTube for public view. He also stated that during remote learning his students have engaged in transformational activities such as creating and sharing Google Slide presentations with their peers for comments and feedback. He noted that he has a math blog for his classes that allows students to post short tutorial videos to share with their peers.

Dean noted that before remote learning he inconsistently used technology at a higher level based on the SAMR model of technology. Dean explained,

> I always incorporate some level of technology into my mathematics instruction to enhance lessons. For instance, I use the school's learning management system to

> post assignments and assessments, and host discussions. However, during remote learning I incorporated technology at a higher level by having the students create video tutorials of their work to share with their peers on Google Classroom and the class website. The students' products of learning were made accessible to other students, teachers, and families.

Evelyn noted that she was a computer science minor but her use of technology in the classroom is limited to the use of keynotes, Google Classroom, and the school's learning management system. She stated that remote learning has caused her to implemented some higher-level technology activities into her instructional practices. Evelyn noted that during online learning she used Pear Deck, an interactive presentation tool to engage her students in learning. Evelyn explained:

> The Pear Deck application facilitated real-time interaction between me and my students. Pear Deck allowed students to access my slides on their devices by inputting a code into their device. The students were able to comment and provide feedback to their classmates based on questions and prompts that I provided. The students also had the opportunity to present their work to their peers for feedback and comments.

Research question 1, aimed at examining the level of technology that middle school mathematics use in their instructional practices. The researcher found that overall, all of the participants use technology as a part of their instructional practices. Most of the participants used technology to enhance the teaching-learning process. The participants stated that remote learning engendered more intentional and creative use of technology.

The participants asserted that engaging in the remote learning process caused them to rethink the importance of technology as an instructional tool.

Research Question #2

What do middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in their middle school mathematics classrooms at a PreK- 8 independent school in Denver, Colorado? Research question 2 sought to gain insight into what middle school mathematics teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in their mathematics classrooms. Date for research question #2 was collected from online semi-structured interviews. Three major themes emerged from the data on challenges to using digital-technology initially and/or completely transform instruction in middle school mathematics classrooms. The major themes, distractions, professional development/training, and lack of curriculum integration emerged from semi-structured interviews.

Distractions. The first major theme in the data analysis on middle school teachers use of technology to transform mathematics instruction relates to classroom management, particularly the ability of technology to distract students from the teaching-learning process. This theme was connected to the research question #2, which sought to address challenges to using digital-technology initially and/or completely transform instruction in middle school mathematics classrooms. The theme of technology as a distraction emerged from semi-structured interviews. The participants noted that one aversion to implementing technology at a higher-level is that technology has the potential to cause distractions. Although technology is aimed at ultimately transforming the teaching-learning process, it may also be a distraction in the classroom According to Green (2019), students may use technology to engage in counterproductive activities such as instant messaging and gaming when the information being presented is not relatable, understandable, or engaging. Similarly, Lindqvist (2015) postulated that a preoccupation with technology may engender distractions in the learning environment.

Participants in the study found that some students engage in student checking, a process in which they had engage in the use of two or more applications in an educational setting, when they are asked to use their digital technology for educational purposes. Typically, one of the applications is non-educational and acts as the distractor in the teaching-learning process (Goundar, 2014; Lindqvist, 2015). All the participants noted that classroom management in terms of mitigating distractions is one of the major challenges to using digital technology at a higher level in their instructional practices Becky stated:

> Although technology can increase student engagement and motivation, it can also distract students from the teaching-learning process. I have seen students switch from an educational computer screen to a game within seconds because they have both applications open. If you do not actively monitor, students will play games or go on social networks during instructional time. Therefore, I limit the use of technology to what I can actively monitor.

Aaron’s view about digital technology as being a distractor was similar to Becky. Aaron explained:

> Students get bored and attempt to indulge in more enticing activities such as games. I have found many of my students playing games when they are working on an online assessment. I frequently monitor to ensure on-task behavior but that is when I see students with several tabs open. This allows the students to easily switch from something educational to something that is non-educational. I believe that this distracts from what they should be learning. Sometimes I have to ask the students to close their computers because even when I'm providing instructions, they are fooling around on their devices. The infatuation with gaming and social media makes it had to use technology to optimize learning.

Camden believed that fostering a learner-centered learning environment was essential for the successful implementation of digital technology as an instructional tool to transform instructional practices. Camden noted that technology can be a distractor in the classroom when students are not taught how to use the tool as a learning tool. She explained:

> I have seen students use social media during class, this is a distraction. But they are social beings living in a technology era. How can we as teachers capitalize on this and educate our students about the 21^{st}-century skills of communication and collaboration? I have also seen students being distracted by games. Unfortunately. I have had to confiscate students' devices because of gaming. However, I believe that if teachers find ways to incorporate gaming in their lessons, then students may engage more. During remote learning, I announced that we will be playing online games to consolidate our understanding of some challenging concepts. The students were so engaged that they requested an additional 10 minutes to continue

> playing. Students were motivated to take on leadership in creating games and playing with their classmates.

Francisca noted that technology is a huge distractor particularly for her students who needs support with executive functioning. She stated that in addition to being distracted by gaming and social media, her students often have issues with staying focused and organized when using digital technology. Francisca explained:

> My students prefer to watch more entertaining videos more than the educational math videos that are assigned by their regular education teacher. I have a small class of five students; therefore, it is easy for me to monitor their technology use. However, I am constantly addressing technology misuse during class. Off-task behaviors are rampant when they are on their devices, as soon as I move away to support one student the others move to another screen. I cannot monitor all the students' screens at once so I resort to paper and pencil.

Dean noted that his students use a stealth move to get their laptops from the non-educational context to the educational context. He stated that he tried using the flipped classroom model of teaching but had to change that teaching strategy because of the high-level of in-class distractions. Dean explained:

> To incorporated more technology into my lessons and give students access to the material before class, I implemented the flipped classroom model. However, during face-to-face class, the students were not fully engaged in completing online assignments. I observed students playing fantasy football, watching videos on *YouTube*, and posting on social media. Also, some students did not watch the

> videos prior to class; therefore, they had to be sent into the hallway to watch the videos. After the first trimester, I decided to scrap the flipped classroom model because it was not working effectively.

The other participants echoed the similar challenge of technology being a distraction in the classroom. Gloria explained, “technology is a major distractor because the students are infatuated by all the quick access that they have to all kinds of information.” Harry stated, “middle schoolers are already challenged to remain focused, using technology adds another layer to the challenge. The key is not reducing the use of technology, but to teach them how to use their devices responsible.” Evelyn stated, “students’ misuse of technology can lead to classroom management issues. Though we have a technology contract, students still find a way to engage with non-educational content during class.”

The participants explained distractors such as online gaming, social media, and watching non-assigned videos during instructional time, which is one of the major challenges of integrating technology in the middle school mathematics classroom to transform instruction. The participants noted that technology integration is beneficial; however, classroom management is adversely affected when students are distracted by technology. Some of the participants asserted that teaching students to use the technology responsibly will reduce the incidences of misuse which leads to distraction.

Professional development/Training. The second major theme in the data analysis of middle school teachers use of technology to transform mathematics instruction was professional development/training. Five participants indicated that they have received a one-time technology training since the school embarked on its one-to-one technology initiative. The participants noted that a one-time training was not sufficient with providing them with the skills and knowledge that is needed to integrate digital technology at a higher-level to transform mathematics instruction.

The participants in this case study described their technology integration training as minimal. The participants noted that emphasis was placed on technology integration training during the initial adoption of the one-to-one technology initiative. However, the emphasis has shifted since the inception of the initiative over eight years ago. The participants noted that professional development is more focused on content area development, equity, reading across the curriculum, and models of best practices.

Two of the participants, Harry and Evelyn, received formal computer science training. Several teachers stated that they have sought help with technology from Harry and Evelyn, primarily during the remote learning process. Six teachers noted that Evelyn created and shared videos with a step by step explanation of how to create and use Google Classroom and Pear Deck. Other teachers stated that both Harry and Evelyn illustrated how to convert Microsoft Word documents and PowerPoint presentations to Google documents and Google Slides to enhance compatibility with Google Classroom. Dean explained,

> I learned how to make pre-recordings using Screencastify, a Google add-on, to asynchronously engage students. He explained that he created Google Slides and then used the Screencastify add on to record himself explaining the steps in problem-solving. The Screencastify presentation is then uploaded to Google Classroom.

Aaron noted he preferred to use traditional models of teaching because that was what he was most comfortable with. He noted that he only received a week of technology training when the one-to-one technology initiative was first implemented. “However, engaging in remote learning has given me a new perspective on the importance of incorporating technology into my instructional practices,” Aaron explained:

> Prior to remote learning I rarely used digital technology in my classroom. My technology training was limited and not very relatable to me at the time. I needed a basic course in using technology before we started to delve into using different applications. During the remote learning process, I learned how to present my lessons using Google Slides and how to use Google Classroom as a learning tool to engage learners. Aaron attributed his success in remote learning to his colleagues who provided support through training.

Janet had very similar challenges to using digital technology to transform mathematics instruction:

> Incorporating technology into my classroom is challenging because of the lack of technology training. When technology training was offered for middle school teachers to support the one-to-one technology initiative, I was employed in the lower school division. Therefore, I did not receive that training. The middle school teachers are very supportive and willing to help me with technology but I need a lot of support to effectively integrate technology to transform my pedagogy.

Other participants asseverated that insufficient training in technology integration is one of the major challenges to using technology to transform mathematics instruction. Participants highlighted factors that precludes them from using technology at the higher levels of the SAMR model of technology to transform mathematics instructions. These factors included being intimated by technology and insufficient training. Becky claimed, “I am not very tech-savvy so I am intimidated by some of the technology that I should be using. I believe that a huge barrier to using technology is insufficient training.” Francisca stated, “when it comes to technology integration, I need a personalized professional development plan, starting with technology 101.” Gloria stated, “lack of ongoing technology integration training is the main deterrent from using digital-technology to transform instruction.”

Most teachers noted that the technology training that they received was insufficient and did not prepare them to integrate technology to transform instruction in their mathematics classrooms. The data illustrated that teachers perceived this as one of the major factors that are keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classroom. Some participants also noted that personalized, ongoing technology training will provide them with the knowledge and skills that are needed to integrate technology at a higher level based on the SAMR model of technology.

Curriculum integration. The third major theme in the data analysis of middle school teachers use of technology to transform mathematics instruction was the lack of curriculum integration. This theme emerged from the research question that sought to gain insight into what teachers indicate may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. Most teachers noted that it is challenging to use technology at a transformational level based on the SAMR model of technology because it was not connected with the math curriculum. According to Bicer and Capraro (2017), technology integration is most effective when teachers can see its connection to the curriculum that they are expected to deliver.

Evelyn stated that the mathematics syllabus does not specifically indicate how or where technology can be integrated to transform the teaching-learning process. Evelyn explained:

> My focus is on completing the curriculum to prepare the students for the next grade-level. I use technology to enhance my lessons but I do find it challenging and time-consuming when I incorporate technology. It is like a two-edged sword, in that when I use technology, students are more motivated and engaged. However, I get through less of the lesson than if I had used traditional methods. The challenge for me is how do I balance the two: technology integration and completing the syllabus.

Harry noted that he incorporates digital technology into his lessons at both the enhancement and transformational levels based on the SAMR model of technology. However, he noted that he tends to use technology primarily to substitute traditional methods. This he attributed to the connection between technology and the mathematics curriculum. Harry stated:

> My use of technology seems isolated, more like an add on to the lessons in the curriculum. Therefore, I frequently use enhancement level activities in my classroom. It takes time to analyze and synthesize the curriculum to determine where technology can be integrated effectively. The main challenge that is keeping me from using technology at the transformational level, more frequently, disconnect between the curriculum and more advanced technology. Also, the focus is on completing the math curriculum so that students learn the foundational skills and knowledge needed to perform at the next-grade level. Unfortunately, technology tends to take a “back seat.”

Janet stated that she uses more traditional models of teaching because those models are more aligned to the school’s math curriculum. Janet explained:

> The math syllabus requires students to complete anchor tasks and specific activities. The sequential nature of the syllabus makes it challenging to integrate technology to transform instruction based on the SAMR model of technology.

Other participants indicated that lack of technology in the mathematics curriculum is one factor that is keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms. Gloria noted, “It is not explicit where I can implement digital technology into the curriculum.” She suggested that “meeting in professional learning communities and collaborating with other schools that use the same curriculum could help us adjust the curriculum so that technology wouldn’t seem like something extra.” Aaron, Becky, Camden, and Dean also indicated that technology integration at the transformational levels of the SAMR model of technology is challenging because the curriculum, as it is, does not allow for much technology integration. Camden stated, "collaborative backward planning would provide the opportunity for mathematics teachers to develop lessons that connect technology and the math curriculum."

Summary

In Section 2, a detailed overview of the research methodology and the findings from semi-structured interviews, document analysis, and virtual classroom observations, were presented. A qualitative case study design was used to explore middle school teachers use of technology to transform mathematics instruction. The SAMR model of technology integration was used as the conceptual framework to ground the study. Two research questions were used to gain insight into teachers' use of technology and factors that may be keeping them from using digital-technology initially and/or completely to transform instruction in middle school mathematics classrooms.

Data for the study were collected from nine participants through virtual semi-structured interviews, documents, and virtual classroom observations. The data were coded to identify emerging themes. Five major themes emerged from the analysis of data. The themes were based on the two research questions. Two major themes that emerged from research question 1, that sought to determine the level of technology that was being used in mathematics classrooms. The two major themes were: technology as an enhancement tool and technology as a transformative instructional tool. The themes of distractions, professional development/training, and lack of curriculum integration emerged from research question 2, which sought to gain insight into what was keeping the participants from using technology transform mathematics instruction.

The COVID-19 pandemic caused a shift in how schools operate. The genesis of remote learning engendered a paradigm shift in the teaching-learning process. Many of the participants asserted remote learning was a challenge. However, they have learned different ways in which digital technology can be used to enhance and transform mathematics instruction. Most of the participants used technology at the substitution and augmentation levels of the SAMR model of technology. However, a few of the participants have inconsistently used technology to transform mathematics instruction.

In Section 3, a project was designed based on the findings from the qualitative case study. The project addressed the problem that was identified in Section 1 and the findings from the analysis of data in Section 2. Most of the participants expressed the need for ongoing technology professional development to develop their knowledge and skills in technology integration.

The collection and analysis of data indicated that there were barriers that precluded the educators from using technology at the transformational level of the SAMR model of technology. The educators adduced that inadequate training, curriculum integration, and technology distractions were factors that prevented them from using technology initially and/or completely to transform instruction in middle school mathematics classrooms. The results from the finding also indicated that the participants primarily used at the enhancement level of the SAMR model of technology to substitute and/or augment traditional practices. The themes from research question #1 and research question #2 are interrelated. There is a connection between use of technology as an enhancement tool and/or a transformational tool and level of technology professional development. There is also a connection between the using technology as an enhancement tool and lack of technology integration in the curriculum. Finally, the theme of technology as a distraction and use of technology at the enhancement level are interrelated. The themes from this section are interrelated and falls under the bigger umbrella of providing training that will build teachers' technology capacity so that they may feel more confident about incorporating technology into the curriculum to transform the learning environment.

Section 3: The Project

Introduction

The project study consisted of a qualitative single case study on middle school teachers' use of technology to transform mathematics instruction. Classroom observations, document analysis, and semistructured interviews were used to gather data on middle school mathematics teachers' use digital-based technology as a transformative learning tool in mathematics instruction and what may be keeping them from using digital technology initially and/or completely to transform instruction in middle school mathematics classrooms. Findings illustrated that digital technology was primarily used at the substitution and augmentation levels of the SAMR model of technology to enhance mathematics instruction.

The findings also indicated that using technology beyond the enhancement level of the SAMR technology model was challenging because of the limited technology training that teachers received. The participants noted that the new model of online teaching that resulted from the COVID 19 pandemic was challenging because of their unfamiliarity with using different online platforms to engage students remotely. Four participants explained that they were only exposed to a one-time technology training when the school adopted the one-to-one technology initiative. Two participants who were employed after the implementation of the one-to-one technology initiative stated that they have not received formal technology training. Only three participants have had some level of formal technology training. However, all the participants indicated that they adapted to the challenges of implementing technology in their instructional practices through the support of other teachers who have formal training in technology.

It was also found that factors such as distractions, professional development/training, and lack of curriculum integration, kept teachers from using digital technology initially and/or completely to transform instruction in their middle school mathematics classrooms. Thus, technology training will help to mitigate the challenges that teachers indicate are keeping them from using technology initially and/or completely to transform instruction (Karlin, Ottenbreit-Leftwich, Ozogul, & Liao, 2018). Furthermore, ongoing training will provide teachers with the skills and knowledge needed to implement technology at the transformational levels of the SAMR technology model. The findings indicated that the participants were not confident in their skills in using technology as a transformational learning tool to engage learners. Therefore, providing teachers with opportunities to become more technologically literate is paramount to engendering a change toward using technology as a transformative learning tool.

Based on the findings, I developed a job-embedded professional development (PD) plan as the project outcome of the qualitative case study. Ongoing, job-embedded professional learning is vital to causing shifts in how teachers and administrators operate in the school system (Bernhardt, 2016), and effective classroom technology integration is primarily attributed to effective technology PD (Karlin et al., 2018). I will collaborate with the director of technology to develop technology integration curriculum materials to guide the technology professional development. A technology audit will be conducted to determine a teacher's skill set and knowledge about technology integration into instructional practices. Further, findings indicated that the mathematics teachers were at different levels in their technology knowledge and skills. Therefore, an effective technology PD has to be individualized to meet the needs of the teachers and provide adequate knowledge (Karlin et al., 2018; Meyers, Brandt, Zhu, & Dhillon, 2016) as well as make them more likely to use digital technology as in the classroom (Bissonnette & Caprino; 2015; Meyers et al., 2016). To address the technology needs of teachers a three-tiered PD plan was established: beginners, intermediate, and advanced. The process of transformation involves having a progression of activities that are key in achieving desired outcomes (Chen, 2015).

The formulation of a professional development plan for middle school mathematics teachers to move from enhancement to transformation levels of the SAMR model of technology in their classrooms will be grounded in the TPACK (Mishra & Koehler, 2006) model of technology integration. The TPACK model of technology explores how teachers acquire knowledge about integrating technology into their pedagogical practices while teaching content to the students (Karatas et al., 2017). The goal of the PD plan is to develop ongoing job-embedded technology implementation training to support teachers in learning how to use technology to transform instructional practices. The desired outcome is capacity building and confidence with effectively implementing digital technology at the modification and redefinition levels of the SAMR model of technology. This outcome has the potential to improve students' reasoning, problem-solving, and critical thinking skills, which will ultimately result in improved student performance in mathematics (NCTM, 2016). The objectives of the professional development plan are to train teachers to use technology beyond the enhancement level of the SAMR model of technology and mitigate the factors that may be hindering the use of technology at the transformational level of the SAMR model of technology.

A program evaluation of the professional development plan was developed to measure the effectiveness of the program and to determine if adjustments are needed to improve the efficacy of the professional development . The efficacy of the professional development plan will be measured by the teachers' use of technology at the transformational level of the SAMR model. Teachers will document and describe the level at which they are using technology in their lesson and unit plans. The efficacy of the technology professional development plan will also be measured by student learning outcomes, which will be measured how students perform on common grade-level math assessment.

The technology professional development plan is based on the findings from the project study on middle school teachers' use of technology to transform mathematics instruction. The plan includes background information, professional development sessions, handouts, PowerPoint presentations, and evaluation tools. The project is designed specifically for middle school mathematics teachers. However, the plan may be modified to support all teachers in incorporating technology at the modification and redefinition levels of the SAMR model of technology. Section 3 includes the rationale for the project, review of the literature, project description, project evaluation plan, and implications.

Rationale

The participants in this study demonstrated, documented, and asserted that the use of technology in the classroom was primarily at the lower levels of the SAMR model of technology. Therefore, technology was inconsistently used to enhance rather than transform mathematics instruction. Online class observations illustrated that activities were primarily at the substitution and augmentation levels of the SAMR model of technology. Data that were collected from document analysis demonstrated that digital technology was inconsistently used before the remote learning process. Based on the teachers' profiles, six teachers have received little or no technology training. All the participants noted that they have access to digital technology and that the study site has invested in providing one-to-one digital technology to all students. Additionally, all classrooms are fitted with SmartBoard Technologies or Apple TV. However, all the participants noted that their use of technology is primarily at the enhancement levels of the SAMR model of technology.

The participates described the reasons for inconsistencies in using technology in their instructional practice as insufficient technology training, lack of curriculum integration, and issues with managing technology distractions during instruction time. But sustained, effective, job-embedded professional development in technology integration has the potential to facilitate the effective implementation of technology as an instructional tool (Longhurst et al., 2016). Teachers who engage in sustained technology implementation training develop more confidence, knowledge, and skills in the use of technology as an instructional tool (Longhurst et al., 2016).

Review of the Literature

Strategy Used for Searching the Literature

A comprehensive search of the literature on technology professional development was conducted. The literature was focused on finding peer-reviewed scholarly literature on ongoing, individualized, and targeted technology professional development , a technology coach, and curriculum mapping for technology into the mathematics curriculum. ERIC, Education Source, Sage, Educational Research Starter, and ProQuest were the databases that were used to find articles on technology professional development . Scholarly articles were found using the search terms *technology integration*, *professional development*, *training*, *technology coaches*, *curriculum mapping*, *TPACK model*, and *targeted professional development*. The articles were organized into three categories: professional development and training, technology coaches, and curriculum planning. Additionally, numerous articles were found on the TPACK model of technology. This model was used as the conceptual framework to ground the professional development plan for the project.

Introduction

This section contains a literature review on professional development for technology integration and planning for the successful implementation of technology at the transformation levels of the SAMR model of technology. The literature review describes the benefits of ongoing, individualized, and targeted technology professional development, technology coaches, and curriculum mapping to incorporate technology into the mathematics curriculum. The major themes from the data collection section of the qualitative case study informed the emerging themes to design a technology professional development plan that provides job-embedded training to support middle mathematics teacher use of technology to transform instruction.

Andragogical strategies, an 8-element model, was used to plan and integrate the technology professional development for middle school mathematics teachers at the study site. Andragogical strategies is a process model that helps learners to gain knowledge and skills by providing useful resources (Knowles, Holton, & Swanson, 2015). The model includes preparation, establishing a healthy climate, planning, diagnosing needs, formulating objectives, designing a pattern of learning experiences, appropriately using techniques and materials, and assessing and reassessing learning outcomes and needs (Knowles et al., 2015). Andragogical strategies facilitate setting objectives to address learning needs, planning, developing, and evaluating learning (Knowles et al., 2015), which are necessary to creating an effective technology PD.

Conceptual Framework

The TPACK framework for the use of technology in instructional practice was the conceptual framework for the study (see Mishra & Koehler, 2006). The TPACK framework adds a technology domain to Shulman's (1986) pedagogical content knowledge framework (Swallow & Olofson, 2017). The TPACK model of technology integration combines technology, pedagogy, and content knowledge for the successful integration of technology into instructional practices (Koehler & Mishra, 2009). The TPACK framework represents a paradigm shift in how educators teach and learn with technology (Wetzel & Marshall, 2012). The technological, content, knowledge intersection of the TPACK model focus on the use of technology to teach content (Mishra & Koehler, 2006). The intersection of the technological pedagogical knowledge represents the educators' knowledge of technology integration as an instruction tool. The TPACK framework illustrates the knowledge of incorporating technology into instruction using a myriad of digital tools at different levels to transform the teaching and learning process (Mishra & Koehler, 2006).

The TPACK model was developed to help educators with technology integration (Mishra & Koehler, 2006). The framework represents the intersection of pedagogical knowledge, content knowledge, and technological knowledge, which are essential to effective technology integration (Mishra & Koehler, 2006). The efficacy of technology integration in the classroom is based on the process of implementation using pedagogical content knowledge (Swallow & Olofson, 2017). Successful technology integration depends on the proximity of the components of the TPACK model; the closer the in the relationship between the components of the model, the more effective is teacher becomes at implementing technology to transform learning (Mishra & Koehler, 2006; Swallow & Olofson, 2017). The TPACK framework recognizes that technology integration is not a single universal approach but rather educators must gauge how technology integration can transform student engagement and learning (Mishra & Koehler, 2006; Swallow & Olofson, 2017). See Figure 4 for an illustration of the model.

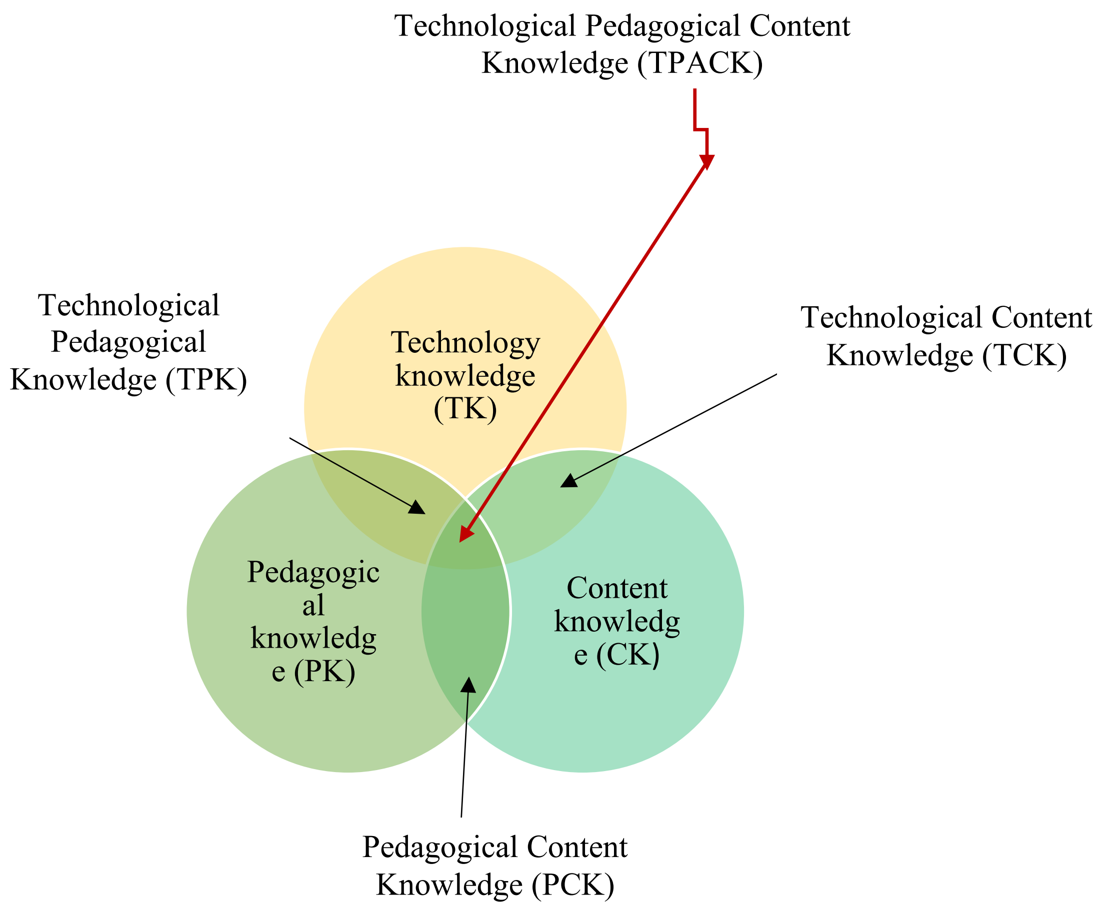

Figure 4. The TPACK framework and its knowledge components. Koehler and Mishra (2009).

Professional Development/Training

The use of technology has grown exponentially in schools; however, teachers are not necessarily equipped with the knowledge and skills that are needed to implement digital technology into their pedagogical practices (Jaegar, 2012; Uslu, 2017). Studies have found that for schools to effectively implement technology into their curriculum, teachers must receive targeted technology professional development (Jaegar, 2012; Karlin et al., 2018; Meyers et al., 2016; Uslu, 2017). Technology professional development is frequently met with skepticism when the individual needs of educators are addressed (Karlin et al., 2018). Technology professional development should be designed and created to build the capacity of educators (Knowles, Holton, & Swanson, 2015). Therefore, an effective PD plan must be individualized, ongoing, and contextual (Longhurst et al., 2016; Meyers et al., 2016). Hands-on, job-embedded technology professional development that is done on-site and focuses on specific instructional needs of the faculty can provide mathematics teachers with the knowledge and skills needed to use technology to transform instruction (O'Hara, Pritchard, Huang, & Pella, 2013). Additionally, technology PD should be holistic, including both instructional and non-instructional components (Althauser, 2015).

The efficacy of a technology professional development is measured by the level at which technology is implemented in the learning environment and how frequently teachers incorporate technology in their instructional practices (Meyers et al., 2016). The onus is on the administrators to equip teachers with the tools necessary to meet the needs of all students. Investing in long-term ongoing technology professional development will help teachers not only in the area of pedagogy but also in the effective use of technology (Koehler & Mishra, 2009). Ongoing, job-embedded PD has the potential to improve teachers' capacity and student achievement (Althauser, 2015). Thus, the initial goal of technology PD should be to shift the way teachers view technology (Meyers et al., 2016). Teachers should first be taught how to use technology effectively in the classroom to improve student achievement (Althauser, 2015; Karlin et al., 2018; Longhurst et al., 2016). Technology professional development should be focused on progressive concepts such as learning to guide students, maintaining student interests; and creating activities that integrate technologies in the existing curriculum (Borthwick & Pierson, 2008; Longhurst et al., 2016). This model calls for a more individualized type of professional development since a one-size-fits-all approach is not very effective in addressing more diverse needs (Longhurst et al., 2016). Teacher learning is a key component of creating effective strategies for teacher adoption of technology in their classrooms (Karlin et al., 2018; Longhurst et al., 2016; Meyers et al., 2016).

Incorporating digital technology into schools' curriculum will require a paradigm shift to employing a more learner-centered approach. The formal curriculum of the study site is based on employing a constructivist approach that perceives that learning occurs based on students' previous experiences and schema (Krahenbuhl, 2016); and real-life problem-solving activities (Uslu, 2017). Teachers are expected to facilitate and expertly guide students through real-life problem-solving activities (Uslu, 2017). In this technology era, students are digital natives who have become disenchanted with traditional teaching methods (Meyers et al., 2016). However, when teachers incorporate technology it is typically done to support teacher-centered instructional practices (O'Hara et al., 2013). To address the shift in how students are educated will require ongoing training. According to Uslu (2017), providing technology professional development for teachers can provide the knowledge and skills that are needed to incorporate technology that promotes a learner-centered approach.

Job-Embedded Professional Development and Technological Pedagogical Content Knowledge for Mathematics Teachers

Effectively incorporating technology into instructional practices can be challenging for mathematics teachers (De Freitas & Spangenberg, 2019). Therefore, mathematics teachers will need continuous training to improve their technological pedagogical content knowledge (De Freitas & Spangenberg, 2018). Studies have found that ongoing, job-embedded PD that provides teachers with specific ways in which to implement technology into their instructional practices engenders positive change in teachers' TPACK and promotes more transformative ways of teaching and learning mathematics (De Freitas & Spangenberg, 2018; Spaull & Kotze, 2015).

Most mathematics teacher training programs do not expose pre-service teachers to incorporating technology to transform instructional practices (De Freitas & Spangenberg, 2019). Therefore, teachers frequently use traditional teaching methods to engage learners (De Freitas & Spangenberg, 2019). Educational systems are impelled to provide students with opportunities to engage in 21st-century competencies such as collaboration and communication through the use of digital technologies (De Freitas & Spangenberg, 2019; Jacobs, 2010). Thus, tiered job-embedded continuous technology professional development is needed to provide opportunities for educators to improve their TPACK (De Freitas & Spangenberg, 2019). Studies have found that when teachers enhance their TPACK through ongoing PD they develop metacognitive awareness about the benefits of technology and are more likely to incorporate technology into their practices with fidelity (Althauser, 2015; Doering, Veletsianos, Scharber, & Miller, 2009).

Curriculum

Curriculum can be defined based on one's philosophical perspectives of what teaching and learning entail. Over the past two decades, there has been a transformation in the philosophy of curriculum (Wiles & Bondi, 2015). This can be largely attributed to the changes that are taking place in society that directly impact the education system. Initially, the philosophical beliefs about curriculum were centered around perennialism, idealism, and realism (Wiles & Bondi, 2015), which expected all students to learn the same content at the same pace with limited differentiation; regardless of interests, learning differences, and the scarcity of resources. Traditional approaches to teaching were teacher-centered and focused on teaching students only one way (Weimer, 2013). Therefore, the teacher was the orchestrator of everything in the classroom. Therefore, the teacher's role was to ask all the questions, plan the lessons, and dispense knowledge to passive students (Nganga & Kambutu, 2017). The focus was on students learning of the objectives rather than learning from the objectives (Jacobs, 2010).

The new paradigm shifts in education fueled by the need to prepare students for the demands of the 21st century have propelled educators to reflect on my practices. Today the epicenter of the philosophy of curriculum is fostering a more experimentalist and existentialist perspective (Wiles & Bondi, 2015), which allows students to construct their knowledge, not solely rely on teachers and textbooks to disseminate information (Weimer, 2013). In an era where the standard-based movement has caused educators to focus on preparing students for high stakes standardized tests, it has become an arduous task for educators to embrace learner-centered curriculum. However, in our dynamic world, it is sagacious that educators provide an environment in which students' learning is personalized; learning is competency-based; learning is not confined to the classroom; and students are empowered to take ownership learning (Nganga & Kambutu, 2017). Thus, curriculum should engage students in 21st-century competencies – critical thinking, communication, and collaboration. Therefore, content must be used to develop a knowledge base and learning skills that foster lifelong learning rather than just cover content (Weimer, 2013). At the crux of cultivating a learner-centered curriculum which provides opportunities for learners to become engaged citizens and thoughtful leaders, is the deliberate use of technology to augment student experiences and transform their learning (Nganga & Kambutu, 2017; Wiles & Bondi, 2015).

Wiles and Bondi (2015) state the being cognizant of the historical framework of education is paramount to curriculum development and a paradigm shift in the delivery of the curriculum. Wiles and Bondi (2015) highlighted three eras in which the changes in society have engendered changes in what defines a curriculum. The evolutionary era saw the recommendation of a standard set of high school courses, and an establishment of a unit of measure for each course (Wiles & Bondi, 2015). At the study site, there are still archival remnants of the evolutionary era; students are still required to study a highly standardized curriculum for core courses.

In the modern era schools reflected the factory model of the organization resulting from the industrialization and economic expansion between 1897 and 1921 (Feldman, 1999 as cited by Jacobs, 2010). Students attended school for approximately 180 days based on the agrarian calendar, six hours per day (Jacobs, 2010). Students at the study site are required to attend school for 180 days, the school day starts at 8:10 and ends at 3:10, dating back to the 19th century. The 19th-century Committee of Ten recommended that all students should be taught the same curriculum regardless of their interests (Jacobs, 2010). At the study site, students are taught four core subjects that serve as prerequisites for promotion to the next grade level. The traditionalists believed that students should move through a fixed, sequential curriculum with progressed determined by grade level transitions (Wiles & Bondi, 2015). More progressive theorists believed that learners should be responsible for organizing and activating knowledge (Wiles & Bondi, 2015).

Advancements in technology and the growth in the use of the internet has created global students. In the postmodern era, digital-savvy students have the opportunity to learn beyond the confines of the classroom (Jacobs, 2010). Changes in world economies and the effacing of borders caused by globalization have caused a paradigm shift in pedagogical practice. Therefore, embracing a more learner-centered curriculum that fosters 21st-century skills requires educators to use technology to not only enhance learning but to modify and redefine the curriculum, thereby transforming learning (Jacobs, 2010; Nganga & Kambutu, 2017).

The COVID 19 pandemic caused schools across the United States of America to engage students in remote learning. This resulted in a paradigm shift in the teaching-learning process. Teachers and students were engaged in virtual learning. The virtual learning environment was appropriate for an era where students are more technologically savvy in terms of knowledge and skills (Smith, 2014). Researchers have found that traditional methods of teaching have resulted in disengagement and disenchantment because students find it challenging to connect with the curriculum (McKnight et al., 2016; Shieh & Yu, 20016; Smith, 2014; Young, 2017).

Curriculum Mapping

Curriculum mapping is a collaborative and continuous process that educators can use as a guide to improve their pedagogy (Archambault & Masunaga, 2015, Jacobs, 2010). Curriculum mapping provides teachers with the opportunity to review, revise, and improve the curriculum more formally to align instructional practices to the goals of the institution (Archambault & Masunaga, 2015). Additionally, the data from curriculum mapping can be used to assess program outcomes, course efficiency, and learning outcome progression to align the program goals to the institutional goals (Schutte, Line, & McCullick, 2018). The mapping process can be completed prospectively; whereby, educators evaluate students' prerequisites skills and knowledge to inform instructional practices that are needed to get students to an end goal (Line, Schutte, & McCullick, 2016). The mapping process may also be completed retrospectively; whereby, the main components of the curriculum are evaluated to determine key elements that need to be covered (Line, Schutte, & McCullick, 2016).

Curriculum maps are developed collectively across vertical and horizontal teams to determine specific learning expectations for subject areas schoolwide (Schutte et al., 2018; Shilling, 2013). Vertical alignment allows teachers to examine and analyze what is being taught at different grade-levels to inform their pedagogy (Komenda, Vita, Vaitsis, Schwarz, Pokorna, Zary, & Dusek, 2015). While horizontal mapping allows teachers at the same grade-level to align content, resources, instructional practices, and assignments (Komenda et al., 2015). These maps allow teachers to exchange knowledge, skills, and instructional strategies that support best practices (Bruhn, Hirsch, Vogelgesang, 2017; Shilling, 2013). Therefore, curriculum mapping is a key component of common planning both in vertical and horizontal academic teams (Komenda et al., 2015; Schutte et al., 2018).

Curriculum mapping can be used to ensure that a school's curriculum meets the needs of students in the 21st-century (Bruhn et al., 2017; Jacobs, 2010). Continuous review of curriculum maps provides the opportunity for educators to replace traditional instructional practices with more contemporary practices, such as using technology to transform learning instead of just enhancing learning (Archambault & Masunaga, 2015; Bruhn et al., 2017; Jacobs, 2010).

Technology Coaches

The advancements in the use of technology have resulted in a change in the way schools engage learners (Jacobs, 2010; Nganga & Kambutu, 2017). Researchers have found that the increased use of digital technology in schools in which there is a disconnect between technology integration and educators' capacity to integrate technology can be challenging (Cooper, 2015; Drennan & Moll, 2018). However, technology coaches can help teachers integrate technology into their instructional practices by providing them with ongoing support (Cooper, 2015; Drennan & Moll, 2018). Technology coaches have the knowledge and skill base to develop educators' TPACK, through the SAMR model of technology, specifically at the transformational level (Drennan & Moll, 2018). The International Society for Technology in Education (ISTE) defines technology coaches as individuals who are trained to support educators in effectively incorporating technology into the learning environment to positively transform student learning (ISTE, as cited in Cooper, 2015). Also, technology coaches have the technical capacity that is essential in helping classroom teachers create lessons that are simultaneously aligned with academic standards and incorporates the use of technology (Cooper, 2015).

Technology coaches play a vital role in helping teachers incorporate technology into their lessons, not as an add-on to lessons but as a transformational learning tool that can be integrated throughout the teaching-learning process (Cooper, 2015; Drennan & Moll, 2018, Foltos, 2014). Technology coaches support teachers by demonstrating how to align the different elements of the teaching-learning process: instruction, curriculum, technology, learning needs, and lesson objectives (Foltos, 2014). The supporting role of technology coaches offers teachers the opportunity to become more technologically literate (Cooper, 2015). The American Association of School Librarians (AASL) (2009), defines technology literacy as “the ability to responsibly use appropriate technology to communicate, solve problems, and access, manage, integrate, evaluate, and create information…” (p. 24). Technology coaches enhance technology literacy through collaboration and communication with teachers by informing them about ways to integrate technology with fidelity (Cooper, 2015). To augment technology literacy, technology coaches also collect and analyze data to determine relevant information based on academic standards, and inform teachers about how to find and use information that has been located (Cooper, 2015). Such technology includes a monitoring tool to mitigate the instances of distraction during instructional time (Cooper, 2015; Drennan & Moll, 2018). The primary purpose of technology coaches is the build teachers’ technology capacity by empowering teachers to lead the integration of technology in their learning environment (Cooper, 2015; Drennan & Moll, 2018). Technology PD that is supported by technology coaches provides the opportunity for more individualized advice, troubleshooting, modeling, planning, and overall additional support for teachers as they integrate more advanced technology into their practice (Duran, Brunvand, Ellsworth, & Şendağ, 2011).

The ISTE standards for technology coaches delineated six responsibilities of technology coaches: visionary leadership; teaching, learning, and assessment; digital age learning environment; professional development, digital citizenship; and content knowledge and professional development. As visionary leaders, technology coaches are responsible for implementing, managing, and sustaining technology integration in schools and the classroom (ISTE, as cited in Cooper, 2015). Technology coaches are also responsible for coaching teachers on how to implement technology-based teaching, learning, and assessment to enhance and transform the learning environment (ISTE, as cited in Cooper, 2015). In the digital age learning environment, technology coaches collaborate with educators to assess digital technology tools and resources to determine compatibility and alignment with the school's infrastructure and curriculum (ISTE, as cited in Cooper, 2015). Technology coaches are also key players in designing, developing, implementing, and evaluating technology PD that engage teachers in developing technology integrated lessons that are rigorous, relevant, and effective (ISTE, as cited in Cooper, 2015). To cultivate digital citizenship, technology coaches promotes using technology to enhance global awareness by demonstrating how technology tools can be used as communication and collaboration tools to engage with others, globally (ISTE, as cited in Cooper, 2015). To assess content knowledge and professional growth, technology coaches frequently reflect on their practices and evaluate their roles to enhance their skills and knowledge of technology integration into the teaching-learning process (ISTE, as cited in Cooper, 2015).

According to Sugar and van Tyron (2014), technology coaches can provide virtual technology support to educators who are unable to engage in in-person training. Similarly, Drennan and Moll (2018) noted that virtual technology coaches can provide hands-on individualized training, resources, and information to support teachers. In addition to providing technology support, remotely, technology coaches can be cost-effective (Sugar and van Tyron, 2014). Therefore, coaches will be able to support teachers with technology training and online resources while they engage students in the online learning process.

Summary

The increasing access to new technology has engendered a shift in the teaching and learning process which has challenged traditional models of teaching (Donnelly & Kyei-Blankson, 2015). This review of literature highlighted themes that were associated with supporting middle school mathematics teachers incorporate technology at the transformation level of the SAMR model of technology. The review of literature also reported themes that were associated with factors that hinder middle school mathematics teachers from implementing technology at the transformational level of the SAMR model of technology. The TPACK model provided the conceptual framework for the project. The model was designed to help educators incorporate technology into their pedagogy (Mishra & Koehler, 2006). This review of literature illustrates the connection between support through ongoing job-embedded professional development and the TPACK framework.

Findings from the qualitative case study illustrated that middle school mathematics teachers needed support to incorporate technology at the transformational level of the SAMR model of technology. The major theme from the review of literature revealed that providing opportunities for ongoing, personalized, job-embedded technology professional development (Copper, 2015), is key to improving teachers' technology competencies. Other themes: curriculum, curriculum mapping, and technology coaches are connected with the major theme of professional development.

These sub-terms illustrated the importance of establishing an effective professional development plan to support teachers as they embrace a paradigm shift in the way they deliver the curriculum in this digital era.

The participants in the study noted that technology distraction, limited training, and lack of curriculum integration as factors that were hindering them from using technology to transform mathematics instruction. The participants understood the value of being technologically literate in the 21st century. They also understood that effective technology training will minimize the issues they expressed were preventing them from using technology at a more advanced level in their classrooms.

The literature also describes the andragogical strategies that would be used to engage the middle school mathematics teachers in on-going job-embedded professional development. Andragogical strategies are a model of adult education that helps gain knowledge and competencies in a collaborative way that encourages engagement (Knowles et al., 2015). Andragogical strategies provide the opportunity for the teachers to think about a broader goal of student achievement (Knowles et al., 2015). Employing andragogical strategies cultivate an environment in which adult learns can collaborate, engage, and build capacity while feeling safe, respected, and supported. Andragogical model provides the opportunity for teams of teachers to engage in training, common planning, and goal setting (Knowles et al., 2015).

Project Description

Findings from the study, information from the literature review, the purpose of the study, and the research questions, informed the creation of a professional development plan to serve as a technology professional development to support middle school mathematics teachers at the study site to use technology to transform mathematics instruction. The technology professional development was related to the TPACK model of technology integration (Mishra & Koehler, 2006). Additionally, andragogical process: preparation, climate, planning, diagnosis of needs, setting objectives, designing learning plans, learning activities, and evaluation (Knowles et al., 2015), was used to plan and integrate the technology professional development for the middle school mathematics teaches at the study site.

Preparing the learner involves providing the participants with information about the findings and an overview of the technology professional development plan, based on the findings. This will provide the opportunity for the learners to be cognizant of the short-term and long-term objectives of the training, understand the value of the professional development, and how they can apply what they have learned to real-life instructional practices (Mews, 2020). Establishing a healthy climate in which participants can work in a supportive, collaborative, and respectful environment (Knowles et al., 2015). Participants will have the opportunity to engage in synchronous and asynchronous learning based on their preference. Learning resources, including technology coaches, handouts, and computers will be easily accessible (Knowles et al., 2015). Participants and the facilitators will engage in mutual planning to engender buy-in and motivate learners to authentically engage (Mews, 2020). An online needs assessment survey will be completed by the participants to diagnose the technology needs of each participant (Knowles et al., 2015). The participants and the facilitators will set short-term and long-term objectives to achieve the goal/learning outcome of the technology professional development (Knowles et al., 2015).

After the pre-work for the technology professional development, a three-tiered professional development will be designed to meet the needs of the participants. According to Mews (2020), evaluating learner readiness is crucial to designing a pattern of learning experiences. Then, the participants will engage in tiered ongoing job-embedded technology professional development that will be focused on providing middle school mathematics teachers with the knowledge and skills needed to use technology to transform their instructions. Finally, the technology professional development process will be evaluated to assess and reassess learning outcomes and re-diagnose needs (Knowles et al., 2015).

The comprehensive technology professional development plan will be implemented starting in January 2021. This will provide sufficient time to plan and prepare for the professional development, conduct online needs assessment, collect and organize resources, determine the mode of delivery: online, in-person, or hybrid, and employ technology coaches to facilitate the professional development. From January 2021 to the end of the 2022 academic year, the administration will provide and support teachers with technology training and opportunities to participate in department-level, monthly PLCs designed to foster ongoing individualized technology training and implementation of technology at the transformational level of the SAMR model of technology.

Resources and Existing Infrastructure

The school adopted a one-to-one technology program which initially started with iPads in 2010. The school then upgraded their technology to MacBook for each student and teacher in the middle school. Additionally, the school has a multi-million-dollar technology center with a technology department, a director of technology, and a technology specialist. Furthermore, teachers are allowed to participate in one-time week-long technology training during the summer. Each week teachers engage in general faculty meetings or vertical team department meetings. However, there are no targeted ongoing job-embedded professional development related to technology integration. Middle school mathematics teachers could be allowed to engage in technology professional development by participating in PLCs and based on their technology competencies. Thus, a schedule of tiered technology professional development, that specifically provide teachers skills and knowledge to integrate technology at the transformational levels of the SAMR model of technology, could be developed to ensure training is done with fidelity. Additionally, the school could use the director of technology and technology specialists as technology coaches, along with hiring additional technology coaches for support. The director of technology and the technology specialist are formally trained with how to use advanced technology. The technology coaches were selected because they received formal technology training and because they are also middle school mathematics teachers who have used technology at the transformational level of the SAMR model of technology. Additionally, the technology coaches were selected because they were the middle school mathematics teachers who steered the remote learning process at the study site. The selected technology coaches taught their colleagues how to use the Google and Zoom platforms to engage learners during remote learning in the Spring. External technology coaches will be hired to provide additional training on the SAMR model of technology and coaching expectations to the internal technology coaches.

Technology Professional Development Plan

The technology professional development plan was developed for middle school mathematics teachers at the start of the January 2021 school term. During the 2021 – 2022 academic year, the administration will provide and support teachers with technology training and opportunities to participate in department-level, monthly PLCs designed to foster ongoing individualized technology training and implementation of technology at the transformational level of the SAMR model of technology. The technology professional development will be coordinated by the school's curriculum, instruction, and assessment (CIA) leader and the director of technology. Internal technology coaches will be selected based on their technological competencies (Cooper, 2015) to plan and lead technology professional development. The internal technology coaches will be selected by a team of administrators which comprise of the curriculum instruction and assessment leader, mathematics department chair, and the director of technology. These administrators will select mathematics teachers who have formal training in technology integration and who are willing to commit to leading ongoing job-embedded technology professional development. The technology coaches teach their tier/cohort of middle school math teachers how to incorporate technology into their instructional practices to transform the teaching-learning process. The coaches will support teachers with planning, resources, and technical assistance. The middle school mathematics teachers' role is to work collaboratively in PLCs. Studies have found that when teachers engage collaboratively in technology professional development they feel more supported by their peers because they can help and guide each other (Longhurst et al., 2016; Meyers et al., 2016; O'Hara et al., 2013).

The technology professional development plan will be implemented at the beginning of the of the January 2021 school term. On the first professional development day in January 2021, mathematics teachers will be briefed about the findings from the study and the steps that will be taken to support their instructional needs. Teachers will be asked to technology needs assessment to determine their technology competencies. An online needs assessment survey with scaling and open-ended questions will be given to middle school mathematics teachers. Scaling questions will be used to assess teachers' technology literacy. Open-ended questions will be used to assess teachers' perceptions about the use of technology as a transformative learning tool. The curriculum instruction and assessment leader and the mathematics department chair will lead this session. The resources that will be needed during this session include: PowerPoint presentation, an approved online needs assessment instrument, and laptop computers. The curriculum instruction and assessment leader will work with the mathematics department chair to evaluate the technology needs assessment survey. The process will be completed in 2 60-minute blocks before the first PD day in January. Middle school math teachers will complete the survey in at most 30 minutes. The quality indicator for this session will be measured by middle school math teachers' prompt completion of the need assessment survey.

The curriculum instruction and assessment leader, mathematics department chair, and director of technology will collaborate to disaggregate and analyze the middle school math teachers' needs assessment survey to determine the tiers of the technology professional development, and identify and select internal technology coaches to lead the technology professional development. The curriculum instruction and assessment leader will work collaboratively with the technology department to arrange the data into simple charts and graphs. The curriculum instruction and assessment leader will then create a presentation to present to the middle school math teachers to illustrate technology competencies that will be used to inform the tiers for the technology professional development implementation. The curriculum instruction and assessment leader and director of technology will identify and select teachers who may assume the role of technology coaches based on their technology competencies and willingness to lead professional development sessions. Raw data from middle school math teachers' needs assessment surveys, technology software to generate charts and graphs, and PowerPoint presentation are the resources that will be needed for this session.

The curriculum instruction and assessment leader, math department chair, and director of technology will meet for 1-2 hours to analyze the data and organize the technology professional development tiers. The team will meet for 30 – 40 minutes to input data into a software to generate simple charts and graphs with the information that will be presented to the middle school math teachers. A brief 30-minute presentation will be made to the middle school math teachers. The teachers will then create 2 – 3 short-term and long-term technology implementation goals. The technology coaches will receive additional training in using andragogy strategies to engage peers in the technology professional development. The quality indicator for this session will be measured by middle school math teachers' development of 2 – 3 short-term and long-term technology implementation goals.

External technology coaches will provide technology professional development leadership training for internal technology coaches that were selected based on the needs assessment survey. The technology coaches will receive training on how to collaborate with the middle school math teachers to integrate technology into the curriculum and how to use technology at the transformational level of the SAMR model of technology to engage learners and mitigate distractions. This training will be done over 4 hours in 60-minute increments. The purpose of this training will be to ensure that internal technology coaches become competent in their ability to lead ongoing technology professional development.

The middle school math teachers will participate in an introductory technology professional development on how to use technology to transform their instructional practices. The teachers will be placed into technology cohorts based on their competencies, knowledge, and skills on how to integrate technology into the curriculum. Each cohort will have a technology coach as the lead. The math teachers will work collaboratively in their cohort/tier to refine their initial goals based on the information that they have gained from their professional development. The technology coaches will work with their cohort to ensure that their technology goals are measurable and attainable. The curriculum instruction and assessment leader, director of technology, and technology coaches will take 45 – 60 minutes to introduce the middle school math teachers to the information on using technology to transform the teaching and learning process. During this time teachers will be taught how to shift from using technology as an enhancement tool to using technology as a transformational tool that has the potential to improve student engagement and learning outcomes. Teachers will work for 60 – 90 minutes to refine short-term and long-term technology goals. The technology coaches will collaborate with each cohort of middle school math teachers to determine ways for measuring these goals. The technology coaches and director of technology will present information from other schools that have successfully used technology coaches to lead technology professional development that has resulted in the implementation technology at the transformational level of the SAMR model of technology. At the end of this session, middle school mathematics teachers create well-developed technology integration goals that they will work collaboratively towards achieving by the end of their training.

After the introductory technology professional development, middle school mathematics teachers will engage in ongoing individualized job-embedded technology training. The training will include all levels of the SAMR model of technology. Tier/Cohort # 1 will start by learning how to use technology to substitute and augment traditional instructional practices. Tier/Cohort # 2 will start by reviewing substitution and augmentation activities. This group will then focus on using technology at a higher level.

Tier/Cohort #3 will engage in training that will sharpen their skills and knowledge on technology integration at the modification and redefinition levels of the SAMR model of technology. The middle school math teachers will meet biweekly during scheduled planning time (60 minutes). During monthly professional developments, middle school math teachers will work in their cohorts for 60 minutes to learn about successfully implementing technology into their instructional practices. This process will be led by the curriculum instruction and assessment leader, mathematics department chair, the director of technology, and the technology coaches. The quality indicator for this session will be measured by middle school mathematics teachers' level of incorporate technology into their instructional practices. Additionally, middle school mathematics teachers' lesson plans and unit plans will reflect the use of technology.

Potential Barriers

A potential barrier for providing the middle school mathematics teachers with tiered ongoing job-embedded technology professional development is time. This technology professional development will have to be done during schedule professional development and PLC times. However, those times are used for collaborative inquiry and data analysis of common assessments. The time is also used for individual planning and collective planning aimed at staying on track to complete the curriculum for each grade level. One solution to this barrier would be to demonstrate that technology is not an add-on to the curriculum but can be effectively integrated into the planning of lessons.

Commitment and motivation to engage in an ongoing technology professional development is another potential barrier to providing the middle school mathematics teachers with tiered ongoing job-embedded technology professional development. Teachers would have to take time away from curriculum planning to engage in technology professional development, this could impact teachers' buy-in to the process. The implementation of technology as a transformational learning tool requires a paradigm and cultural shift in instructional practices. It is essential to build teachers' momentum to motivate them to stay committed to engaging in ongoing technology professional development with fidelity. Highlighting the goals and objectives of the professional development, providing comprehensive information about the process, providing constructive feedback, and ongoing communication about how the professional development is progressing towards the goals, are ways to mitigate this barrier.

Another potential barrier to providing the middle school mathematics teachers with tiered ongoing job-embedded technology professional development would be adding extra responsibilities to the director of technology and the technology specialist. These personnel are not educators and may not be comfortable training teachers. Securing external candidates as technology coaches to facilitate technology professional development can also be a potential barrier. To address the potential barrier of securing external coaches, the administrators may ask participants who have formal technology training to lead as technology coaches. The administrators may financially compensate personnel for additional responsibilities.

Project Evaluation Plan

The effective implementation of a technology professional development relies on resources that are dedicated to the program, input such as funding, personnel- -educators' knowledge and willingness to incorporate technology as a learning tool, school infrastructure to support the use of technology (Chen, 2015; Lalima & Dangwal, 2017). The goal of the technology professional development is for middle school mathematics teachers to gain knowledge, skills, and competencies to effectively implement technology to transform mathematics instruction. The desired outcome of the technology professional development is to build middle school mathematics teachers' capacity to use technology to transform mathematics instruction. The desired outcome has the potential to improve students' engagement and performance in mathematics (NCTM, 2016). The achievement of the desired outcome is dependent on inputs, activities, and outputs/outcomes (Chen, 2015). Inputs are the foundation of the program and are essential in sustaining the program (Chen, 2015). Therefore, the inputs that may be considered paramount to the efficacy of the technology professional development program include funding and personnel- faculty and experts in the field of technology. To transform the inputs into outcomes (Chen, 2015) will require activities such as needs assessment of teachers, ongoing professional development for teachers, and funding for personnel such as providing stipends for technology coaches and the director of technology.

According to Chen (2015), the process of transformation involves having a progression of activities that are key in achieving desired outputs. The outputs of a program are used to measure if the program's short, intermediate, and long-term goals are achieved (Chen, 2015). Thus, the outputs of the technology professional development include teachers becoming more competent in the use of technology to transform mathematics instruction and increased collaboration among teachers. Those outputs will inform the outcome of the technology professional development program and help to achieve the desired goal of middle school mathematics teachers' use of technology to transform instruction and by extension improved student performance in mathematics. Chen (2015) noted that long-term outcomes imply that the program was effective in achieving its goal.

The objectives of the technology professional development plan were created based on the findings of the study. The first objective of the technology professional development plan is for teachers to use technology beyond the enhancement level of the SAMR model of technology. The second objective is to minimize the factors that may be preventing the use of technology at the transformational level of the SAMR model of technology. An objective-based approach to program evaluation will be used to assess the efficacy of the technology professional development plan. The objectives of the technology PD plan will be used as the focus for collecting data to determine if the professional development plan satisfies those objectives. The objectives of the professional development plan represent the purpose of the evaluation (Spaulding, 2014). Therefore, only data that are vital to the process will be collected. Data will be collected from classroom observations, lesson plans, and online surveys. Selecting data collection methods that are aligned to research methods that provide relevant and timely feedback, are most suitable (Chen, 2015).

The data will be used to determine the level at which middle school mathematics teachers are integrating technology into their instruction based on the training that they have received. Data will describe the progress that the teachers are making towards incorporating technology at the modify and redefine the teaching-learning process based on the SAMR model of technology. Perception data will also be collected to evaluate the teachers' opinions about the technology professional development to make informed changes to the professional development plan. Surveys will be used to determine teachers' attitudes towards a shift in pedagogical practices and whether the training is impacting their practices within the classroom (Spaulding, 2014).

The technology coaches will also engage in reflective practice by collecting formative data on method of delivery, pacing, and resources, after each professional development session to inform upcoming sessions. The value of formative data is enhanced by timely feedback to stakeholders (Chen, 2015). Furthermore, formative evaluation data allow the technology coaches to identify and address issues that may occur during the implementation phase of the program; thereby influencing the overall program (Chen, 2015). Program evaluation data will be communicated on an ongoing basis via different mediums such as email, and PLC meetings to keep all the middle school mathematics teachers informed about the process. Disseminating information to stakeholders engenders buy-in and comprehensively addresses the feasibility of a program in real-world situations (Chen, 2015). Also, since stakeholders can inform the program evaluation process, communicating information to the middle school mathematics teachers is critical in determining whether the goals of the technology professional development plan meet their expectations (Chen, 2015).

Technology coaches will use a logic model flowchart to help the middle school mathematics teacher better understand the program and to communicate the evaluation process (Chen, 2015). This logic model will visually represent the relationship between the technology professional development inputs: funding, resources, and personnel and the short-term and long-term outcomes of the program. The model will delineate the program evaluation process for the technology professional development and communicate the progress and actions that need to be taken to achieve the desired outcome of the technology professional development.

Logic Model for Middle School Math Teachers Technology

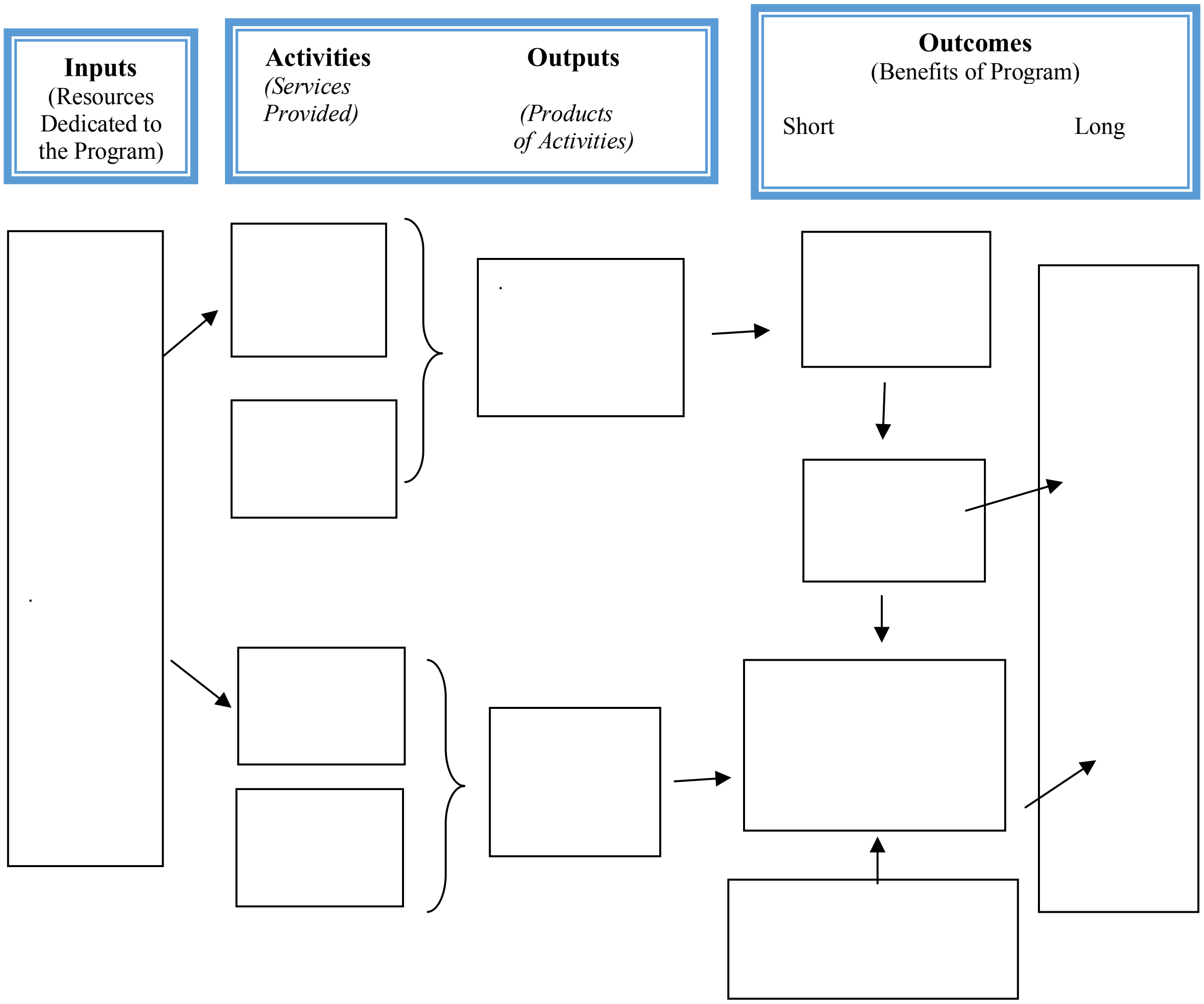

Figure 5. Logic model flowchart.

Project Implications

This qualitative case study explored middle school teachers' use of technology to transform mathematics instruction. One of the major findings indicated that the teachers were more adept at using technology to enhance mathematics instruction. Therefore, teachers demonstrated more competence in using technology to substitute and/or augment traditional modes of instruction. The findings also indicated that most of the teachers received little or no technology training. This precluded them from incorporating technology into their instructional practice. Therefore, I developed a technology professional development project to help middle school mathematics teachers use technology at the modification and redefinition levels of the SAMR model of technology to transform mathematics instruction. The project was developed based on the findings from the study and the review of literature on how to support the integration of technology into the teaching-learning process. Developing a technology culture is integral to the successful implementation of advanced level technology into the curriculum. The NTCM (2016) found that when technology is integrated at the transformational level of the SAMR model, students' critical thinking, problem-solving skills, and academic performance in mathematics, improves.

The COVID 19 pandemic influenced the way schools across the world engaged learners. In the United States of America, schools moved to remote learning, in the Spring, to continue the education process. Teachers used different online platforms to teach students. *Schoology*, *Google, Seesaw*, and *Zoom* were the most commonly used online platforms. Teachers were charged with using technology to teach and evaluate learning. The participants in the study highlighted some of the challenges they faced with moving their classes online. The challenges stemmed from limited knowledge regarding using technology to transform mathematics instruction and engaging students solely on online platforms. Teachers were required to engage learners synchronously and asynchronously. Some participants relied on their peers who were more tech-savvy to help them create online classes, plan lessons, and develop assignments and assessments.

Based on the findings from the study, a technology professional development plan was developed to support teachers. The plan illustrated how andragogical strategies will be used to support the middle school mathematics teachers' technology literacy. The teachers will also engage in a yearlong job-embedded technology professional development by participating in PLCs. The professional development will be developed and delivered by technology coaches. Technology coaches will be able to support teachers, remotely. Technology professional development that is delivered by coaches is effective because they can provide individualized feedback, model, plan, and provide additional support (Meyers et al., 2016). Collaborative technology professional development provided the opportunity for collaborative inquiry and support (Longhurst et al., 2016; Meyers et al., 2016; O'Hara et al., 2013).

This qualitative research focused on middle school mathematics teacher use of technology to transform instruction. However, this study may be used for other departments and grade levels, particularly in these unprecedented times when schools have moved to online or hybrid models of teaching. The project may be modified to address the needs of different types of schools. The technology professional development plan may be used in other school settings to build educators' technology knowledge, skills, and competencies.

Conclusion

In section 3, a technology professional development plan was created to address the findings from the case study. The technology professional development plan focused on using technology coaches to deliver individualized, ongoing, hands-on, job-embedded training using a cohort/tiered system (Longhurst et al., 2016; Meyers et al., 2016). A comprehensive review of literature was conducted to determine how to help middle school mathematics teachers incorporate technology at the modifications and redefinition levels of the SAMR model of technology to transform mathematics instruction. The review of literature revealed the tenets of an effective technology professional development and the importance of creating a collaborative culture to support the process of technology integration into the curriculum. The TPACK model was used as the conceptual framework for creating a professional development plan. This model delineated how teachers may augment their technology capacity through ongoing job-embedded professional development. Andragogical strategies were used for developing professional development sessions. This 8-element model of educating adults illustrates the hierarchical way of engaging adults in professional development. A comprehensive program evaluation was developed the assess the efficacy of the technology professional development. A logic model was used as a tool to evaluate the program. Additionally, an objective-based approach was used to determine if the technology professional development plan is meeting its objectives and overall goal.

Section 4: Reflections and Conclusions

This qualitative case study was conducted to explore middle school teachers' use of technology to transform mathematics instruction. The study addressed the problem of digital technology being used to enhance instructional practices instead of engaging students in a transformative learning experience. The study focused on middle school mathematics teachers' current use of technology and factors that may be keeping them from using digital technology initially and/or completely to transform instruction in middle school mathematics classrooms at the study site. This section presents the strengths and limitations of the project study and recommendations for future studies. In this section, I will also reflect on my practice as a doctoral student, a novice researcher, and an educator.

Project Strengths

The study was guided by two research questions to explore middle school mathematics teachers' use of technology and factors that may be hindering the use of technology at the transformative level of the SAMR model of technology. The SAMR model of technology was used as the conceptual framework to ground the study. Data for the study were collected from online semistructured interviews, class observations, and lesson and unit plans. The findings from the research indicated that teachers primarily used technology at the enhancement level of the SAMR model of technology. The findings also revealed that little to no technology training precluded the middle school mathematics teachers from using technology to transform instruction. There is a direct correlation between the efficacy of a technology professional development and the likelihood of a shift in pedagogical practices (Longhurst et al., 2016). Thus, the findings informed the development of a technology professional development plan.

The technology professional development plan was designed to be delivered in tiers or cohorts based on data from the needs-assessment survey. This is one of the strengths of the plan because teachers will receive the support that is tailored to their specific technological needs. Findings from the qualitative case study showed that teachers were at different levels of technology literacy, whereas some teachers were able to help their peers with incorporating technology during remote learning, and others noted that they would need a beginner's class in technology. Researchers have found that effective technology professional development is individualized to meet the needs of learners (Longhurst et al., 2016; Meyers et al., 2016; O'Hara et al., 2013). Effective technology professional development should examine ability levels to determine activities that will be most suitable to sustain teacher engagement throughout the process (Longhurst et al., 2016). Determining the alignment between participants' technology competencies and level of training that need to advance those competencies should inform technology professional development (Karlin et al., 2018). The technology professional development plan is expected to be delivered in three tiers: beginners, intermediate, and advanced.

The technology development plan was also designed to be ongoing and job-embedded. This is a strength of the project because several participants noted that they have received little or no formal technology training. As a result, most participants used technology to enhance their pedagogy rather than transform instruction. Technology has the potential to improve student achievement in mathematics when it is being used to modify and redefine the teaching-learning process (NCTM, 2016). However, one time technology training has been ineffective in leading to a paradigm shift in how technology is used to transform learning (Karlin et al., 2018). But ongoing job-embedded professional development provides the opportunity for teachers to be engaged through daily activities and responsibilities and require them to attempt new ideas and analyze the effectiveness of their actions (Hunzicker, 2010). For instance, Longhurst et al (2016) found that teachers who engage in sustained, ongoing, job-embedded technology professional development over 2 years increased their technology competencies and literacy, incorporated more advanced level technology activities into their practices, and observed a significant increase in student achievement data. Thus, the major strength of this project is the potential to improve students' performance in mathematics achievement.

Further, the project design allows for teachers to collaborate regularly through PLCs and faculty meetings. This will provide opportunities for middle school mathematics teachers to engage in collaborative inquiry geared toward technology-based instruction (Carpenter, 2017; Machado & Laverick, 2015). Collaboration provides additional guidance and allows teachers to assist each other in developing skills and knowledge needed to integrate technology to transform their instruction. Engaging in PLCs empowers teachers to engage in the learning process and causes them to be intrinsically motivated to use technology to transform mathematics instruction (Lange, Range, & Welsh, 2012). Allowing teachers to work in teams engenders capacity building, which will lead to an increase in the use of technology at the transformational level of the SAMR model of technology (Lange et al., 2012; NCTM, 2016). Working collaboratively toward a common goal also engenders relationship building which is a characteristic of a healthy school climate (Fullan, 2011). Additionally, peers will be used as technology coaches to support their colleagues. Internal technology coaches can provide additional one-on-one support to their peers that will assist them with effectively incorporating technology into their instruction (Karlin et al., 2018).

Another major strength of the project is that it is timely in facilitating remote learning. The COVID 19 pandemic has resulted in issue-based learning (Sadler, Friedrichsen, Zangori, & Ke, 2020). This societal, health issue led to schools being tasked with educating students remotely using digital technology. Providing teachers with technology training during this time will help them incorporate technology activities to transform instruction and increase student engagement (Sadler et al., 2020). When teachers are trained on how to effectively incorporate technology into their instruction, they are more likely to use what they have learned into their lessons (Meyers et al. 2016; Sadler et al., 2020). For example, when teachers are taught how to use breakout sessions in Zoom, they may use the online platform to facilitate small group differentiated instruction (Sadler et al., 2020). Collaboration through technology professional development supports novel curricular changes that directly incorporates technology into the teaching-learning process (Sadler et al., 2020).

Finally, the technology professional development plan will be evaluated using a logic model flowchart to determine if the short-term and long-term goals are achieved.

Continuous data collection from a myriad of sources will reveal strengths and areas for growth which will inform changes to the plan. The process of formative and summative evaluations is essential to the efficacy of technology professional development (Winslow, Dickenson, Weaver, & Josey, 2016). The program evaluation will provide data on if the goals were achieved and modifications that need to be made to ensure the success of the program (Winslow et al., 2016).

Limitations

This project study was conducted in one school and focused on middle school educators' use of technology to transform mathematics instruction. Therefore, all aspects of the study may not be transferable to other schools or academic subjects. However, the technology professional development plan may be transferable to other school systems because the strength of the plan is grounded in educational theory (Parker, Abel, & Denisova, 2015). Additionally, data were collected from nine participants, so the findings cannot be generalized to all other school settings. The data may also have the potential for participants' bias. However, the triangulation of data collection tools may have mitigated self-representation biases (Karlin et al., 2018).

Another limitation is that the technology professional development will be delivered by internal technology coaches and monitored by the director of technology. This is an additional responsibility for the personnel; therefore, they may experience burn out or may not have the time needed to deliver the training, collected formative feedback, and modify the professional development. Employing external technology coaches who are experts in the field would be more feasible.

Recommendations for Alternative Approaches

I explored middle school mathematics teachers' use of technology to transform instruction at an independent PreK–8 school. An alternative approach to the study would be to examine middle school mathematics teachers' use of technology and student achievement in mathematics. This approach would have taken place over an extended period, and quantitative data would be collected from pretest and posttest data to determine if a positive correlation exists between technology integration and mathematics achievement. Additionally, the study was conducted in an independent school and focused on middle school mathematics teachers, but another approach would be to conduct research in a public-school district across several different schools. Teachers in a different setting may reveal different findings which may have resulted in a different project. Conducting the study in a public-school district would have also resulted in a larger more diverse sample of teachers, which would increase reliability of findings (Creswell, 205), making the results more transferable and generalizable (Burkholder et al., 2016).

Another alternative approach to the study would be to extend the study to include all the teachers at the study site. Teachers from other departments and the lower school division would benefit from technology training, particularly with the new mode of teaching students. Extending the study to the entire school would result in a larger more diverse sample size and increase the reliability, credibility, and validity of the findings (Burkholder et al., 2016). Furthermore, if the research was conducted schoolwide then the lower teachers would have the opportunity to engage in the technology development plan. This would support vertical team curriculum mapping from PreK to eighth grade, thereby resulting in more uniformity in the implementation of technology throughout the school.

Scholarship

I started the journey with my research topic at the forefront of my mind. As a Black female mathematics teacher who recognized that my middle and high school advanced mathematics classes did not have many students with my characteristics, I was saddened. Therefore, my initial research topic was factors that were impeding Black female students from pursuing science, technology, engineering, and mathematics (STEM) majors in high school and college. However, after attending my first residency in Atlanta, Georgia, I realized that this was a topic I needed to tackle after I completed my doctoral studies. The residency provided insight into the challenges that were ahead and led to the realization that I needed to embark on a study that was more relevant to my school setting and my role as a mathematics teacher. I also realized that embarking on my initial study would have been time-consuming and permeated with my own biases. I changed my topic at the residency to my current topic: middle school mathematics teachers use of technology to transform instruction.

My doctoral journey has been an arduous one, from changing my research topic to aligning the different components of the study. However, this journey has taught me to be committed to a task, set personal deadlines, establish SMART (specific, measurable, achievable, relevant and time-based) goals, and set boundaries. I also learned how to write through writing blocks that experienced. I recognize that as a learner I did not differ much from my students who struggled to answer math problems. Therefore, I used some of the dialogue that I have with my students to encourage myself. I reminded myself that productive struggle is paramount for growth and that dedication and perseverance developed character. I also reminded myself of the real reason why I pursued higher education—to positively influence my students' learning. As a result, I employed all the strategies that I learned in my courses to help my students become more independent learners and critical thinkers.

I have also learned that being a scholar requires a willingness and openness to receiving constructive feedback. The feedback from my committee members motivated me to continue working on my research. The feedback also made me a better writer and a more critical reader. Scholarly writing and reading require advanced skillsets that allow a learner to read multiple peer-reviewed articles then synthesize and analyze the information promptly. As a learner, I constantly reflected on my style of writing to ensure that it was meeting doctoral standards.

As a doctoral scholar, I learned the importance of ensuring neutrality during the research process. This allowed me to collect data that were reliable and valid. I learned the importance of using an interview protocol to maintain integrity during the process. I also learned the importance of ensuring that all the participants felt safe during the entire research process and that integrity was maintained. Being a doctoral scholar demonstrates dedication, grit, and motivation.

Project Development

The development of a research study taught me the importance of alignment of all the components. The key to a quality research study is ensuring that all components of the study are aligned (Butin, 2010). Alignment creates cohesion between the problem statement, purpose, conceptual framework, research questions, and methodology. I learned that the purpose of the study should flow naturally from the problem statement. The research questions should also be aligned with the purpose, problem statement, and conceptual framework. The design alignment tool was helpful in aligning all the components of the study, producing more comprehensive research.

One of the most valuable lessons was that the research questions and the conceptual framework guided the whole data collection process and informed the major themes of the study. The research questions and the conceptual framework grounded the study. The research questions guide the data collection process, and the conceptual framework allows readers to make sense of the phenomenon being studied by connecting theory and context which explains the importance of a topic of study (Ravitch & Carl, 2016). The conceptual framework helped me to understand how my positionality and identity as a middle mathematics teacher influenced the way I collected and analyzed data.

Another valuable lesson that I learned was the willingness of participants to engage in conversations about incorporating technology to transform learning. The participants were eagerly seeking to know how ways in which they could increase students' engagement and motivation primarily during the era of remote learning. The participants expressed their concern about unfinished learning as a result of students who were not motivated to engage synchronously and asynchronously. Therefore, creating a professional development plan required much thought and research about tenets of effect technology professional development as well as developing an evaluation plan to assess the efficacy of professional development required critical thinking and decision-making. I had to be cognizant of the most effective program evaluation approach and the best data collection tools to ensure that the technology professional development will be implemented with fidelity and efficacy.

Leadership and Change

Leadership is a multifaceted phenomenon. Embarking on this doctoral journey helped me recognize that one of the most important attributes of leadership is the willingness to learn. At the center of my role as a researcher, leading this project involved learning how to conduct a valid and credible quantitative case study research. I had to learn how to sync each component of the study into a comprehensive whole. Other key components of leadership include being team-oriented humble, open, moral, and willing to build capacity. I have been influenced by leaders who are team-oriented and believe that the strength of the organization lies in the collective power of the group. These leaders believe that motivating others to support the common goal of the organization is key to engendering change (Northhouse, 2016). These leaders are focused on building and sustaining trust and respect; therefore, they welcome open and honest feedback.

Another important tenet of leadership is creating leadership opportunities for others. The technology professional development plan encouraged the use of internal technology coaches to lead the professional development sessions. Creating future leaders is essential to ensuring the sustainability of the institution. Therefore, allowing faculty members to act as emergent leaders. and to reach their true potential is essential to change (Northouse, 2016). This process of distributive leadership builds capacity, foster collaboration, and empowers followers (Fullan, 2011).

During these unprecedented times, educational leaders have to reexamine and modify established systems such as the models of teaching. During this research process, I have worked with leaders who embraced the notion of changing how students are educated. Remote learning has caused educational leaders to reassess how to engage learners. This has propelled the move towards providing effective technology integration training for teachers. As a learning leader, I have become more aware of how to motivate and encourage. This learning helped me create a technology professional development that would effectively support middle school mathematics teachers' use of technology to transform instruction.

Reflection of Self as a Scholar

At the start of my doctoral studies, I was timid but excited to embark on a new academic journey. I had some trepidation because this entire journey was new to me: this was my first time studying online and my first time studying in the United States. I initially struggled with the acceptable writing style and use of English. However, the support and feedback from exceptional professors helped me with my writing. As a scholar, I believed this journey would have been similar to my previous studies in terms of workload and level of critical thinking. However, pursuing doctoral-level studies was significantly different from the bachelor's and master's degree work. Doctoral-level work was not just a "sit and get" situation, instead of as a scholar I was required to think critically about how to make informed decisions about educational systems.

The doctoral journey requires motivation, grit, commitment, and being cognizant of setting boundaries. As a scholar and an intermediate leader in my school, I had to deliberately set boundaries by creating a schedule that delineated time for work and time to work on my studies. Though I did not slavishly adhere to the schedule, it provided a guide and kept me on-track with completing assignments and completing the research process. As a scholar, I also learned to set realistic goals and to reward myself when those goals are achieved.

As a Walden University scholar, I recognize the importance of aligning research on social change. This was my first experience with relating studies to effecting social change. This was at the forefront of my mind as I embarked on my research study. As I developed my research study, I was concerned about the ability of the findings to engender positive change. However, as the project progressed I recognized that building the technology capacity of teachers and students is essential in this era where students need to be equipped with 21st-century competencies to effectively function in the global world. Therefore, the research has the potential to effect positive social change by improving teachers' technology literacy and empowering students to become actively engaged independent learners.

Reflection of Self as a Practitioner

After successfully educating students for 22 years, I believed that I knew a lot about what it means to provide a "good" education for my students. However, being enrolled in the EdD program with a specialization in curriculum, instruction, and assessment, has made me realize the deficits in some of my practices. This program has provided valuable tools that are paramount to improving my instructional practices. I have gained expertise in the most current research and best practices in learner-centered curriculum and instructional design, instructional strategies, effective pedagogy, evaluation, student assessment, and teacher professional development.

Pursuing doctoral studies in education has empowered me to positively influence students, colleagues, and the broader school community. I have completed education courses and research courses that have caused me to reflect on my practices as an educational practitioner, and that have also provided me skills and knowledge that are paramount to meeting the diverse learning needs of the students that I serve. Courses have taught me the importance of creating a learner-centered classroom in which there is a sharing of "power" within the classroom. Thus, instead of being the sole dispenser of knowledge, I provide the opportunity for students to share their knowledge about concepts. As a practitioner, I have used the knowledge gained from educational courses to inform my instructional practices. I also used my knowledge to lead professional development on learner-centered approaches and data-driven instruction.

As a mathematics teacher, I am passionate about using data to inform my instructional practices. Being a doctoral student allowed me to augment my data collection and analysis skills. Based on my improved knowledge and skills about using data to adjust instructions, I was asked to lead data teams. I taught my colleagues how to use multiple data points such as formative assessment data from tests, quizzes, and skills assessments to drive my instructional practices. I worked collaboratively with different academic teams to develop and employ an ongoing cyclical model of data. Therefore, the data from formative assessments are used to modify instructional practices through differentiation, develop intervention and enrichment strategies, group students, and pace the curriculum in ways that all students may achieve improved learning outcomes.

My doctoral studies also empowered me to take on the role of leading culturally responsive teaching professional development. Learning about how to promote the success of diverse learners, provided me with the tools to help my colleagues understand biases in the curriculum and develop strategies to address and mitigate biases in instructional practices. In our current social climate students of color across the United States are beset with fear of physical violence. However, as educators, we must also be cognizant of the emotional stress and fears that our diverse students face daily. Educators and administrators must become culturally competent and engender cultural competency to echoed throughout the entire school community. Based on this understanding, my colleagues and I worked collaboratively on unit internalization to ensure that we were fostering culturally responsive teaching within our classrooms.

Becoming more culturally aware can positively influence educators’ instructional practices and improve student engagement (Moule, 2012). For instance, understanding that African American students codify life differently and place great value on learning outside of the classroom (Moule, 2012); means that I would have to engage more with families and learn what is going on in their communities then make connections to what is being taught. Moule (2012) noted that African American students are more engaged when instructional practices connect what is happening in the classroom to what is happening in their communities. As it relates to supporting Latinos/as students, I now understand why in previous years those students did not readily participate in activities that involved “playing” with food. I have changed how I teach students the relationship between the volume of a cone and a cylinder, instead of using rice as I did in previous years, I used sand. I also used tennis balls to teach about spheres and hemisphere instead of using oranges.

Gaining comprehensive knowledge about different educational theories and concepts has aided in my professional development. As a scholar-practitioner, I now understand the importance of being a lifelong learner. Education is a dynamic field; therefore, keeping abreast of changes in educational theories and best practices, is essential to providing quality education to students. Making the connection between theories and practice has improved my overall pedagogy and leadership skills. My students have become more engaged learners, my instructional moves have improved significantly, I have embraced a learner-centered approach, and I have become a more critical thinker.

Reflection of Self as a Project Developer

Before embarking on my doctoral journey, I completed four research studies as partial fulfillment of my bachelor’s and master’s degree programs. However, my previous studies were in the form of a dissertation. My prior research studies focused on broader educational issues, for instance, my masters' degree investigated the relationships among some learner variables and a set of United States grade eight students' performance on the end of grade reading comprehension test. This research sought to fill a gap in knowledge about practice; thereby, making an original contribution to the education field. I initially planned on doing a dissertation as partial fulfillment of my doctorate in education. However, I was interested in applying my research to addressing a gap in practice in a local setting. I aimed to develop a study to empower mathematics educators to use technology to transform their instructional practices.

As a novice project developer, I had to work assiduously at creating a project that could be addressing a gap in practice. Though I was cognizant that a project study would require the development of a product to address the gap, I was not sure what the final product of the study will be. I reflected on how to best help middle school mathematics teachers to incorporate technology at the transformational levels of the SAMR model. The only logical project direction that I could take was creating a technology professional development to support all teachers based on their needs. Therefore, I started to do comprehensive research on the most effective ways to engage teachers in technology training. Organizing the literature and aligning the information to the themes from the data-informed a comprehensive study that may be modified to support all grade-levels and academic disciplines.

Reflection on the Importance of the Work

Positive social change is a key element of the Walden University mission and vision. Walden University trains and inspires scholars to become leaders of change. Therefore, Walden scholars are equipped with the knowledge and skills needed lead positive change within our organizations and the society. As a Walden scholar I am tasked with upholding the mission and vision of the institution by applying the skills and knowledge learned to solve real-world issues. Being a member of the Walden community will provide me with the tools needed to continue to champion the mission of engendering positive social change. I see myself as a change agent who is willing to educate, engage, and mobilize individuals to identify and address educational issues that continue to perpetuate the achievement gap.

Doctoral and research work are of paramount importance in the field of education. Education is a dynamic discipline that cannot effectively function in a static environment. Since education is such a dynamic discipline, the doctoral program in education educated me about current best practices, effective teaching, evaluation, and student assessment that will meet the diverse needs of students. I believe that all educators must learn new ways to engage learners. In the 21st-century, schools should be providing students with skills and knowledge that are required to function effectively. The curriculum for this doctoral program was comprehensive which provided me with a wealth of knowledge and skills that will help me become a better educator and a leader.

The COVID-19 pandemic has impacted the way we engage learners, I believe that my project study is very timely and relevant to the issues that schools are facing today.

Providing educators will skills and knowledge to engage learners, remotely or in a hybrid setting, will reduce the level of stress and anxiety that educators may experience while working online. This major change in education illustrates the importance of continuous learning in the field of education.

Implication, Applications, and Directions for Future Research

One of the major themes from the research study indicated that middle school mathematics teachers primarily used technology to substitute and/or augment to enhance traditional instructional practices. It was also found that the teachers were not averse to using technology; however, they expressed the need for technology training. The connection between the use of technology and training implies that there would be a paradigm shift in the teachers' use of technology if they are trained in how to use technology to transform mathematics instruction. The data indicated that teachers who were trained in using technology were more likely to integrated technology to enhance and transform mathematics instruction. This implies that there is a correlation between the use of technology and teachers' technology competencies.

The research study explored middle school mathematics teachers' use of technology to transform instruction. Although the study was limited to middle school mathematics teachers, the study may apply to other grade-levels and other academic disciplines. Additionally, the study was conducted in an independent school. The study may apply to other school systems in which a similar problem exists, where technology is being used to enhance rather than transform instructional practices.

The technology professional development plan was applied to an independent school, with a small number of mathematics teachers. However, the application of the professional development plan may be transferred to other school systems in which a similar problem exists, where technology is being used to enhance rather than transform instructional practices. The technology professional development plan may be effective for any group of teachers who are having challenges with implementing technology at the modification and redefinition levels of the SAMR model of technology.

This study was limited to middle school mathematics teachers' use of technology to transform instruction at an independent school. However, I would recommend that future research be conducted to extend this study to other school systems and subject areas. Qualitative case study methodology was used to examine middle school mathematics teachers' use of technology to transform instruction. Future research may use different methodologies to investigate the phenomenon. I would recommend using quantitative methods to investigate the relationship between teachers' use of technology and the level of implementation in their instructional practices. Therefore, employing correlation research methods would allow researchers to collect data to determine the degree to which a relationship exists between variables. The technology professional development plan focused on using the internal technology coach model to lead tiered training sessions. I would recommend future studies on using a different model to deliver professional development to teachers.

Conclusion

In section 4 of the project study, I presented the strengths and limitations of the study. I reflected on myself as a scholar, practitioner, and project developer. I presented recommendations for alternative approaches to the study and future research. I also reflected on the importance of engaging in research and the impact that the work could have on effecting social change. Finally, I outlined the implications of the study and how the findings and methodology may apply to other studies.

This study examined middle school mathematics teachers' use of technology to transform instruction. The findings indicated that when technology was used in mathematics classroom, it was used to enhance instruction rather than transform the teaching-learning process. According to the NCTM (2016), using technology at the transformative levels of the SAMR model of technology improves student engagement, fosters higher-level thinking, increase students' academic performance and reasoning in mathematics. The findings also indicated that teachers were willing to incorporate technology into their practice; however, they needed to be targeted ongoing training to develop the skills and competencies to use technology at a higher level. In March 2020 schools across the United States decided to close their physical space to protect students and staff. Administrators and teachers were tasked with engaging learners in a remote classroom setting. This posed a challenge for educators who were not technologically literate and savvy. Educators had to be taught how to use different platforms to teach and assess students. This phenomenon revealed the importance of using technology as a teaching tool in the 21st-century.

Qualitative research methodology was employed to collect and analyze data about middle school mathematics teachers' use of technology to transform instruction. Qualitative methods transcend strict compliance to a research method and design in that the fidelity of participants and their experiences provides a more holistic description of the phenomenon (Ravitch & Carl, 2016). Thus, I believe that it was important to use qualitative techniques such as interviewing to gain first-hand insight into the teachers use of technology and factors that were hindering teachers from using technology to transform instruction. This research has the potential to steer social changes within school systems by providing recommendations for system-wide changes geared towards empowering middle school mathematics to become technology literate which will lead to a paradigm shift in the use of technology in the classroom. This shift has the potential to improve students' academic performance, critical thinking, and problem-solving skills. Therefore, educators intentionally augment their technology competencies to adapt instructional approaches designed to effectively prepare students with 21st-century that enhance communication, critical thinking, collaboration, creativity (Jacobs, 2010). It is crucial that students are equipped with the 21st-century competencies to effectively function in a world that is changing at warped speed.

Completing a doctorate in education required hard work, dedication, tenacity, and support. Working with a research committee provided academic support throughout the research process. My research committee chair and second members proved invaluable at all stages of the research process, providing constructive feedback that successfully guided my entire research. As I embarked on an online doctoral program, I believe that it was imperative that my team and I were transparent, respectful, and openly communicated throughout the process. Though the doctoral journey was challenging, my professors and the doctoral committee made the work seem manageable because of their unwavering support, I salute their professionalism and care. I am motivated to continue to contribute to the education discipline by conducting studies geared toward improving student achievement.

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Appendix A: The Project

Technology Professional Development Plan for Supporting Middle School Mathematics Teachers Use Technology to Transform Instruction

Project Overview

Research literature indicated that there exist benefits to using technology at the transformational levels of the SAMR model of technology. The NCTM (2016) found that when mathematics teachers engage in using modification and redefinition activities to transform their instruction, student engagement increases, and students' critical thinking and problem-solving skills improve significantly. As a result, students' overall performance in mathematics improves (NCTM, 2016). However, the outcome of a qualitative case study that found that middle school mathematics teachers primarily used technology at the substitution and augmentation levels of the SAMR model of technology. Therefore, the main purpose of technology was to enhance rather than transform instructional practices. The findings indicated that middle school mathematics teachers were not averse to using technology at higher levels; however, insufficient technology integration training precluded their use of technology at the transformational threshold of the SAMR model of technology. Additional research literature review illustrated the importance of engaging teachers in individualized, ongoing, job-embedded technology professional development to support teachers with incorporating technology into their instructional practices. This resulted in the creation of this technology professional development plan. The goal of the technology professional development plan is for middle school mathematics teachers to use technology to transform instructional practices. The desired outcome is capacity building and confidence with effectively implementing digital technology at the modification and redefinition levels of the SAMR model of technology. This outcome has the potential to improve students' reasoning, problem-solving, and critical thinking skills, which will ultimately result in improved student performance in mathematics (NCTM, 2016).

The objectives of the PD plan are to train teachers to use technology beyond the enhancement level of the SAMR model of technology and mitigate the factors that may be hindering the use of technology at the transformational level of the SAMR model of technology. The success of the technology professional development plan is will be measured by middle school mathematics teachers' use of technology at the transformational levels of the SAMR model of technology. This will be demonstrated through lesson and unit planning including the incorporation of technology activities at the modification and redefinition levels of the SAMR model of technology. Technology coaches will also observe and provide feedback to the teachers about technology implementation at the transformation levels of the SAMR technology model. The TPACK model of technology was used as the framework for developing the professional development plan. This will ground the continuous job-embedded professional development throughout the school year. The technology professional development plan includes the timeline for implementation, *Google* Slides, technology coach evaluation tools (checklist), and formative and summative evaluations to assess the goals and objectives of the plan.

The first session of the technology professional development will be held on the first professional development day in January 2021. In this session, middle school mathematics teachers will have a short discussion on the findings from the qualitative case study. This session will be led by the curriculum, instruction, and assessment leader and the mathematics department chair. Teachers will also be introduced to the conceptual framework that will be used to support the technology professional development plan. The middle school mathematics teachers will also complete an online technology needs assessment to determine the level of training that they will require to use technology to transform instruction. Another outcome of this session is to select technology coaches to lead professional development sessions, based on their degree of technology competencies. The outcome of this session will be to organize teachers into tiers/cohorts based on their technology competencies that were identified in the need assessments. This will inform the level of training that each teacher will need to successfully incorporate technology to transform mathematics instructions. During this session, the middle school mathematics teachers will work collaboratively in their cohort to develop 2 – 3 short-term and long-term goals.

On the second day of the professional development week, middle school mathematics teachers and the technology coaches will engage in two different sessions. During this session, each cohort will continue to work together to establish short-term and long-term technology goals. Each cohort will be supported by external technology coaches in setting measurable, relevant, and timely goals. The internal technology coaches will receive training on being emergent technology leaders. This training will be conducted virtually by external technology coaches and the director of technology. The outcome of this session is building the capacity of the internal technology coaches by providing them with the knowledge, skills, and materials needed to successfully lead the technology professional development. Another outcome of this session is well-developed short-term and long-term goals from each cohort of middle school mathematics teachers.

On the third day of training, the middle school mathematics teachers will work in their technology cohorts to learn about how to incorporate technology into their instruction. Cohort #1 will begin with the basic use of technology at the substitution and augmentation levels of the SAMR model instead of traditional instructional practices. Cohort #2 will review substitution and augmentation mathematics activities and practices and then focus on using modification and redefinition practices and activities to transform the teaching-learning process. Cohort # 3 will review using technology at the higher levels of the SAMR technology model. This cohort will then work on honing their skills and knowledge about how to use technology to modify and redefine their instructional practices. The outcome of this session is teachers will start to create lesson plans that specifically delineate the use of technology throughout the lesson.

The professional development plan will be ongoing throughout the school year. Middle school mathematics teachers will engage in technology training during their regularly scheduled professional development calendar days. In addition to the sessions, the program will be evaluated by employing an objective-based approach to determine if the activities of the program are aligned to the desired outcomes of the project. The teachers and the technology coaches will provide ongoing feedback through formative evaluations which determine if adjustments need to be made to ensure the success of the technology professional development plan. Google Forms will be used as the tool to collect quick formative data on method of delivery, pacing, and resources. A summative evaluation will be used to determine if the program achieved its overarching goal. This data will be measured against the outcome of the project based on the logic model flow chart for middle school math teachers' technology professional development.

Roles and Responsibilities of Participants

Participants	Roles and Responsibilities
Associate Director of Programs	The associate director of programs to ensure that the infrastructure, resources, finances, and personnel are available to effectively support the implementation of the technology professional development plan. This individual must approve all aspects of the plan and the evaluation process.
Curriculum, Instruction, and Assessment (CIA) leader	The CIA leader will coordinator the technology professional development plan. This individual will work with the mathematics department chair and the director of technology to plan the program and ensure that all the components of the program are functioning effectively. The CIA leader will lead the initial professional development. The CIA leader will be the point of contact for the participants. The CIA will meet with the mathematics department chair, director of technology, and technology coaches to discuss how the program is progressing. This individual will visit middle school mathematics teachers' classes to assess their implementation of technology. Additionally, this individual will report to the associate director of programs.
Director of Technology	The director of technology will ensure that the technology infrastructure at the school can support middle school mathematics teachers' use of technology to transform instruction. This individual will also work with technology coaches to sharpen their technical skills. Additionally, the director of technology will provide technical support to the teachers.
Mathematics Chair	The mathematics department chair will help the technology coaches with facilitating professional learning communities during department meetings. The mathematics department chair will ensure that technology integration aligns with the mathematics curriculum. This individual will also examine each middle school mathematics teacher's curriculum map to see where technology is implemented into the curriculum. Additionally, this individual will review teachers' lesson plans and unit plans to determine the level of technology integration.
Technology Coach	The technology coaches will support tiered technology professional development sessions throughout the school year. The technology coaches will also be responsible for keeping abreast of research-based technology best practices. This individual will also be responsible for supporting teachers with updated technology resources. Additionally, technology coaches will be responsible for conducting formative evaluation, providing continuous feedback, and adjusting training to meet the technology integration needs of middle school mathematics teachers.
Middle School Mathematics Teacher	Teachers will engage in technology professional development with fidelity. The teachers will provide feedback to the technology coaches and use the feedback and recommendations from technology coaches to inform their practice. Also, middle school mathematics teachers will incorporate technology into their lessons at the transformation level of the SAMR model of technology.

Project Timeline

Professional Development Week: The CIA leader and the mathematics department will present the findings from the study and the technology professional development plan. During this week, teachers will take a need assessment survey to determine middle school mathematics teachers' degree of technology competencies to place teachers in cohorts. Internal technology coaches will be selected from among middle school mathematics teachers. These coaches will be trained by external technology coaches. Each technology cohort will work collaboratively to develop short-term and long-term goals. The CIA leader will work collaboratively with the technology coaches and the mathematics department chair calendar technology professional development sessions for the middle school mathematics teachers.

Week 1: Technology coaches will work with their technology cohorts to develop and establish working norms. The technology coaches will also provide resources to the teachers. Technology coaches will work with their cohort to develop a cyclical model of coaching, observing, and feedback. This will be used to create a coaching calendar for the school year. The technology coaches will also introduce the teachers to the objective-based approach that will be used to evaluate the program. The technology coaches and their cohorts will complete a formative evaluation to determine the strengths of the program and areas for improvements.

Week 3: The technology coaches and their cohorts will discuss the findings from the formative evaluation. The technology coaches will work collaboratively with their cohorts to adjust the professional development process and the calendar to meet the needs of the teachers. The data will inform future bi-weekly coaching, observation, and feedback sessions. The teachers and the technology coaches will work collaboratively to redefine the goals of the professional development plan based on the feedback about the pace, resources, and content of the professional development.

Week 5 and beyond: Technology coaches will continue to lead a bi-weekly cyclical process of technology training, observation, and feedback as a process of support middle school mathematics teachers in incorporating technology at the transformational levels of the SAMR model of technology. The technology coaches will work with their cohorts to develop lesson plans that incorporate technology in the teaching-learning process. Technology coaches and teachers will complete a formative evaluation of the process on a bi-weekly basis. These evaluations will be used to inform the professional development process. Technology coaches will meet monthly to discuss their progress. The coaches will also discuss current research on technology integration and ways in which to adjust the training model to reflect more current practices. The coaches will also meet with the CIA leader and the mathematics department chair to discuss the progress of the professional development plan. During the final week of the 21- 22 school year the teachers, technology coaches, and mathematics department chair will complete a summative assessment of the technology professional development to determine if the plan achieved its goals and desired outcomes. The CIA leader will assess the findings presented by the technology coaches and the mathematics department chair to determine plans for future technology professional development.

Materials

- Technology Needs Assessment
- Formative and Summative evaluations
- Timeline for Technology Professional Development Implementation
- Google Slides

Technology Needs Assessment	
Select the level that best describes your technology competencies	
Beginner	Limited technology skills and knowledge. Requires technology support.
Average	Moderate knowledge of some technology programs and applications. Requires some help with technology.
Advanced	Proficient in the use of a myriad of digital technology. Does not require additional technology support.
How often do you use technology in your mathematics instruction?	
Not at all	
Once per month	
Weekly	
Almost every class	
Every class	

Select the level of technology that you most frequently use in your class.	
Not at All	Only use traditional models of teaching
Substitution	Use technology as an alternative for teaching and learning with no functional change.
Augmentation	Use technology as a substitute for traditional instructional practices, with functional improvements.
Modification	Use technology at a level that allows for a functional redesign of instructional practices.
Redefinition	Use technology at a level that allows for the creation of tasks that can only be completed with digital technology.
Using the 5-point scale below, indicate your level of comfort with incorporating technology at the modification and redefinition levels to transform mathematics instruction.	
1	Very uncomfortable
2	Uncomfortable
3	Somewhat comfortable
4	Comfortable
5	Very comfortable

Use the space below to answer the following open-ended questions
1. How did you incorporate technology during remote learning? 2. What type of technology development would be most beneficial to help you implement technology to transform your instructional practices?

Formative Evaluation for Middle School Mathematics Teachers

The teacher will be asked to answer the following questions using Google Form. This process will be completed bi-weekly as a part of the professional development cycle.

1. Did you use technology in the past two weeks at a higher level?
2. Based on the mathematics activities for each level of the SAMR model, which level of technology did you use most frequently since the last training?
3. Describe one way in which you used technology this week?
4. Did you feel like you had enough support from your technology coach with the implementation of technology? Why? Why not?
5. What would be most beneficial in implementing technology into your instructional practices?
6. Provide suggestions that will help the technology coaches the best support your technology integration needs.
7. Check all that applies:

   ________ This week I integrated technology into my instructional practices.

   ________ This week I integrated technology into assignment and assessment.

   ________ This week I used at least one technology activity at the transformation level of the SAMR model of technology.

________ This week I collaborated with colleagues to create lesson plans that required the use of technology at the transformation level of the SAMR model of technology.

________ This week my students collaborated using digital technology.

8. Provide any feedback that will help the program achieve its goal and desired outcome.

Formative Evaluation for Technology Coaches

1. How did you support teachers this week with technology implementation?
2. What were some areas of success and areas for improvement?
3. Did you support teachers with incorporating technology into their lesson plans?
4. Did you have to adjust any of your professional development sessions? Why?
5. Describe your overall views of supporting middle school mathematics teachers with integrating technology into their instructional practice.
6. Provide any additional information below.

Summative Evaluation for Middle School Mathematics Teachers

1. Describe your overall experience with the ongoing job-embedded technology professional development.
2. What aspects of the professional development was most beneficial? Why?
3. Which aspects of the professional development plan need to be improved? Suggests areas for improvements.

4. Describe how engaging in the technology professional development influence your use of technology in your classroom.
5. Do you believe that the tiered model for delivering the professional development was effective? Why? Why not?
6. Do you believe that having your colleagues lead as technology coaches were beneficial? Why? Why not?
7. Do you have any additional suggestions to improve the professional development plan for the next school year? Please list.

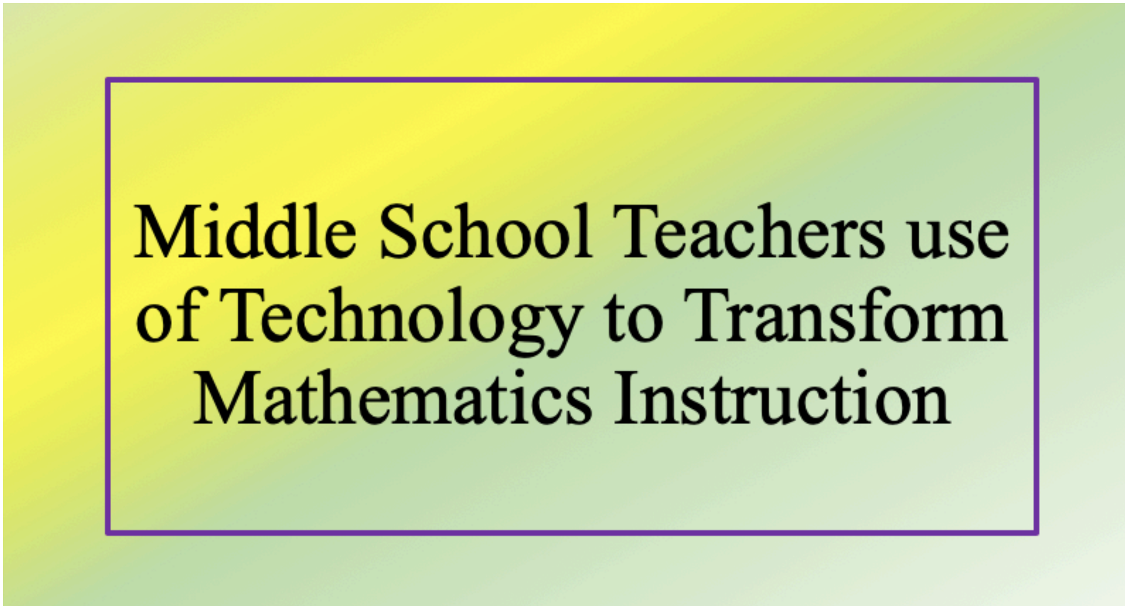
Summative Evaluation for Technology Coaches

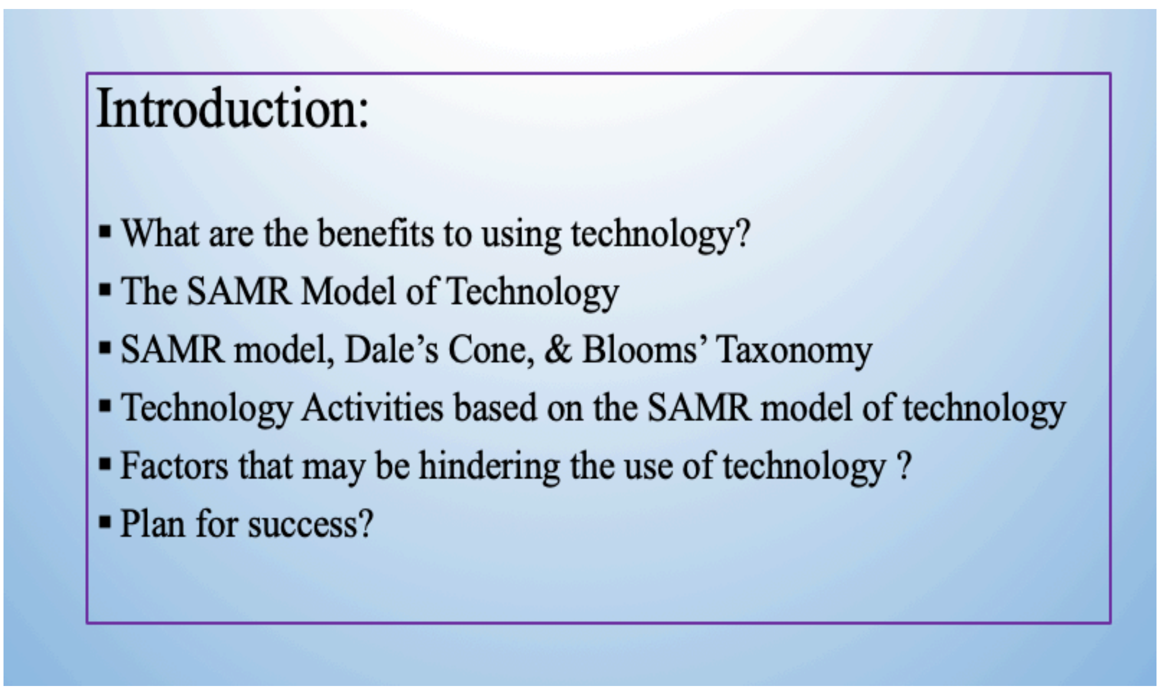
1. Describe your overall experience with leading ongoing job-embedded technology professional development.
2. Do you believe that the tiered model for delivering the professional development was effective? Explain.
3. How did data from the formative evaluations inform your practices throughout the school year?
4. Did you use current technology research to adjust your professional development sessions?
5. Do you feel that your role as a technology coach influence middle school mathematics teachers to use technology to transform their instruction? Explain.
6. Do you have suggestions to improve the professional development plan for the future school year? Explain.

Timeline for Technology Professional Development

January	▪ Present research findings ▪ Present an overview of the technology professional development plan ▪ Train technology coaches ▪ Conduct needs assessment survey ▪ Establish technology professional development days ▪ Place teachers in technology cohorts based on technology competencies ▪ Set short-term and long-term technology integration goals ▪ Bi-weekly meetings
February	▪ Begin cyclical coaching cycle: coach, observe, provide feedback. ▪ Technology coaches meet with CIA leader to discuss the areas of strength and areas that need improvement ▪ Address changes based on formative evaluation ▪ Bi-weekly meetings
March	▪ Technology coaches attend training session to shore up on their method of delivery ▪ Continue cyclical coaching cycle: coach, observe, provide feedback. ▪ Adjust professional development based on research, current training, and formative evaluation. ▪ Bi-weekly PLC ▪ Monthly meeting with CIA leader and director of technology
April	▪ Continue cyclical coaching cycle: coach, observe, provide feedback. ▪ Use formative evaluation to inform necessary changes ▪ Bi-weekly PLC ▪ Monthly meeting with CIA leader and director of technology
May	▪ Continue cyclical coaching cycle: coach, observe, provide feedback. ▪ If necessary, use formative data to modify the content and pace of the technology professional development ▪ Bi-weekly PLC ▪ Monthly meeting with CIA leader and director of technology
June	▪ Whole group meeting (middle school mathematics teachers, mathematics department chair, CIA leader, and the director of technology ▪ Reflection on technology integration ▪ Summative evaluation of the technology professional development ▪ Development of a plan to sustain technology use for the upcoming school year.
August	▪ Use summative evaluation data to inform changes to the technology professional development for the new school year. ▪ Provide training for technology coaches ▪ Communicate the findings of the technology professional development during a scheduled professional development day
September - November	▪ Continue cyclical coaching cycle: coach, observe, provide feedback. ▪ Formative evaluation of the process ▪ Bi-weekly PLC ▪ Monthly meeting with CIA leader, mathematics department chair, and director of technology
December	▪ Summative evaluation to determine if teachers would benefit from additional technology professional development ▪ Recommendations for future training

Session 1: Google Slides Presentation

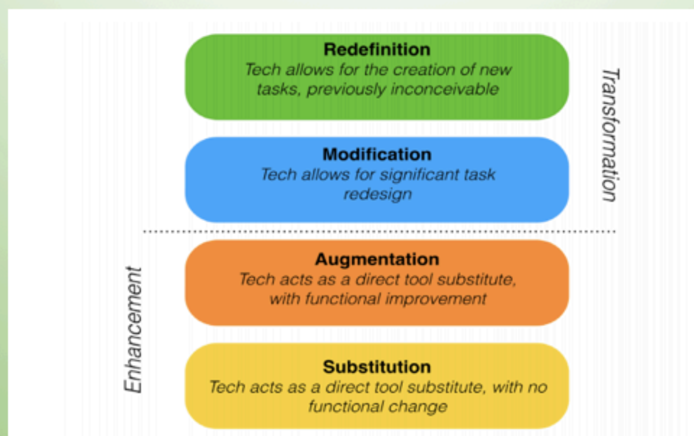




Some Benefits of Using Technology to Transform Instruction

- Incorporating technology allow teachers to differentiate and individualize instruction to meet the diverse learning needs of students (McKnight et al., 2016)
- Incorporating technology can enhance student participation (Cox, 2019).
- Incorporating technology enhances collaboration and allows for immediate feedback which improves student learning outcomes (Cox, 2019; Eyyam & Yaratan, 2014; McKnight et al. 2016).
- Using technology at the transformational level of the SAMR model of technology provides the unique opportunity for students to explore mathematical concepts beyond the classroom which increases students' access to information and ideas; enhances collaboration and communication; and fosters critical thinking (NCTM, 2016).

SAMR Model of Technology

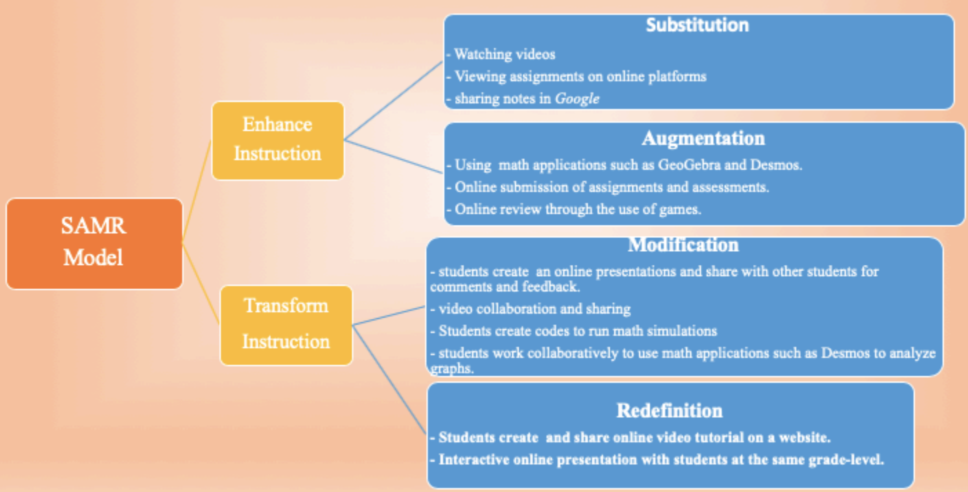


SAMR model of technology integration (Puentedura, 2009).

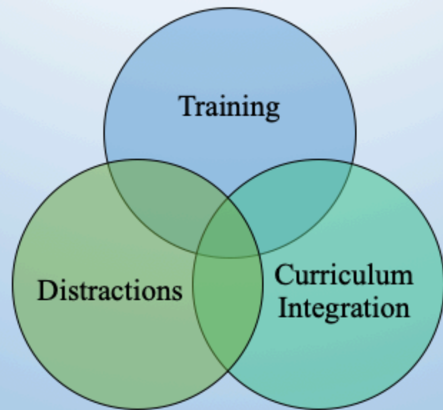
SAMR Model, Dale's Cone, & Bloom's Taxonomy

Illustration of how the levels SAMR technology model (Puentedura, 2009) are related to Bloom's Taxonomy, and Dale's Cone of Experiences

Technology Activities based on the SAMR model of technology



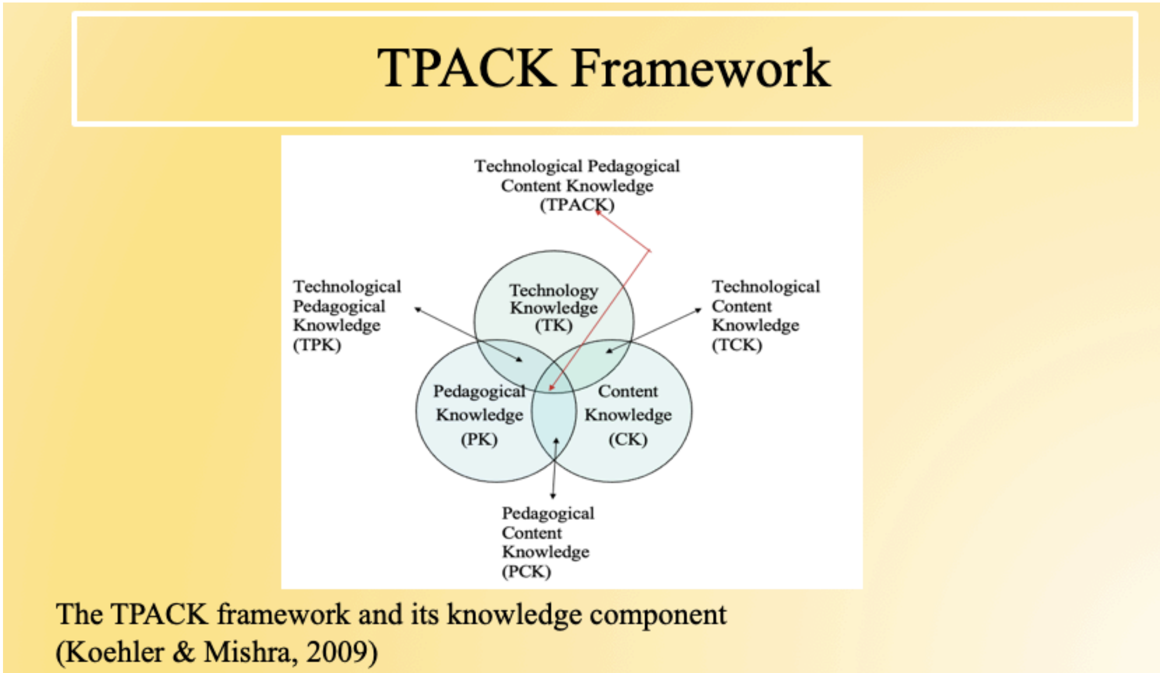
Factors are Hindering Technology Integration to Transformation Instruction

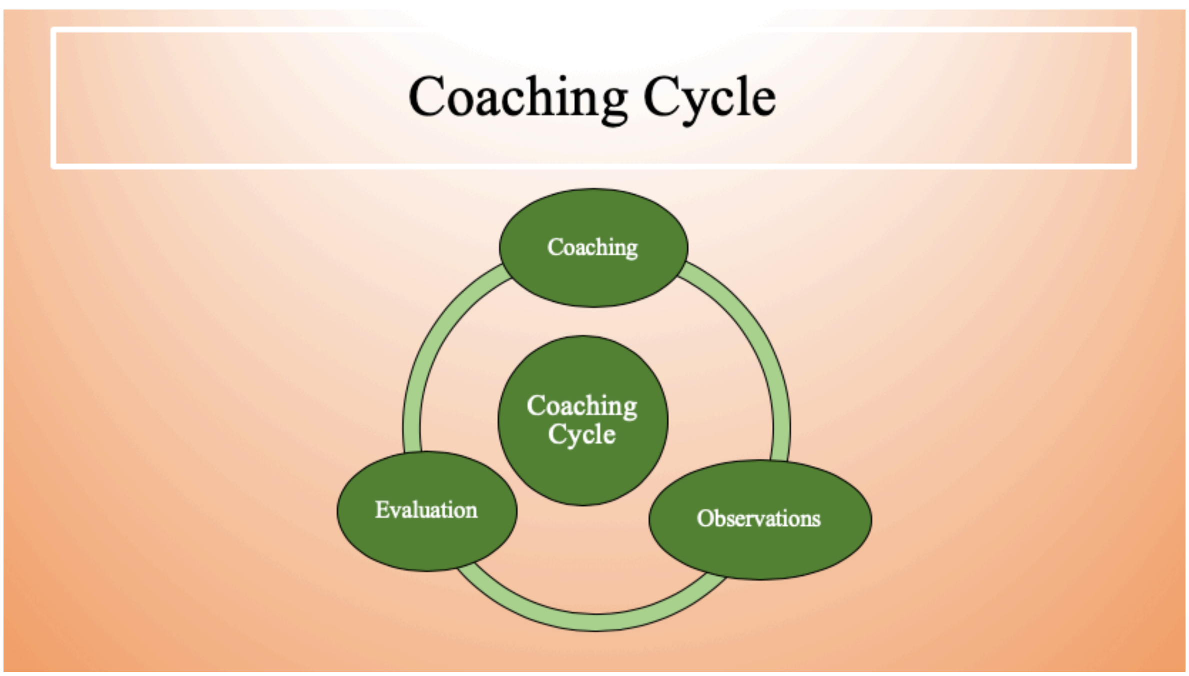


Plan for Success

On-going, Job-Embedded, Tiered Technology Professional Development

- Today you will complete an online needs assessment survey.
- A team will work collaboratively to organize the data.
- Results from the survey will be used to place middle school mathematics teachers in technology cohorts for the afternoon sessions
- Technology coaches will lead and support technology cohorts.
- Middle school mathematics teachers will then be trained on how to integrate technology to transform instructions.
- Middle school mathematics teachers will collaborate in bi-weekly technology PLCs during planning.
- The technology plan will be evaluated: formal evaluation and summative evaluation.


TPACK Framework
Technological Pedagogical
Content Knowledge
(TPACK)
Technological
Pedagogical
Knowledge
(TPK)
Technology
Knowledge
(TK)
Technological
Content
Knowledge
(TCK)
Pedagogical
Knowledge
(PK)
Content
Knowledge
(CK)
Pedagogical
Content
Knowledge
(PCK)
The TPACK framework and its knowledge component
(Koehler & Mishra, 2009)


Coaching Cycle
Coaching
Coaching
Cycle
Evaluation
Observations

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Appendix B: Observation Protocol

Observation Protocol

The observational checklist was used during 30-minute class section to collect detailed notes and descriptions related to the purpose, problem statement, and research questions.

Observation checklist
Date: ______________________ Grade Level: __________________ Period: _____
Was there evidence of technology use? Yes No
If technology was used who used the technology? Teacher
Students
Use of digital technology:

- digital technology acts as an alternative for teaching and learning with no functional change (Substitution)

  Notes:

- digital technology acts as a substitute for traditional instructional practices, with functional improvements (Augmentation)

  Notes:

- digital technology allows for a functional redesign of instructional practices (Modification)

  Notes:

- digital technology allows for the creation of tasks that can only be completed with digital technology (Redefinition)

Notes:

Additional notes:

Appendix C: Interview Guide and Interview Questions

Interview Guide

Date: _______________

Time:_________________

Parts of the Interview	**Interview Questions**
	Hi, I am Camille James. Thank you for participating in my research project that is titled, middle school mathematics teachers use of technology to transform mathematics instruction. The purpose of the interview is to gain insight into the level at which you use technology and what may prevent the use of technology to transform instruction. This should last np more than 60 minutes. I will use you answers as a part of my data analysis. I will not identify you in my documents, and no one will be able to identify you with your answers. You can choose to stop this interview at any time. Also, I need to let you know that this interview will be recorded for transcription purposes. ▪ Do you have any questions? ▪ Are you ready to begin?
Interview Question 1	How comfortable are you with using technology in your classroom?
Interview Question 2	Can you provide examples of how you incorporate technology into your mathematics instruction?
Interview Question 3	What are your views on digital technology as an instructional tool?
Interview Question 4	What supports and encourages the use of technology inside the classroom?
Interview Question 5	What barriers that may be keeping you from using digital-technology initially and/or completely in classrooms, beyond substituting and/or augmenting traditional methods?
Closure	▪ Thank you for your answers. Do you have anything else you'd like to share? ▪ Do you have any questions for me? ▪ Thank you for your time. Goodbye.