EFFECTIVE INSTRUCTIONAL PRACTICES: SECONDARY SCHOOL TEACHERS VIEW ABOUT TEACHING SECONDARY MATHEMATICS WITH TECHNOLOGY

by

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To my lovable parents
who are my first teachers

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ABSTRACT

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The study explores the integration of technology in teaching mathematics, providing current secondary mathematics teachers with effective practices and guiding future mathematics teachers toward a technology-pedagogical approach. In this study, I focused on effective teaching practices with technology in teaching mathematics to current secondary mathematics teachers to guide future mathematics teachers in adopting a technology-pedagogical approach. This research addressed secondary mathematics' preparedness level to implement effective teaching methods in the digital age. A district from a Midwest state was used to collect data using a sequential explanatory method; a survey was sent to the secondary mathematics teacher with an option for those who wanted to participate in the interview. The results indicated that current teachers have some knowledge of technological tools but not to the full extent that they can integrate them into their daily instruction. The study suggested that current secondary mathematics teachers require ongoing professional development to enhance their technological knowledge and use it effectively.

These results have implications for current teachers who require well-equipped preparation using NCTM's effective instructional practices with technology in teaching mathematics. These teachers require more technology training, which can help them choose the appropriate technology to use in a particular instructional strategy. Universities must equip teacher candidates with technological skills to integrate these tools into the eight mathematical instructional practices.

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CHAPTER ONE

INTRODUCTION

Mathematics education plays a significant role in students' lifetime learning experience. Starting from Pre-kindergarten, the primary focus of education is on reading, writing, and math. Mathematics teaches students around the globe to think logically and understand mathematical concepts. Mathematics is a universal language that uses numbers, symbols, Greek letters, and equations to solve problems. Wittgenstein (cited in Raven & Skovsmose, 2019, p.121) stated, "Mathematics expresses laws pertaining to a world of ideas." Learning mathematics at an early age helps students apply the concepts in mathematical applications in business, science experiments, programming, measurements, astronomy, technology, and in every career. In addition, math develops analytical and critical thinking skills for better reasoning. Reasoning and critical skills enable logic to solve complex problems.

Learning is an ongoing process for humans of all ages, and their learning behavior changes with the environment over time. In the 21st Century, learners are more engaged in activities and interact with others to share their knowledge instead of listening to lectures. Reusser (2000) described that "learning is an active and constructive process. Even if treated in many schools as rather passive recipients of information, children are active individuals who construct and modify their mathematical knowledge and skills by interacting with the physical environment, materials, teachers, and other children" (p.18). Although, in elementary schools K-2, students learn mathematics using manipulatives to build a strong mathematical foundation, starting from third grade, learning shifts entirely to paper and pencil work. Students with fewer hands-on activities struggle to explore and connect to mathematics. Students' early active learning experience turns into passive learning from the upper elementary through secondary levels.

Secondary mathematics teachers face challenges in their classroom, struggling to engage students. Teachers are scrutinized to produce better results and follow the pacing guides, and student's academic achievement is a component of their evaluation. In the 21st Century, which is considered a digital age, teachers must have training in 21st-century integrative mathematics skills. Students are more technologically savvy and tend to learn actively with technology. Harasim (2017) described active learning with technology as "encouraging students to participate and act, such as conducting a real experiment, rather than learn passively (listening to a lecture, reading a book). Active learning is typically student-centered, and the role of the student is to engage in an activity" (p.71). Secondary mathematics teachers must change traditional teaching approaches to nontraditional ones by adopting student-centered classrooms.

In the 21st Century, the ideal role of a teacher is as a facilitator, to be no longer dependent on chalk and talk (Hidayu et al., 2019; Canses & Sabahattin, 2018). Mathematics is no longer about right or wrong answers; it is all about how many ways a student can solve a problem; it is all about their thinking and creativity. Viro et al. (n.d.) explained that "students must learn to apply and develop 21st-century skills while learning school subjects such as mathematics through project-based or applied for work" (p.14). Teaching has shifted from teacher-centered to student-centered. In the digital age, the teaching and learning process has changed, and technology tools like Google Documents for assignments and Google Forms have been used to apply for formative/summative assessments. Teachers need more training to use appropriate technology in their everyday practice.

Teacher preparation is essential to shape teachers for the future of the 21^{st} Century. Student teaching is the first teaching experience of prospective teachers. Canses & Sabahattin (2020) explained, "the pre-service teachers were not able to make enough use of learner and teacher skills during their practicum teaching at schools. Moreover, a positive, medium, and significant correlation was found between 21^{st}-century learner and 21^{st}-century teacher skills" (p. 181). Therefore, the pre-service teachers will adopt the same traditional teaching approach in their future classrooms. Currently, traditional teaching may be at odds with students' learning.

This dissertation aims to study the current teacher's experience using effective instructional practices in teaching secondary mathematics with technology in the 21^{st} Century to investigate what teacher candidates need to be prepared for. In order to better understand what is necessary to prepare teacher candidates, it is essential to know more about how current mathematics teachers feel about their preparation to teach effectively with technology. Therefore, the research question for the study was:

> How prepared do secondary mathematics teachers feel to employ effective teaching instructions in the technology age?

Background

The dilemma in the current secondary education system is challenging a traditional teaching approach. Harasim (2017) argued that "new technologies are transforming the world of work and the nature of the organizations" (p. 3). The traditional teaching approach is not effective with technology. The nontraditional teaching method with technology is more student-centered than the conventional teacher-centered teaching approach. Students prefer to work in groups to share and collaborate on their work instead of sitting in rows by themselves.

Conventional assessments measure students' growth, and students are forced to study in fixed settings. The paper and pencil assessments are designed to be completed in a specific time with either yes/no answers or multiple choices. Memorization is the norm in the K-12 education system instead of teaching students to transfer their knowledge to solve real-world tasks. Darling-Hammond & Bransford (2005) argued that "the mere memorization of information is usually not sufficient to support transfer" (p. 61). Students have an insufficient conceptual understanding of the problem-solving process by memorizing it.

Technology has changed the learning attitude, the transfer of knowledge, the methods of sharing content, and the availability of information. Tunjera & Chigona (2020) revealed that "technological advancements have made it increasingly easy to share and access this information almost instantly" (p.126). In the digital age, paperwork has transformed into cloud settings, and technology makes resources available anytime. However, in the education arena, students sit in rows, listen to the lecture, take notes, and then do bookwork on paper; teachers grade some assignments for a right or wrong answer. Walle et al. (2010) stated that students "listen, copy, memorize, and drill" (p.14). As a result, students do not get an opportunity to improve the weak performance area of the content. Technology allows teachers to provide instant feedback to students on their work instead of waiting days to get their paperwork back and losing the connection to their learning, creating learning gaps.

With the rapid technological change, the districts have tried to keep up with the technology and provide additional professional development to their teachers. Still, they have so far largely failed to provide the resources to implement new pedagogies. Warner & Kaur (2017) stated that "in secondary schools, teachers are continually encouraged to receive teacher training. However, despite all this occurring and instructional information placed in documents and sent to schools, the traditional modality of teacher-centered instructions continues as the major instructional approach" (p. 194). The main problem in 21st-century teaching was therefore identified as a lack of student-centered pedagogy; teacher candidates are adopting the traditional instructional strategies from the cooperating teacher. Current teachers must also move from a talk-and-chalk approach to a more student-centered one.

The in-service teachers need to be skilled in nontraditional approaches like blended learning, flipped classrooms, project-based learning, inquiry-based learning, math talk, and technology integration into their lessons. Warner & Kaur (2017) stated that "the classroom environment transformed into an active and interactive setting, where the learning occurred cooperatively and collaboratively" (p. 194). Technology has shifted learning behavior; students interact with others and complete tasks by sharing their ideas. Teachers can create interactive lessons using technology tools, which allows students to explore and connect mathematical concepts with real-world applications. The nontraditional approach engages students in activities, enabling them to authenticate their learning.

Consequently, pre-service teachers need to be prepared for active learning pedagogies. Tumjera and Chigona (2020) advised converting teaching into the use of technology-enhanced practice (p.126). The 21st-century learning skills teach students to inquire about concepts and creatively collaborate to solve complex problems using critical thinking. Communication is a primary component of 21st-century learning skills; students are more responsible and active learners by participating in group discussions and sharing their knowledge.

Relationship between Technology and Mathematics Education

Technology is used in everyday life for communication, education, science, sports, and business, as well as for analyzing data, and it is integrated into several fields. Technology consists of tools, systems, and applications. Weinhandl et al. (2021) stated, "Modern technologies have become an integral part in our society and are increasingly shaping the teaching of mathematics at every level of education" (p.1). Furthermore, Weinhandl et al. described, "modern technologies for teaching and learning mathematics we consider contemporary hardware products such as pads with keyboard, digital pen, and internet access as well as mathematical (e.g., computer algebra systems or 3D geometry software packages) and general (e.g., learning or central management systems) software packages." (p.2). Several applications in education benefit both teachers and students with technological tools. For example, teaching mathematics with virtual manipulatives, graphing calculators, sketchpads, and interactive whiteboards develops students' mathematical understanding. McCulloch et al. (2018) stated, "The number and variety of technological tools that teachers and students have access to in schools have risen sharply in the mathematics classroom is no exception" (p. 26). Access to technology is not limited to teaching and learning; applications like Lumio and PearDeck give teachers instant access to provide feedback and encourage students to explain their mathematical reasoning.

Using multiple technologies in mathematics teaching is challenging. In-service must know appropriate technological tools to integrate into teaching practices. Association of Mathematics Teacher Educators: Standards for Preparing Teachers of Mathematics (AMTE: SPTM (2017) identified "the need to develop expertise with spreadsheets, computer algebra systems, dynamic geometry software, statistical simulation, and analysis software, and other mathematical action technologies" (p. 117). In the digital age, students benefit from learning mathematics with simulation, for example, calculating the distance between Earth and the international space station, estimating the rate and time of traveling cars, and many more real-life applications. Serin and Oz (2017) stated, "The potential of technological devices to enrich learning and teaching of Mathematics has been recognized recently" (p. 148). Technology has changed the way of thinking and learning.

A more nontraditional approach encourages students to participate actively in inquiry-based group discussions. Students have an innovative approach to connecting the concept to real-world applications and solving complicated problems. Tumjera and Chigona (2020) described that "the use of technology in education is largely accepted to be an integral and expected part of teaching and learning in this digital age" (p. 126). A teacher's content knowledge is vital to advancing students' logical and critical thinking by connecting mathematical knowledge to real-world applications to meet diverse students' individual needs. Content and technology knowledge is imperative for current teachers to teach mathematics with the nontraditional approach using technical tools.

Based on the above arguments, my primary focus in this dissertation is to examine current teachers' views about their teaching experience using recent technological advances. Understanding the experience of in-service teachers will help clarify what the teacher candidates need to learn to prepare to teach in person and in virtual classrooms with technology.

Definitions

Effective Teaching Practices is a framework that supports teaching skills to promote students' mathematical understanding and learning. *Principles to Action* (2014) stated that "effective teaching engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically" (p. 7). Eight mathematics teaching practices are: 1) establish mathematics goals to focus learning, 2) implement tasks that promote reasoning and problem-solving, 3) use and connect mathematical representations, 4) facilitate meaningful mathematical discourse, 5) pose purposeful questions, 6) build procedural fluency from conceptual understanding, 7) support productive struggle in learning mathematics, and 8) elicit and use evidence of student thinking. I will explain these eight mathematical teaching practices in the next chapter.

Equity is a sensible term that demands accommodations to promote learning according to individual students' needs. Equity is a broad topic that includes students' identities and social justice. I will briefly discuss access and equity in the next chapter.

Nontraditional approaches, like project-based, inquiry-based, student-centered, and teacher-centered learning, have shifted the learning culture. An *inquiry-based instructional approach* is a pedagogical approach that invites students to explore academic content by posing, investigating, and answering questions. A *student-centered learning* is a learning environment where the student actively focuses on learning outcomes by participating in group discussion, using creativity to solve the assigned tasks, and the teacher facilitates completing the task.

The 21st Century is considered an epoch of knowledge. According to Boss (2015), *21st-century skills* are an aptitude that requires students to acquire specific knowledge, understand concepts, and employ strategies such as critical thinking, collaboration, communication, and solving problems creatively. Brooks-Young (2010) defined 21st-century skills as "the content knowledge and applied skills that today's students need to master to thrive in continually evolving workplace and society" (p. 6). These 21st-century skills prepare students to be creative, use critical thinking, and develop good communication skills to collaborate effectively with their team of different backgrounds.

Project-based learning has converted the climate and culture of instruction and knowledge. Urbani et al. (2017) developed a model of 21st-century teacher education programs. They stated that "current educational policy, such as the Common Core State Standards (CCSS), represents a shift away from rote learning and memorization of facts to the development of the 21st-century skills of creativity: critical thinking; communication; collaboration; and information, media, and technology skills (IMTS)" (p.27). Student-centered learning and project-based learning go together. *Student-centered learning* allows students to use 21st-century skills with their conceptual understanding. Students work in small groups collaboratively. *Student engagement* is the process of involving students actively in activities to develop critical thinking. I agree with Limniou et al.'s (2017) definition of student engagement, "for students to be engaged with their learning process a learning approach which supports knowledge" (p.198). In project-based learning, sustained inquiry is a crucial element. Students are engaged in group discussions to develop the need to know and apply the list of research ideas to the concept.

Traditional teaching is lecture-based instruction combined with individualized student practice that measures concept mastery with formative or summative assessment. In this approach, students understand the process but struggle to connect the concept to real-world applications. *Passive learners* sit in a lecture-based classroom and passively listen to the lecture, receive instructions, and get no feedback. Students take notes on long lectures and practice the concept by doing classwork/homework, and teachers do not have time to grade every question on the assignment. As a result, students receive grades for participation and effort, not mastery.

A *flipped classroom* is a strategy to engage students in learning outside the classroom. Lage et al.'s. (as cited in Limniou et al., 2017) define a "flipped classroom as a process of inverting the classroom that has traditional settings and now takes place outside the classroom with technology integration" (p.198). In the *technology-enhanced classroom,* students use technology to explore and have a conceptual understanding of the content to solve complex problems. *Active learners* engage in the instructional and learning process by participating in group discussions and working collaboratively.

A *virtual classroom* is where students participate in the class through Google Meet, WebEx, Microsoft Teams, or Zoom. Globally, during the pandemic crisis, the virtual classroom was the only option for educators to deliver instructions to their students. Teachers schedule virtual meetings and teach by using technology tools. I define *the prospective 21^{st}-century classroom* as a technology-enhanced classroom in which teachers will provide instructions using blended learning, flipped classrooms, and synchronous and asynchronous strategies.

Theoretical Framework

Learning is a life-long experience process from childhood to adulthood; adults learn differently from children. Adults are accountable for developing communities, dealing with personal and professional challenges, and sharing their experiences with others; these aspects benefit adults in learning new information, techniques, and fast-changing technology. Knowing 21st-century skills is a significant change for educators as they shift from lecture-based learning to student-centered learning, and teachers must be trained to teach mathematics effectively by differentiating students' learning. For example, Dumont et al. (2010) indicated that "the quantity and quality of learning thus become central, with the accompanying concern that traditional educational approaches are insufficient" (p. 20). In the 21^{st} Century, learning has shifted from a traditional approach to technology-based learning with the exceptional demand for competencies. Technology provides several learning options, which has changed the learning attitude.

Furthermore, Dumont et al. (2010) explained that "21^{st}-century competencies include deep understanding, flexibility, and the capacity to make creative connections, including good teamwork" (p. 20). Learners develop additional conceptual understanding by illustrating the learned concepts to real-world problems. Knowles (1984) defined "the mission of education as to produce competent people" (pp. 18-19). Therefore, there is a need for competent cooperating teachers who teach tasks using effective teaching practices. In addition, student teachers will have the experience of practical approaches to applying those instructional strategies in their future classrooms.

The brick-and-mortar approach has changed to innovative student-centered classrooms with technology. "Change is at such an accelerated pace that even some of the routine tasks of daily living require new learning" (Mariam & Bierema, 2014, p.5). With technological advancement, educators must modernize their instructional strategies to assist students in developing skills that are ready for use in the future. Darling-Hammond (2008) proposed that "students need to be prepared as self-directed, lifelong learners for jobs that do not yet exist, to use technologies that have not yet been invented, and to solve problems that we don't even know are the problems yet" (p. 11). Rapid technological change is a significant challenge for educators as they collaborate and create technologically enhanced tasks to develop critical thinking skills and prepare students to apply their knowledge in the future. Knowles (1984) suggested that "people who are able to apply their knowledge under changing conditions; and we know that the foundational competence all people must have been the competence to engage in lifelong self-directed learning" (p.19). In addition, due to a lack of resources and knowledge in technology, not all educators are proficient in technology and struggle to provide online instruction to students during the pandemic.

Meanwhile, during the pandemic, educators adopted online self-directed learning and quickly learned new technology tools and techniques to teach students virtually. Lindeman (1926) stated that "a new kind of education with its initial assumption affirming that *education is life*-not a mere preparation for an unknown kind of future living" (p. 6). During the unexpected crisis of COVID-19, *adults* instituted Lindeman's statement that *education is life by* educating themselves, learning from YouTube and Google Education to find a new way of teaching. Online learning is not a new concept for adults, and distance learning was a popular method of teaching from a distance. However, distance learning has transformed into online learning with technology. In addition, the pandemic crisis has changed teaching and learning. Because teacher candidates need to learn new, effective technology, it is essential to understand better how in-service teachers, who will become their guides during student teaching, understand these areas. The adults of the 21^{st} Century are tech-savvy and use various social media platforms to interact and learn from each other. Still, they are not acquainted with using technology precisely in teaching. As a result, it is a complex task to consider: How do adults learn to acquire knowledge, what is in their minds, and what are they thinking? "Knowledge is a central driving force for the prosperity of individuals" (Mariam & Bierema, 2014, p. 4). First, adult learning develops knowledge through observation and discussion of a specific topic of their interests, and then adults transform their learning experience with a profound understanding of the subject.

Adult learners apply their prior knowledge to uncover new ideas by interacting and observing other people's behaviors and transforming their experiences into new skills. A social learning theory encompasses learners' behavior by interacting with peers, collaborating with people of similar interests, and transforming learning experiences into lifelong knowledge. In the proposed study, I considered the social and transformative learning theories the best fit for secondary mathematics teachers with effective teaching practices.

Social Learning Theory

Several theories have been proposed on human behavior over the decades; in 1941, social learning theory was established from Miller and Dollard's initial work on social learning. Miller & Dollard (1941) stated that "human behavior is learned; precisely that behavior which is widely felt to characterize man as a rational being, or a member of a particular nation or social class, is acquired rather than innate" (p. 1). Humans represent the community and its culture from childhood to adulthood by portraying their behavior.

However, an environment influences the social behavior in which adults live instead of ultimately inheriting the cultural mindset for personal and professional growth. Also, Vygotsky (1978) argued that "learning is a necessary and universal aspect of the process of developing culturally organized, especially the human psychological function" (p. 90). In addition, Vygotsky's sociocultural theory highlights that cognitive development is contingent on a child's social and cultural background and how a child interacts with others. Likewise, Vygotsky's sociocultural theory is relevant to adults learning how adults professionally apply and share their prior practices to advance their learning.

Social learning theory is associated with behaviorism and cognitivism. Moreover, Mcleod (2016) described "social learning theory as a bridge between traditional learning theory (i.e., behaviorism) and the cognitive approach, by focusing on how mental (cognitive) factors are involved in learning" (p.2). Behaviorism focuses on the learner's behavior with the stimuli-response model, and cognitivism advocates for how the human brain processes new information. Social learning theory involves learners using several learning models, such as observations and modeling, to collaborate and develop critical skills.

In 1970, Albert Bandura combined behaviorism and cognitivism with social components. Albert Bandura studied Skinner's behaviorism and developed the social learning theory. Bandura (1971) indicated that "man's capacity to learn by observation enables him to acquire large, integrated units of behavior" (p. 2). According to Bandura, observing others encourages individuals to learn different strategies to construct and advance their learning. Bandura believed that learners could gather additional knowledge and shift their behaviors by watching others.

Learning is a social process of engaging in discussions and activities of common interests. Additionally, Vygotsky (1978) expressed that "learning as a profoundly social process emphasizes dialogue and the varied roles that language plays in instruction and mediated in cognitive growth" (p. 131). Adults demonstrate new behavior by interacting with others in unique ways, like using technology, engaging in personal and professional discussions, and observing others' behaviors to learn further information. Language plays a significant role in learning, and humans use language to express new information in a specific way. Also, Bandura (1977) revealed that "new patterns of behavior can be acquired through direct experience or by observing others" (p. 3). He suggested three observational models: a live model, a symbolic model, and a verbal instructional model. Interacting with others allows learners to share their experiences and gain new ideas through observation. In addition, educators watch and model instructional strategies to improve their teaching practices.

Social learning theory is a model of human behavior that emphasizes the social environment in which learners explore the possibilities of learning prospects. Bandura (1977) proposed four mediational processes to determine the new behavior: attention, retention, reproduction, and motivation. Bandura's social learning theory component fully applies to the need to prepare secondary mathematics teachers.

Finally, social learning theory is more effective in educating student teachers by observing current teachers, which will benefit them in modeling their teaching. Therefore, in this dissertation, observation and modeling components of social learning theory allow prospective teachers to know effective teaching methods and implement them in future instruction. Social learning theory posits that knowledge is developed by interacting with others and transforming learning individuals' behavior.

Transformative Learning Theory

Transformative learning is defined as a learner's thinking behavior involving a mindset shift. Knowles defined andragogy as the art and science of adult learning, and in the early 1980s, Jack Mezirow introduced the transformative learning theory by clarifying how adults interpret their learning experiences. Mezirow (1996) described "learning understood as the process of using a prior interpretation to construe a new or a revised interpretation of the experience in order to guide future action" (p. 162). Mezirow's transformative learning theory illustrates how adult learners describe the meaning of their experience in formal, nonformal, and informal learning in the social and cultural environment. Student teachers transform their pedagogical knowledge by establishing their practice in the potential teaching space. This dissertation study focused on adult learning and how current teachers experience effective instructional practices with technology, which can lead teacher candidates to transform future classrooms with effective teaching strategies.

The transformative theory is about change by considering a learner's growth and development as an outcome. Mezirow (1991) outlined the 10 phases of transformational learning as making a change in experience and believes that a transformed experience is not practical until the learner reveals his new learning experience, including the underlying beliefs and assumptions that make sense of change. The 10 phases are dominant in some of the phases depending on individual learning environments, which summarizes transformational learning into three stages: critical reflection, discourse, and Action. As mentioned, the three stages of transformative learning are imperative for teachers to reflect on and discuss effective teaching practices with other educators and take appropriate steps to improve teaching.

The first learning stage is critical reflection, which sets the stage for defining and discussing the cognitive development process. Furthermore, Mezirow (1991) described transformative learning as "the process of learning through critical self-reflection, which results in the reformulation of a meaning perspective to allow a more inclusive, discriminating, and integrative understanding of one's experience and learning includes acting on these insights" (p. 1). Critical reflection allows individuals to discuss their broad conceptual understanding, suggestions, and awareness with others, which benefits educators by enhancing innovative ideas. Additionally, Mezirow (1991) acknowledged that "reflection involves a review of the way we have consciously, coherently, and purposefully applied ideas in strategizing and implementing each phase of solving a problem" (p. 101). Therefore, teachers can evaluate and enhance their effective teaching practices using self-critical reflection by adding suggested strategies to their instructions.

The next stage of transformative learning is a discourse in which adult learners effectively communicate their experiences with others. Mezirow (2000) defined "discourse as the process in which we have an active dialogue with others to better understand the meaning of an experience" (p.140). According to Mezirow, discourse is an honest attempt to discover and build new understanding. On the other hand, Duchy (2012) explained discourse "to test whether new meanings are genuine and authentic" (p.44). Educators reveal and delve into their experiences with others to connect the new learning as collaborative learners using a frame of reference. A frame of reference transforms individual learners or others by critically reflecting in discussions. A frame of reference comprises a habit of mind and a point of view. A habit of the mind interpreting the meaning of experience becomes a point of view with immediate discussion by analyzing a specific experience.

After reflecting on and discussing the experience, individuals take action on the new venture, which is the last transformative stage. Mezirow (1991) explained, "transformational theory holds that planning and taking action that is making decision-is an integral phase of the transformational process" (p. 205). Planning and taking action play a significant role in making decisions for instructional design. In the transformational process, educators carefully consider who the learners are. What are they learning? How are they learning? What will be the events that engage learners actively? The dissertation study collects information about teachers' views of their teaching experience to transform their teaching experience into action in future classrooms.

Finally, transformative learning theory is an advantage to prospective secondary mathematics teachers because it allows them to use the current teachers' experience to transform their future instructional strategies. Therefore, the three stages of transformative learning theory in the proposed dissertation will allow teachers to reflect on and discuss their learning to create and lead their decisions into action. Mezirow's transformative learning theory supports teachers in transforming their instructional knowledge into an active educational opportunity in their classrooms.

Applying Adult Learning Theories

Social and transformative learning theories are the best fit for the proposed study. Social learning theory promotes adult learning by observing and interacting with others to embrace new concepts and instructional strategies. At the same time, transformative learning theory is employed in individuals' observed behavior to model their unique experiences. The two theories described above clarify the need to study the expertise of cooperating teachers and transform their observations into future teaching. Merriam and Bierema (2014) expressed that "the way we communicate with others and build communities all require us to learn new information, new procedures, and new technologies" (p. 1). This dissertation study focused on teacher's perceptions of effective teaching to reveal the best instructional practices, which will assist in preparing future secondary mathematics teachers in the digital age

Technology as Related to Social Learning Theory

Bandura's (1977) social learning theory explains that learning is a cognitive development that entails socializing with others and observing their activities. Mariam and Bierema (2014) considered "the social context of learning today is the knowledge age, technology, and demographic changes" (p.1). The demographics of the United States are changing; with the increasing population of English Language Learners, teachers must be prepared to use several strategies, including educational technology, to meet the unique needs of the students. Parker (2013) addressed that "technology infused lives of today's learners" (p. 54). Technology provides opportunities to create student-centered learning, allowing learners to express and share their ideas using technology tools like jam board, whiteboard, Google Docs, voice recording, and language translation.

Technology has changed adults' learning behavior. Adults prefer to learn at their own pace and time and share their experiences with others. Merriam and Bierama (2014) stated that "with the internet, a wide range of educational opportunities exists from synchronous instructions that are in real-time with learners meeting online to engage in discussions, lecture, or activities, to asynchronous instructions that are not bound by time and can be accessed at learners' leisure, 24/7" (p.193). Informal learning is becoming popular with the internet access. Also, universities allow learners to join hybrid classes in their formal education. Furthermore, Parker (2013) stated that "technology is not just a device that is utilized as a tool. Rather, technology has infused every aspect of society to essentially change the thought process in learning" (p. 55). For example, with the availability of the internet, learners can access textbooks in digital form on their phones, tablets, or computers instead of carrying physical books. In addition, technology extends informal learning opportunities to individuals to explore the topics of their interests and socialize with others via social networks to develop skills to advance their careers. With the availability of technology, adults prefer to learn in an informal setting at their own time and pace.

In the digital age, adults rely more on technology, but at the same time, technology is a challenge for teachers due to a lack of technical training and resources. Merriam and Beirama (2014) described that "technology is affecting what we learn, how we learn, and how we teach" (p. 204). In addition, with the rapid technology change, educators are battling to keep up with new educational technology. For example, new educational technology applications and software are in demand, shifting the teacher's role as the facilitator. This dissertation will examine the effective instructional practices of secondary mathematics teachers with technology in the digital age and how their experience will benefit the prospective teachers who will collaborate and interact with other educators to develop the best instructional practices with technology.

Technology as Related to Transformative Learning Theory

Mezirow's (1991) transformative learning theory supports the need to learn more about in-service teachers and understand that social constructs with technology expand the possibilities for constructing their instructional ideas. As mentioned above, technology is challenging, and teachers' roles are changing to transform traditional teaching into modern teaching using technology. Merriam and Beirama (2014) described that "the access to online resources and relationships is challenging our conceptions of education and educators, and requires us to revisit how we facilitate sense-making, coaching and credentialing" (p.205). Adults are transforming their working behavior into a collaborative-centric workplace to discuss their instant opinions and experiences. In education, teachers collaborate with their grade-level teachers to develop tasks and common assessments and examine data to use appropriate instructional strategies to meet the needs of students.

The technology framework is shifting, creating overwhelming information for adult learners. Hefzallah (2004) stated that "learning in the modern world is the learning of the process of learning" (p.39). However, knowing technology is different from implementing technology correctly in developing mathematical tasks and requires time to practice learning new applications and technology tools. Therefore, in-service teachers must understand the technology's strengths and limitations to create effective instructional designs.

A paradigm has shifted in teaching, using conventional and new instructional technologies to accomplish academic goals and objectives. The dissertation focuses on transforming traditional education into nontraditional teaching using technology. Educational technology creates the learning environment to access information with various technologies, transforming the learning to eternal rather than the material learned from books. Adult learners are becoming independent with technology and transforming their professional skills to advance their careers.

Adult Learning in Crisis

In the digital age, adult learners are overwhelmed with technology, struggling to transform conventional teaching into modern teaching. Especially in the COVID-19 crisis, transforming the traditional approach into virtual education has become a new learning zone for teachers to adopt the nontraditional approach. Mezirow (1991) suggested that "transformation theory provides a different perspective from the currently predominant approaches" (p. 7). The first stage of transformative theory indicates that it is time to reflect on the traditional approach and transform it into a nontraditional one by adopting concurrent teaching. Teachers' in-person roles shifted to virtual educators using modern technology tools and platforms.

The K-12 in-service teachers struggled to adopt remote teaching during the pandemic crisis and were challenged to learn new technology tools quickly. Eschenbacher and Fleming (2020) expressed "to reshape transformative learning so that it supports the kind of learning that is sufficiently complex and nuanced to enable us to deal with contradictions, ambivalence, and meaning making in a world where not knowing is the new normal" (p. 657). The districts provided minimal virtual training to all teachers to shift in-person classrooms into virtual learning. Mezirow's transformative learning is a learning process experience that makes sense for the occasion when the inadequate expertise of remote teaching turns into a minimally successful experience. Every time a new strategy is implemented, educators need extra time and resources to prepare their lessons: no one was ready for the global crisis of COVID-19.

During the crisis, the districts bypassed the first and second stages of transformational learning. Instead, they jumped into the third action stage to deliver instructions remotely with minimal training and experience, which was a misleading approach. The question is, "how do the educators respond to the situation?" The districts must implement all three stages of transformational theory and develop a plan of action for the future. In addition, faculty educators add more technology tools to the methods course to prepare potential secondary mathematics teachers.

Purpose of Study

This dissertation examined the views of current secondary mathematics teachers on effective teaching practices with technology. In this study, it is essential to consider the current secondary mathematics teachers' effective instructional practices with technology as a training component to prepare better future teachers equipped with effective instructional strategies and technology tools. I will specifically study feelings about current instructional practices and teaching experience with in-service teachers, as well as their reflections on their preparation during their pre-service training. My primary question~~s~~ for this study were: How do current secondary mathematics teachers feel about effective mathematical instructional practices as they apply to teaching in the classroom?

Significance

Previous studies have demonstrated that in-service secondary mathematics teachers are not knowledgeable of nontraditional approaches in the digital age. Educators are not adequately prepared with technical knowledge. Hidayu, Faizah, and Izaham (2019) revealed that "teachers themselves have insufficient knowledge" (p.25). In other words, teachers need to be trained in technology to teach the required skills for the future. "The most recent technology like artificial intelligence, robotics, and the Internet of Things (IoT) will replace some human jobs in the future; therefore, the students today must possess skills that will not be replaceable by the technology" (Hidayu, Faizah, & Izaham, 2019, p.25). During the pandemic crisis, all schools were closed worldwide; technology is evidence of the development of a new virtual learning norm. Teachers are not knowledgeable about using appropriate technology tools for math classes to make instructions available and meet students' needs. No study has been found to teach in a crisis, and this study will add a new component to the teacher preparation program.

The answers to these research questions will allow future work to analyze the teacher preparation program and the prospective student teachers who are studying the teaching methods without technology-enhanced practices. "The potential of the technology can only be realized in schools when it has been properly adopted and integrated with the teacher preparation programs" (Tunjera & Chigona, 2020, p.127). In all, teaching with technology has become an essential part of education. Both teacher candidates and in-service teachers need extensive knowledge of technology integration in mathematics classes with appropriate digital tools such as digital graphing calculators, sketchpads, and digital manipulatives.

With the evolution of technology, the education industry is struggling to prepare pre-service and in-service teachers to be compatible with a rapid change in the digital world. In-services teachers preferred to teach with the traditional approach and struggled during a pandemic due to a lack of interest in learning new instructional strategies with technology. Canses and Sabahattin (2018) expressed that "with all transformations and changes in education, learner characteristics and teacher characteristics have changed" (p.182). Bedir (2019) suggested that "it has become inevitable that 21^{st}-century learners must be equipped with new knowledge and skills necessary throughout life for successful adaptation to a changing world" (p.828). Therefore, teacher candidates must be acquainted with various pedagogies related to technology.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Over the last two decades, research on teaching secondary mathematics has focused on increasing all students' mathematics learning (NCTM, 2000). Secondary mathematics teachers battle to deliver high-quality instructions to prepare students for college and career readiness, as Daro et al. 2011; and Sztajn et al. 2012 identified that student learning of mathematics develops and progresses across K-12 grades. Secondary mathematics teachers face challenges in their classrooms and struggle to engage students. Students are deficient in learning mathematical concepts, which challenges them to connect the concepts to real-world applications. Students are taught the procedures to solve the problems. With a lack of conceptual understanding, students are unprepared to advance in postsecondary mathematics education.

Teacher preparation is essential to preparing teachers for the future of the 21st century. Technology has moved the Sage on Stage to student-centered learning. Students are more social, collaborative learners and responsive to technology with their different needs, goals, and learning preferences (Taylor & Parson, 2011, p.6). Current secondary mathematics teachers must use equitable instructional strategies in their classrooms with technology. Teachers can use online instructional resources to create rich interactive lesson activities in the digital age. In-service teachers are required to have training in 21st-century integrative mathematics skills.

Student-centered tasks encourage students to participate in activities and represent their constructive experience. Teaching virtual and in-person classrooms simultaneously is another challenge for teachers. Teachers are trained to lead with a traditional approach and engage students in textbook or worksheet assignments. Harasim (2017) described "active learning with technology is student-centered, and the role of the student is to engage in an activity rather than learn passively, listening to a lecture, reading a book" (p.71). During the pandemic year 2020, teachers could not teach online creatively and engage students in online activities. Teaching with a non-traditional approach was challenging, and teachers acknowledged that it was time to change a traditional approach to a non-traditional one. Teaching has shifted from teacher-centered to student-centered. Teachers need more training to use appropriate technology in their everyday practice.

Currently, formal teaching is at odds with students' learning. Viro et al. (n.d.) explained that "students must learn to apply and develop 21st-Century skills while learning school subjects such as mathematics through project-based or applied for work" (p.14). Therefore, teachers must practice informal instructional strategies like connecting the concepts to real-world applications and engaging students in tasks.

In this chapter, I will first explain the best practices for teaching mathematics at the secondary level. Then, I will describe each instructional practice for secondary mathematics. Additionally, I will explore the best instructional practices with access and equity. Next, I will reveal how technology has impacted the best instructional practices in virtual and in-person teaching. Next, I will provide research findings on the teaching experiences of current secondary mathematics teachers using technology. Next, I will identify the current teacher's challenges in using best teaching practices with technology in their classrooms virtually and in person. Finally, I will discuss the implications of these findings for my proposed study.

Effective Teaching Practices

Secondary mathematics teachers are focused on students' achievement, teaching students for standardized tests without making mathematics connections in everyday life. As a result, students tend to master the procedures and shortcut methods to reach the answer without a conceptual understanding and struggle to solve applications due to insufficient practice in problem-solving skills. According to Kops (2009), identifying the critical area of performance and then adjusting instructional strategies will improve learning quality. Zemelman et al. (2005) explained, "the nature of the interactions between kids and teachers maximizes the student learning" (p.4). Kops (2009) argued that "best practices are practices that have been shown to have good results and have been selected using a systematic process" (p.50). Best practices are the strategies to engage the students in mathematical activities, work collaboratively to delve into the task to reach their conclusion, and communicate their conjectures with various representations. Zemelman et al. (2005) described that "best practice is a philosophy- a set of harmonious and interlocking principles of learning, that is student-centered, experiential, expressive, reflective, authentic, holistic, social, collaborative, democratic, cognitive development, constructivist, and challenging" (p.227). In addition, best teaching practices encourage students to collectively contribute in group discussions and communicate their mathematical propositions to solve complex problems.

The National Council of Teachers of Mathematics (NCTM) developed a challenging curriculum framework with interactive instructional strategies. Zemelman et al. (2005) indicated that "in 1987, NCTM published standards document, established the guidelines for how learning goals for children can be described in Best Practice terms-progressive, developmentally appropriate, research-based, and eminently teachable" (p.7). The purpose of developing a framework of instructional strategies was that all students could access high-quality, engaging mathematics instructions (NCTM, 2000, p.2). In addition, teachers assist students in investigating conjectures with different representations of the various perspectives of mathematics.

Teaching mathematics requires content knowledge to unpack the standards of a lesson to engage students in mathematical inquiries. *Principles to Actions Ensuring Mathematical Success for All* described that "student learning of mathematics depends fundamentally on what happens inside the classroom as teachers and learners interact over curriculum" (NCTM, 2014, p.8). Providing high-quality instructions influences student learning. Mathematics learning is an active learning process (NCTM, 2014). The NCTM continued developing strategies to have students understand the concepts and follow the procedures to solve applications. In 2014, NCTM provided a framework of eight mathematics teaching practices to improve teaching-learning mathematics. Eight mathematical teaching practices provide insight into student engagement in exploring mathematical concepts to make sense of their inquiry. Teachers' beliefs play a significant role in these teaching practices. Next, I will describe these eight mathematical teaching practices.

Establish Mathematics Goals to Focus Learning.

While planning a lesson, teachers must determine what and how students will learn to progress their mathematical skills. According to *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, p.12):

> Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

The goal statement is a road map to guide the instructions in the classroom. Teachers post their daily goals to help students understand their learning expectations. For example, establishing a mathematical goal is necessary to make instructional decisions that connect students' prior knowledge with a new mathematics concept. As a result, students understand the connection between mathematical ideas.

The first instructional practice is understanding and developing a plan unit-by-unit and lesson-by-lesson (NCTM, 2014). Mathematics teachers must create learning goals for each unit and lesson, compare them with other teachers, and then identify common learning goals with rigorous standards. Teachers must establish student-friendly goals "for participation that positions every student as a competent mathematics thinker and valued mathematics contributor" (NCTM 2018, p.29). Next, the teacher creates a plan of action with the established goals that students should understand the concept in-depth and represent their work in multiple ways from a mathematical perspective. Smith and Stein (2011) suggested that "the key is to specify a goal that identifies what students are to know and understand about mathematics as a result of their engagement in a particular lesson" (p. 13). The specific goals specify what students will learn and what they will do. Hiebert et al. (2007, p.51) suggested that:

> Without explicit learning goals, it is difficult to know what counts as evidence of students' learning can be linked to instructional activities and how to revise instructions to facilitate students' learning more effectively in future lessons.

Formulating clear, explicit learning goals sets the stage for everything. Establishing mathematical goals to focus learning helps teachers adjust their instructions by observing students' understanding and transition towards the learning goal. According to Boston et al. (2017), "goals for students' mathematical learning should support teachers' decisions in selecting tasks, asking questions, and framing the direction of whole-group discussion" (p.24). Teachers refer to the learning goal that encourages students to focus, participate, and monitor their progress during instructions. Thus, mathematical learning goals support both teaching and student learning.

Several best teaching practices are associated with establishing mathematical goals to focus on learning, such as implementing tasks, asking questions during instructions, and student discourse. Goal setting sets a stage for student-centered learning; teachers develop tasks to engage students in discussions, promote their thinking skills by connecting the mathematical models, and students take ownership of their learning. With the use of mathematical goals, "students can self-assess and focus (refocus) their learning, which is an important factor in student achievement" (Boston et al., 2018, p.24). In addition, by establishing a learning goal, students know their level of learning and skills mastery.

Implement Tasks that Promote Reasoning and Problem-solving.

After establishing clear goals, teachers develop tasks based on the student's prior knowledge, encouraging reasoning and problem-solving skills. Tasks encourage students to focus on a mathematical idea to present their thinking in multiple representations. *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, p.17) suggested that implementing tasks develops reasoning skills; students explore the concepts using different strategies to represent their learning experience. It stated:

> Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem-solving, allowing multiple entry points and varied solution strategies.

Developing appropriate tasks using students' prior knowledge and engaging students in critical thinking to connect the concept to real-world problems is essential. Smith and Stein (1998) categorized tasks as 1) memorization, 2) procedures without connections to concepts or meaning, 3) procedures with connections to concepts and meaning, and 4) doing mathematics (p.345). According to Smith & Stein, the first two categories of tasks ask students to use previously learned formulas, definitions, and rules. They give students only one level of thinking to explain the procedure to solve the problem without connecting a concept. The third and fourth categories of tasks ask students to think and describe the process by connecting them to the task and developing the solution with various mathematical aspects (Stein & Smith, 1998). Doing mathematics requires students to use multiple representations and methods, which leads them to develop levels of thinking as they work through the task by connecting their prior knowledge.

Not all tasks allow students to think at different levels and explain the procedure with conceptual understanding. Smith & Stein (2011) argued that "different tasks provide different opportunities for student learning" (p.15). Student engagement and learning are higher with tasks involving higher thinking and reasoning than routinely applying the procedures (NCTM, 2014). Effective teaching requires developing and implementing tasks involving students thinking about what they know and using their prior knowledge to justify their conjecture.

Implementing the tasks engages students in problem-solving and exploring mathematical concepts and their relationships (NCTM, 2014). Teachers must establish a specific goal and select the task that engages students and demands to explain the conceptual understanding using various representations. Mathematical tasks allow students to engage in problem-solving, promoting new mathematical knowledge and conceptual understanding. Students who are actively involved in tasks can explain that their reasoning makes sense at various levels of mathematics.

Use and Connect Mathematical Representations

Mathematical representations allow students to think and connect their ideas at various mathematical levels to understand the concepts. Tripathi (2008) described that "a representation would include concrete, verbal, numerical, graphical, contextual, pictorial, or symbolic components that depict aspects of the concept" (p.438). The teacher uses a specific goal to engage students in a different representation, interpreting and explaining their conceptual understanding. NCTM (2014) suggested that:

> Effective teaching of mathematics engages students in making connections among mathematical representations to deepen their understanding of mathematics concepts and procedures and as tools for problem-solving.

Multiple representations allow students to investigate the concepts through a variety of lenses. Before implementing a task, the teacher determines how students can represent and connect the ideas for an in-depth conceptual understanding. NCTM (2014) indicated that visual, symbolic, verbal, contextual, and physical representations are related to understanding the concept's depth. Students can model the idea with physical representation by using manipulatives and connecting it to real-world problems.

Visual representation allows students to draw, look at the pattern, interpret the graph, express their understanding of mathematical concepts and procedures, make sense of problems, and engage in mathematical discourse (NCTM, 2014, p. 25). Tripathi (2008) argued that using multiple representations and connecting the concepts has been an issue for mathematics educators. It is imperative to reform secondary mathematics teaching through practice to initiate tasks with connectivity by applying various representations. When setting goals for the lesson and implementing tasks, teachers need to consider how they want their students to see this concept. Are these tasks and contexts of their cognitive level? (Tripathi, 2008). Multiple representations encourage all students to participate in activities; English Language Learners can express their mathematical ideas and connect the concept with their prior knowledge. For example, Boston et al. (2017) depicted:

> Students should have frequent opportunities not only to learn to use and work with representations in mathematics class but also to translate between and

> among representations. Sufficient opportunities help them see mathematics as a web of connected ideas. In supplying such opportunities, teachers should engage students in dialogue about representations and the relationships between them to help develop students' representational competence, an essential aspect of mathematical understating.

By linking multiple representations, students have an opportunity to think and explain the relationship between them, which is an essential component of learning and doing math. Therefore, in-service teachers must practice creating and implementing a task with multiple representations and allowing students to share their thinking methods.

Teachers select tasks that allow students to decide which representations to use to make sense of the problems (NCTM, 2014). Various representations will enable students to dig deeper into the concept and compare it to justify their understanding with other students. In addition, multiple representations permit students to solve the problem more than one way than memorize the steps to come to the solution.

The 21st-century classroom teachers require more training to select and implement tasks to engage students; those are in-person and online learning simultaneously. Tripathi (2008) expressed that "much effort is needed from the community of mathematics teachers" (p.441). In-service teachers must practice digital tools like virtual manipulatives and online graphing calculators. Students will have an opportunity with available resources to learn problem-solving strategies.

Facilitate Meaningful Mathematical Discourse.

Goal setting is the lesson's substance to promote higher-order thinking and problem-solving skills in multiple representations, allowing students to express and discuss their mathematical ideas to justify their conclusions. According to NCTM (2018), "teachers create structures that position students as mathematically competent and capable of sharing their mathematical thinking, connecting with peers to understand others' mathematical ideas, and participating in mathematical argument" (p.30). Through discourse, students develop mathematical language, express their thoughts compared to others, and view themselves as mathematically capable. NCTM (2014) stated that:

> Effective teaching of mathematics facilitates discourse among students to build a shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Mathematical tasks encourage reasoning and problem-solving skills to engage students in the argument to connect their response to a mathematical concept. Students learn collaboratively by listening and explaining their reason and deeply understanding mathematics. The teacher's primary role is to prepare the task considering how to create a student discourse with multiple representations. What type of questions are provided for the explanation? Smith & Stein (2011) designed five practices for orchestrating productive mathematical discourse:1) anticipating, 2) monitoring, 3) selecting, 4) sequencing, and 5) connecting.

Teachers' lesson planning is vital to execute Smith & Stein's five practices for student discussions. First, content knowledge is imperative to delve into the topic to create a task strategically. Second, content knowledge is essential to dig into the topic to create a task, considering how students interpret the task. In Smith & Stein's first practice of anticipating, teachers must solve the problem in various ways as expected from the students. In-service teachers must practice monitoring students' representation and inviting them to share their thoughts. According to *Principles to Actions Ensuring Mathematical Success for All,* "teachers must determine how to build on and honor student's thinking while ensuring that the mathematical ideas at the heart of the lesson remain prominent in class discussion" (NCTM, 2014, p. 30). By using Smith & Stein's five practices, teachers ensure that all students can share their thoughts on the established goal of the lesson.

Meaningful mathematical discourse allows students to understand mathematics' significance by connecting the concept to the applications. "Connections among solutions do not always arise naturally from the discussion, as they seemed to do in this situation" (Smith & Stein, 2011, p. 58). Emphasizing the student's opinions by asking questions will inspire students to connect the concept mathematically in multiple situations.

To create productive discussions, Smith & Stein (2011) suggested a set of moves in addition to the five practices mentioned above, "learning how to follow up on the ideas that surface in such student presentation is much more difficult" (p. 69). The suggested set of moves for teachers to engage students in discussions is: 1) revoicing, 2) asking students to restate someone else's reasoning, 3) asking students to apply their reasoning to someone else's reasoning, 4) prompting students for further participation, and 5) using wait time.

The teacher asks students to clarify their argument more and inspire other participants to agree or disagree with the statement. Following the agree or disagree statement, students can restate and compare their reasoning. "The key is for teachers to prompt students to give more than their agreement or disagreement and to press them to explain why they agree or disagree" (Smith & Stein, 2011, p. 71). Encouraging students to participate further extends the opportunity to include more ideas in the discussion. "Giving students time to compose their responses signals the value of deliberative thinking, recognizing that deep thinking takes time" (Smith & Stein, 2011, p. 72). Waiting time gives other students time to think and share their ideas. Smith & Stein advised that a pause is marked as a closure to one phase of the discussion and the opening of another (p. 73). Mathematical discourse allows students to explore mathematical concepts to justify and explain why their reasoning makes sense. Practicing a student discourse requires a lot of preparation during task development with established goals to encourage students to relate to each other's mathematical thinking.

Pose Purposeful Questions

Questioning is essential for effective teaching, allowing teachers to make instructional decisions and considering students' prior knowledge and current understanding of a concept. Smith and Stein suggested that "teachers need to develop a range of ways of interacting with and engaging students as they work on tasks and share their thinking with other students. A specific type of questions that can push students' thinking toward core mathematical ideas" (p. 61). Posing purposeful questions creates an interaction between teacher and students; good questions allow students to explore mathematical concepts and take possession of their thinking. According to *Principles to Action* (NCTM, 2014):

> Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense-making about important mathematical ideas and relationships.

Asking purposeful questions allows students to investigate the concept at a distinct mathematics level by linking their prior problem-solving experiences. Student engagement in discussion depends on the pattern of questions formed by the teacher, which involves students explaining their claim's reasoning. Smith & Stein recommended, "to help teachers develop good questioning skills that will challenge students to think at deeper levels and introduce teachers to a set of discussion" (p. 61). Secondary mathematics teachers must have training in creating meaningful inquiry-based questions to inspire students to use various methods to solve problems with reasoning.

Creating inquiry-centered questions is a critical task for teachers; NCTM (2014) proposed the following types of questions: 1) gathering information, 2) probing questions, 3) making the mathematics viable, and 4) encouraging reflection and justification. The first type of question allows students to recall definitions, formulas, and steps to solve the problem; students are limited to the solution process and struggle to connect the concept to various mathematics fields. Then, teachers ask basic questions and move forward without offering an opportunity to justify the answer to the problem.

Probing questions allow students to relate and elaborate their thinking process by connecting various mathematical representations. "Good questions also force students to articulate their thinking so that it is understandable to another human being; this articulation, in and of itself, is often a catalyst to learning" (Smith & Stein, 2011, p.

62). Good questions help students understand and link the concepts by collecting the knowledge and being thoughtful in discussions. Students gain confidence in participating in discourse to explain new mathematical ideas. "Students reveal a deeper understanding of their reasoning and actions, including making an argument for the validity of their work" (NCTM, 2014, p. 37). Probing questions allows students to think and solve problems in multiple ways, engage in discussions, and challenge their peers.

Another two types of questions are funneling and focusing. Funneling is like the first type of questioning, as mentioned above. However, the teacher asked questions that led students to solve the problem without articulating or connecting the concept. Focusing is an inquiry-centered approach to probing questions, which teaches students to explain their reasoning. According to *Principles to Action* (NCTM, 2014), "focusing is a pattern of questioning involves the teacher in attending to what the students are thinking, pressing them to communicate their thoughts clearly, and expecting them to reflect on their thoughts and those of their classmates" (p. 37). Probing focus questions inspires students to explore the task using various representations to make a viable argument supporting their thinking.

The purpose of probing meaningful questions is to advance students' understanding and build on their investigation of the task, not limiting it to the funnel. A teacher's role is to create and ask purposeful focus questions that make mathematical sense and validate their reasoning. Validating the logic, students think carefully about each question and explore all aspects of mathematics rather than get the task's solution.

Build Procedural Fluency from Conceptual Understanding

Teaching mathematics with a traditional approach only allows students to learn by memorizing the steps and solving the problem without connecting the concepts. In the 21st century, it is necessary to make pedagogical adjustments; student discourse and probing questions are essential for developing conceptual understanding to explain the procedure fluently. *Principles to Action* (NCTM, 2014) explained that:

> Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematics problems.

Secondary mathematics teachers require an education involving students to investigate the concept in-depth and apply the adaptable procedures to rationalize their interpretation. "Students should develop an increased capacity to link mathematical ideas and a deeper understanding of how more than one approach to the same problem can lead to equivalent results, even though the approaches might look quite different" (NCTM, 2000, p. 354). Solving a problem using conceptual mathematical knowledge develops flexible procedural fluency to represent various methods. "When students can see the connections across different mathematical content areas, they develop a view of mathematics as an integrated whole" (NCTM, 2000, p. 354). For conceptual understanding, it is imperative to solve problems with multiple representations and explain their relationship.

Developing procedural fluency is essential for effective mathematics teaching. The teachers must delve into the tasks to consider that students can connect their conceptual understanding to build procedural fluency. "When procedures are connected with the underlying concepts, students have better retention of procedures and are more able to apply them in new situations" (NCTM, 2014, p. 42). Conceptual understanding builds and encompasses mathematical knowledge, allowing students to define the procedure fluently. "Fluency is not a simple idea" (NCTM, 2014, p. 42). Building procedural fluency requires extra education and practice to prepare students to solve problems mathematically and contextually.

Creating tasks sequentially and considering the connection between conceptual understanding and procedural fluency is essential to promote mathematical learning. Boston et al. (2017, pp. 56-57) described Briars (2016) three essential components to planning a sequential task: 1) begin tasks that develop conceptual understanding by building on students' informal knowledge, 2) tasks should support students in developing informal strategies to solve problems, and 3) students need to refine informal strategies to develop fluency with standard methods and procedures (algorithms or formulas). Students' prior knowledge sets the stage for using or developing strategies, comparing and contrasting their peer approaches to efficiently explain the problem's solution.

Building procedural fluency from conceptual understanding is to engage students in solving problems, using various methods, and explaining their procedures explicitly. "Demonstrating flexible use of strategies and methods while reflecting on which procedures seem to work best for specific types of problems" (NCTM, 2014, p. 47). The procedural fluency from conceptual understanding builds confidence in students to use applicable procedures efficiently with appropriate concepts.

Support Productive Struggle in Learning Mathematics

Tasks that stimulate reasoning skills make students struggle to find a solution. Then, the teacher supports their struggle by connecting their prior knowledge and posing purposeful questions relative to the task. For example, NCTM (2014) stated that:

> Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and support to engage in productive struggle as they grapple with mathematical ideas and relationships.

A productive struggle is an essential element of teaching; Bosten et al. (2017) stated that "teachers consistently facilitate students' conceptual understanding" (p. 183). In planning, teachers "delve more deeply" (NCTM, 2014, p. 48) into a lesson to find out where students can get stuck and prepare in advance how to support students in figuring out the solution. "In the productive struggle, students must work to make sense of a situation and determine a course of action to take when a solution strategy is not stated" (Bosten et al., 2017, p. 183). Students feel challenged when they cannot connect the concept that makes sense to their thinking, and teachers support them in building a capacity to persevere. With a teacher's support, "students come to realize that they are capable of doing well in mathematics with effort and perseverance in reasoning, sense-making, and problem-solving" (NCTM, 2014, p. 52). After experiencing a productive struggle, students understand, connect the concept, and take ownership of their learning, which makes sense to explain their reasoning.

A task with directive instructions will make students solve and find a correct answer instantly. The directive instructions describe how to and what to do in the task, "which lowered the cognitive demands of the task" (Boston et al., 2017). As a result, students make progress without conceptual understanding and cannot explain the mathematical justification of their solution, which is short-term learning. In contrast, students productively struggle to learn to explain and justify their thinking process and turn it into long-term mathematical knowledge.

As discussed above, student struggle is essential for effective teaching, allowing teachers to support their students by incorporating best teaching practices. "Teachers must accept that struggle is important to students' mathematics learning, convey this message to students, and provide time for them to try to work through their uncertainties" (NCTM, 2014, p. 50). Also, students must understand that productive struggle allows them to consider "what it means to know" (NCTM, 2014, p. 49). Tasks that promote problem-solving skills take time to solve, and students get frustrated; to avoid frustration, teachers start walking through the steps to come to a conclusion, which is not supported by a struggle. Teachers must practice posing purposeful questions to help the productive struggle and allow students to think about how the task makes sense.

The purpose of supporting productive struggle is to plan what might be a challenge for students ahead of time, and they cannot make progress without teachers' support. To support a productive struggle, an interaction between teacher and students, "the teacher asks students to explain their thinking and pose questions based on the students' thinking rather than on the way that the teacher is thinking about the task" (NCTM, 2014, p. 49). Teachers need to practice giving enough time to students to reach the point where they cannot figure out the way to solve the problem, and "the teacher asks questions that scaffold students' thinking without stopping in to do the work for them" (NCTM, 2014, p. 52). The teachers facilitate discussions on misconceptions, errors, and confusions, promoting student discourse to justify mathematical understandings.

Elicit and Use Evidence of Student Thinking.

The last effective instructional practice is to use evidence of students' thinking about mathematical concepts to make instructional decisions. "Evidence of student thinking and understanding is critical" (Boston et al., 2017, p. 149). According to *Principles to Action* (NCTM, 2014, p. 53):

> Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instructions continually in ways that support and extend learning.

Teachers need to plan lessons carefully with an objective of what students will think, not knowing what the teacher is thinking. "Preparation of each lesson needs to include intentional and systematic plans to elicit evidence that will provide a constant stream of information about how student learning is evolving toward the desired goal" (NCTM, 2014, p. 53). In addition, teachers must have subsequent lessons to support students' learning and address misconceptions, inaccuracies, and complexities in understanding the concept.

Teachers collect evidence of students' learning using different assessment approaches, such as posing purposeful questions, using mathematical discourse to explain multiple representations, and using a formative assessment. "Formative assessment is an essential interactive process, in which teacher can find out whether what has been taught has been learned, if not, to do something about it" (Bosten et al., 2017, p.149). Formative assessment informs students' learning, and responsive teaching meets students' learning needs by giving feedback on their current understanding. According to Leahy et al. (2005), "In classrooms that use assessment to support learning, teachers continually adapt instruction to meet student's needs" (p. 19). Teachers make decisions based on what students learn and adjust instructions despite learning still occurring.

Eliciting and using students' evidence of learning provides teachers insight into deciding the following action. "Task that requires students to explain, represent, and justify mathematical understanding and skills provide stronger evidence of their understanding for ongoing assessment and instructional decisions" (NCTM, 2014, p. 54). Thus, evidence of students' understanding of learning mathematics is an essential component of the intended goal of the lesson, and teachers carefully respond and support students' conceptual knowledge while moving them toward procedural fluency and advanced mathematical reasoning (NCTM, 2014).

Finally, eliciting and using evidence of students' thinking informs the teacher to make instructional decisions to meet students' needs and support the productive struggle. Teachers use the evidence to address the specific missing mathematical idea of the established goal by asking questions, reinstating a problem, and encouraging students to explain their thinking. NCTM (2014) stated that "teachers guide their teaching and learning interactions by evidence of student thinking so that they can assess and advance student reasoning and sense-making about important mathematical ideas and relationships" (p,57). The evidence-based practice aims to build procedural fluency from a conceptual understanding of mathematics, not t" learn the steps and procedures to solve the problem.

Effective Teaching Practices with Access and Equity

Teaching involves several essential queries in planning the curriculum, units, and day-to-day courses to provide equitable, high-quality instructions to all students. The eight best teaching practices create a learning environment by providing diverse students access to the same curriculum, tools, and technology. According to *Principles to Action* (NCTM, 2014, p. 59):

> An excellent mathematics program requires that all students have access to a high-quality mathematics curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential.

Access and equity involve designing and planning the task to connect the student's background and prior knowledge to facilitate meaningful discourse by probing purposeful questions and responding to their productive struggle in learning mathematics. For example, NCTM (2014) stated that "our vision of access and equity requires being responsive to students' backgrounds, experiences, and knowledge when designing, implementing, and assessing the effectiveness of a mathematics curriculum" (p.60). Likewise, Aguirre et al. (2013) addressed that "some students are never allowed to engage with mathematics rich and meaningful ways that emphasize critical thinking and problem solving" (p.5). Thus, teachers ensure that instructional strategies, curriculum, and support are equally accessible to meet the needs of students of all backgrounds.

Teachers' belief is essential in access and equity by differentiating the curriculum with a presumption of students' mathematics competency. For example, Aguirre et al. (2013) suggested that "teachers examine their beliefs about learners, learning, and mathematics content, as well as their everyday teaching and classroom practices" (p.5). However, NCTM (2014) addressed that "equity in school mathematics outcomes is often conflated with equality of inputs" (p.60). Moreover, teachers can change their beliefs by implementing tasks that promote higher-order thinking skills by supporting all students in their classrooms without mathematical competency.

Student achievement gaps result from the inequitable curriculum, lack of high-quality instructions, lower expectations, and focus on deficit skills. Flores (2007) stated that "achievement gaps without monitoring opportunities gaps that cause them invites a focus on deficit models to "explain" low performance in terms of factors such as cultural differences, poverty" (p.40). *Principles to Actions* (2014) recommended that "all students attain mathematics proficiency and increase the number of students from all racial, ethnic, gender, and socioeconomic groups who attain the highest levels of mathematics achievement" (p. 60). Teachers must offer high-quality instructions by employing a rigorous curriculum, which requires all students to participate in activities equally to express their mathematical thinking.

Equity is about fair-mindedness to provide opportunities to all students, especially underserved or marginalized students, to promote problem-solving skills, which build confidence in learning mathematics and develop a mathematical identity. Bosten et al. (2017) defined student identity as "the dispositions and deeply held beliefs that students develop about their ability to participate and perform effectively in mathematical contexts and to use mathematics in powerful ways across the contexts of their lives" (p. 6). Teachers can connect and encourage all students to apply their prior mathematical knowledge to solve the problem and support their productive struggle to assist them in developing mathematical identity. Implementing the effective teaching practices described above helps teachers meet all students' needs, building confidence in mathematics as a competent learner. Additionally, Aguirre et al. (2013) developed five equity-based instructional practices that strengthen mathematical learning and cultivate positive student mathematical identities (P.43): 1) going deep with mathematics, 2) leveraging multiple mathematical competencies, 3) affirming mathematics learners' identities, 4) challenging spaces of marginality and 5) drawing on multiple resources of knowledge. The first two equity practices allow teachers to develop high cognitive order tasks using their students' mathematical experiences. The third equity practice will enable students to take ownership of their learning by explaining and sharing their mathematical ideas within their group in the class. The fourth equity practice allows students to connect multiple representations to justify their authentic reasoning. Finally, the teachers can apply the last equity practice to support students by learning and understanding their experiences with mathematical understanding, learning about students' culture, language, and families to help students learn everyday mathematics in real life.

Boston et al. (2017) argued that "teachers need to pay attention to the instructional opportunities that are provided to students, particularly to historically underserved and/or marginalized youth" (p.5). The best practices of access and equity aim to provide high-quality instruction to students of diverse backgrounds. Access and equity allow all students to participate in rigorous mathematical curriculum activities to attain mathematical competency. Teachers can support all students by providing tools and resources to develop problem-solving skills and build confidence in learning mathematics to succeed in real life.

In the 21st century, the nation's classrooms have changed into diverse learners. Darling-Hammond & Bransford (2005) stated, "teachers need to have the knowledge, skills, and attitude to create democratic classrooms and implement a culturally responsive and inclusive curriculum" (p. 233). Thus, teachers must understand their students' culture and mathematical ability to deliver the instructions equally.

Effective Teaching Practices with Technology

The Role of Technology

The evolution of the internet has altered the thought process and learning. "Technology is not just a device that is utilized as a tool. Rather, technology has infused every aspect of society to change the thought essentially process in learning" (Merriam & Bierema, 2014, p.191). Technology provides quick access to explore and learn with immediate access in the digital age. As a result, traditional teaching has shifted to digital learning or eLearning (Merriam & Bierema, 2014. P.191). Technology has become a need for daily life, and educators need to learn new technological tools and related pedagogies. Mishra & Koehler (2006) suggested that the Technological Pedagogical Content Knowledge (TPACK) structure as a standard of teacher knowledge is essential for technology integration. Technology integration allows teachers to use technological tools and develop performance tasks, projects, and instant feedback on student's work, which helps students strengthen their skills to solve complex problems and prepare for 21st-century skills. Brooks-Young (2010) explained that "students today have very definite views about what constitutes effective use of technology or best strategies for finding and evaluating information" (p. 5). Students prefer to do projects by using technology to explore concepts rather than long paper assignments. The traditional assessment methods teach students to study traditionally and ill-prepared for the 21st-century world.

Technology has affected teaching and learning. Meriam &Bierema (2014) stated that "with the internet, a wide range of educational opportunities exists from synchronous instruction that is in real-time with students meeting online to engage in discussions, lectures, or activities to asynchronous instructions that is not bound by time" (p. 193). Unfortunately, in-service teachers do not have the technological resources, tools, and training to integrate technology into their daily practices. For example, in-service teachers struggled to teach virtually during the pandemic due to the lack of synchronous training.

Technology has changed learning; online learning, like Khan Academy, provides a supplementary resource for each subject. As stated by Strutchens et al. (2018), "the use of technology for teaching through problem-solving underlines some aspects of the mathematical activity such as visualization, representation, formulation and conjectures, and generalization" (p. 126). Therefore, secondary mathematics teachers must be well-trained in technology tools to demonstrate mathematical concepts, like using a graphing calculator on a Chromebook, laptop, or iPad.

Educators struggle with technology due to rapid changes in technology. Darling-Hammond & Bransford (2005) explained that "a variety of concrete tools-from manipulatives and drawings to graphic displays and calculators" (p. 92) challenges teachers to use virtual manipulatives, geoboards, and computer-assisted programs. In the traditional teaching approach, teachers use actual manipulatives, geoboards, and graph the functions on graph paper. In the 21st century, teaching and learning have an epistemological disparity, and teachers are trained to teach with a traditional approach while students learn with technology. Students struggle to understand and apply the concepts to real-world problems with this conflict. Strutchens et al. (2018) stated that "nowadays, the attempts to introduce technological resources in mathematics teaching raise new challenges for teachers and teaching" (p. 127). All secondary mathematics teachers must develop technology-based instructions and design mathematics lessons integrating technology to engage students in high-level thinking and reasoning.

Research on Effective Teaching Practices

In 2014, the National Council of Teachers of Mathematics published *Principles to Actions: Ensuring Mathematics Success for All* to support the Common Core State Standards. In *Principals to Actions*, the primary focus was on teaching practices with a vision that all students learn mathematics. In addition, NCTM (2014) described "the actions required to ensure that all students learn to become mathematical thinkers and are prepared for any academic career or professional path that they choose" (p.vii). *Principles to Actions* instituted the eight mathematics teaching practices, allowing teachers to develop tasks for students to demonstrate mathematical reasoning in multiple ways.

The teaching practices are connected to other practical approaches, like selecting a task and establishing the mathematical goal, setting a stage to make instructional decisions, and engaging students in meaningful discussions. For example, Boston et al. stated that "goals for students' mathematical learning should support teachers' decision in selecting tasks, asking questions, and framing the direction of whole-group discussions" (p.24). Further, Boston et al. stated that "teachers' use of goals to guide instruction supports students' ability to monitor their mathematical learning" (p. 24). The purpose of establishing the goals is to engage students in higher-order thinking.

Selecting a task and setting goals does not necessarily meet the needs of all students; teachers develop lessons in isolation with the slightest knowledge of students' culture to provide equitable instructions. For example, Boston et al. addressed that "deficit beliefs regarding the mathematical abilities of students of color, students who are poor, or students for whom English is not their first language lead to different opportunities to engage" (p. 25). As a result, students' mathematical competencies are misjudged. As a result, marginalized students have fewer opportunities to advance their mathematical knowledge. Also, NCTM (2014) addressed three research findings, first that "not all tasks provide the same opportunities for student thinking and learning" (p.17). Therefore, teachers need to alter their instructions by eliciting and using evidence of student thinking to meet the needs of all students with equity.

The second finding of NCTM (2014) addressed that "students' learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where the tasks are routinely procedural in nature" (p. 17). Lastly, NCTM (2014) synthesizes that "tasks with high cognitive demands are the most difficult to implement well and are often transformed into less demanding tasks during instruction" (p. 17). The teachers lower their expectations of the challenging tasks with evidence of students' struggle and thinking level by posing a few purposeful questions and having a minor mathematical discourse. As a result, students do not have an opportunity to explore the concept and struggle to build procedural fluency from conceptual understanding.

The lower expectations of challenging tasks lead students to learn mathematical procedures. Boston et al.(2017) addressed that "if students have not been given opportunities to develop an understanding of when to use a procedure and why students will often apply procedures in ways that are inappropriate to mathematical task at hand" (p. 66). In addition, Boston et al. (2017) stated that "conversely when procedures are connected to conceptual understanding, students are better able to retain the procedures and make more appropriate decisions in how they apply them to new situations" (p. 66). When students learn mathematics procedures without a cognitive demand, they memorize the steps to solve the problems and struggle to apply the concept to solve complex problems.

Teachers must plan multiple questions when students work individually or in small groups on a task. Boston et al. (2017) suggested that "teacher's questions can support high-level thinking, prompt for explanations and connections, and encourage students to delve more deeply into mathematics. Teachers' questions can also serve to elicit facts, procedures, or calculations" (p. 93). Teachers can encourage students to think deeply by asking, explaining their reasoning, and collecting evidence of their level of thinking and understanding of the concept. In addition, teachers include questions with "why," which promotes a higher level of thinking.

Using multiple representations sustains the level of mathematical and conceptual understanding. Boston et al. (2017) suggested that "by asking students to describe their mathematical thinking using multiple representations and making connections between them, we gain a better sense of the internalized understandings that students hold about abstract mathematical ideas" (p.120). Teachers should encourage students to use multiple representations to develop a solution, which allows students to think and solve problems in more than one way.

Lastly, the most critical practice is to support productive struggle in learning mathematics; when students struggle in mathematical reasoning and cannot find a solution, the teachers' role is to facilitate by asking questions to delve into the task to promote mathematical thinking instead of lower task expectations. Boston et al. (2017) expressed that "tasks that promote productive struggle that encourages reasoning and problem-solving challenge students but be within their reach" (p.206). As mentioned above, not all tasks provide equal learning opportunities to all students; teachers must adjust the task according to students' mathematical abilities. More research is needed on the best instructional practices relevant to culture and provide equitable instruction to all students to learn mathematics.

Conclusion

Study in Future on Effective Teaching Practices

In this literature review, I studied eight mathematical teaching practices; my primary study resource is a book, *Principal to Actions: Ensuring Mathematical Success for All* (NCTM, 2014). This study delved into eight instructional practices and learned that each pedagogy is connected to other instructional techniques to create engaging and higher-order learning classrooms. But it is a critical topic. My research question is: How do current secondary teachers feel about employing effective teaching instructions in the technology age?

Improving teaching practices has always been a vital question over the decades. Still, the pandemic year 2020 challenged faculty educators, in-service teachers, and teacher candidates by suspending face-to-face instruction. In addition, the education industry was hit hard by the unpreparedness of synchronous or asynchronous approaches to delivering instructions. Finally, the lack of training on technology tools to teach mathematics challenged the districts.

In the future, universities must prepare potential educators to practice the eight mathematical instructional practices with advanced technology. Therefore, more research is required on teaching methods, including the new research-based practices in the curriculum, so that future teacher candidates can explore and emphasize the best instructional practices in their future classrooms. Furthermore, teaching and learning with technology are essential in the digital age. Therefore, the current teachers must practice teaching mathematics with virtual manipulatives, Desmos, GeoGebra, Sketchpad, Equatio, and advanced technology tools.

The immigrant population is increasing in the nation. Therefore, it is also essential for teachers to practice teaching students of diverse backgrounds by providing equal access to all educational opportunities. In addition, this will help prospective teachers design and plan lessons by emphasizing eight mathematical practices that consider students' cultural backgrounds. Finally, I concluded that current teachers must have more training in eight mathematical teaching practices with technology, access and equity, diversity, and responsiveness to the students' culture.

CHAPTER THREE

METHODS

This dissertation examined the current challenges in the secondary mathematics education system with a nontraditional approach using technology. Harasim (2017) argued that "the world of work" (p. 3) has changed, but the conventional teaching approach in K-12 education has not changed. The primary challenge for in-service teachers is a lack of student-centered pedagogy. In addition, traditional teaching may conflict with technology-savvy students. In 2014, NCTM introduced eight effective instructional practices to change conventional approaches with nontraditional approaches. In this research, I used the sequential explanatory case study as a mixed methodology approach to examine the experience of current secondary mathematics teachers using NCTM's effective instructional practices with technology.

Rationale of Study

Based on the above arguments, my primary focus in this study was to examine the current secondary mathematics teacher's experience with technology to guide future secondary mathematics teachers in concurrent classrooms. Thus, my emphasis was on the in-service teacher's experience because teacher candidates adopt the pre-established instructional strategies, curriculum, and procedure by following the lead of a cooperating teacher during their field experience. However, the teacher candidates do not get enough experience from their cooperating teachers using nontraditional approaches (Canses & Sabahattin, 2020). Traditional teaching does not support students in exploring and understanding mathematical concepts to apply in real-world applications.

This dissertation aimed to study the essence of the concurrent teaching of in-service teachers. To do so, I examined in-service teachers' reports about their recent classroom experiences and views about teaching and technology. Merriam-Webster's dictionary describes *concurrent* as "occurring or existing simultaneously." Hence, in this dissertation study, contemporary teaching and concurrent classrooms refer to teaching in-person and online simultaneously in a classroom. In this study, it is essential to gather the information that will inform both researchers and practitioners about how to utilize the current teacher's teaching experience to prepare the prospective secondary mathematics teacher candidates to teach effectively in concurrent classrooms and maximize engagement with equity in potential classrooms. Therefore, four specific research questions were derived from the literature.

1. To what extent do current teachers report engaging in the best practices in mathematics instruction, as identified in Chapter Two?
2. To what extent do current teachers report engagement with equity issues in their mathematics instruction?
3. How much did their teacher preparation program prepare them to teach with technology?
4. What is the current teacher's level of knowledge of technology?

Research Design

After considering different approaches to a case study structure in this dissertation, I used an explanatory sequential case study to describe teachers' perceptions of the fundamental nature of concurrent teaching. This method allowed me to collect and analyze mixed quantitative and qualitative data.

The sequential explanatory case study uses mixed methods to collect the data sequentially in two phases. Creswell & Clark (2008) defined "the sequential explanatory design involves implementing the methods in two distinct phases, starting with quantitative data collection and analysis, connecting from the quantitative results to a qualitative phase, and using the qualitative data collection and results to follow up or explain the initial quantitative results" (p. 377). Therefore, the explanatory sequential case study was the best approach for the research, and this methodology provided comprehensive information on the case. Furthermore, the researcher uses a sequential explanatory research approach to explain the wide-ranging analysis by merging quantitative and qualitative data. Creswell & Clark 2008) demonstrated that "priority is typically given to the quantitative data, and the two methods are integrated during the interpretation phase of the study" (p. 178). Therefore, I chose the sequential explanatory approach to analyze quantitative results to describe the findings of primarily collected data.

Quantitative Phase

The first phase of the sequential explanatory method is quantitative methods. Quantitative methods collect numerical data using the following research types: survey, correlational, experimental, or causal-comparative. According to Hoy (2010), "quantitative research is a scientific investigation that quantified measures of performance" (p. 1). First, the researcher collects the data and then analyzes it by examining the sample to make decisions for the second phase.

Quantitative research is objective, and the investigator focuses on what is the topic. Sukamolson (2007) described Cohen's statement that "quantitative research is defined as social research that employs empirical methods and empirical statements as a descriptive statement about what "is" the case in the "real world" rather than what "ought" to be the case." Sukamolson discussed observations from Creswell, explaining that "quantitative research is a type of research that explains phenomena by collecting numerical data that are analyzed using mathematically based methods in particular statistics." The researcher collects several numerical phenomena from data collection instruments like surveys. Creswell (2014) described that "survey research provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population" (p. 13). The investigator collects unbiased data using surveys and illustrates the results to the population.

The researcher interprets epistemology and assumptions as two fundamental theories in quantitative research. As Sukamolson describes it, "the quantitative view is a being realist or sometimes positivist." The researcher uncovers the existing reality in the realists' view and links the positivist views to cause and effect, focusing on the objective. The first quantitative phase of the proposed study involved in-service teachers sharing their views concerning personal effective instructional practices in the classroom by participating in the survey. The survey had the option to participate in the study. The survey's primary focus was to collect data on effective instructional practices, social justice, and knowledge of technology. In addition, the survey collected data on how often the current teachers use instructional practices with technology in their classrooms. At the end of the survey, the participants answered the open-ended questions and were asked if they were interested in the study's second phase. Then, they provided their contact information to schedule the interview.

Qualitative Phase

The second phase of the sequential explanatory method used qualitative methods. The researcher collected numerical data from the first quantitative phase and analyzed the results to establish the second qualitative phase. Creswell (2014) specified that "the quantitative results typically inform the types of participants to be purposefully selected for the qualitative phase and the types of questions that will be asked of the participants" (p. 224). After analyzing the quantitative data, the researcher planned the next phase of the study to explore the phenomenon of the selected participants and accumulate specific information about the issue.

In addition to quantitative data, surveys can also collect open-ended questions. Then, the researcher used open-ended questionnaire questions for the qualitative phase to conduct the interviews. For example, Creswell (2014) explained that "a typical procedure might involve collecting survey data in the first phase, analyzing the data, and then following up with qualitative interviews to help explain the survey responses" (p. 224). Thus, the qualitative phase was created over the quantitative phase with the participants' responses.

Furthermore, Creswell (2014) clarified that "the overall intent of this design is to have the qualitative data help explain in more detail the initial quantitative results" (p. 224). Thus, the objective of the qualitative phase is to explore the results in more depth. In the second qualitative phase, the researcher plans to collect the descriptive phenomena using a distinct method, such as interviewing the selected participants and employing structured, semi-structured, unstructured, or informal interviews. The structured interviews comprise a preset script; all interviewees will have the same questions (Hartas, 2010; Savin-Baden & Howell, 2013). Hartas (2010) explained that "semi-structured interviews involve a researcher working through their analytic interest in real-time, creating distinctive and unique discourse" (p. 62). The researchers will collect data on the actual interests of the participants.

On the other hand, unstructured interviews allow a researcher to discuss open-ended questions for a specific objective. Hartas (2010) explained that "researchers may begin their project using unstructured interviews and move on to using semi- or even structured interviews" (p. 62). However, a researcher can collect the data from the informal interview.

In this dissertation, I used semi-structured interviews to discuss the appropriate questions for further in-depth information on teaching experience. The intended interview script would delineate the primary numerical data from the first quantitative phase and the open-ended questions on the survey. The purpose of using the sequential explanatory case study was to reveal the teaching experience of in-service teachers in depth through mixed methods.

Participants

The participants were in-service mathematics teachers at the secondary level. I selected in-service secondary mathematics teachers from a district in a midwestern state. The chosen district's in-service teachers' instructional experience will be relevant to my study to guide the preparation of potential mathematics teachers at the secondary level. The district has 50 in-service secondary mathematics teachers, and 41 in-service teachers (82%) completed the survey. Three (7%) in-service secondary mathematics teachers were interested in participating in the study's second phase, which was the interview process.

Participants Demographics

Survey Participants

There were 41 survey participants, and 68.3% responded to race/ethnicity questions. 14.6% of the participants identified as male, and 53.7% of the participants identified as female. No participants identified as non-binary/third gender preferred not to answer or select "Others." This result indicated that female participants were more represented than male participants. 12.2% identified as African/American, 2% as Asian, and 53.7% as White Caucasians. No participants identified as Arabic/Middle Eastern, Latino/Hispanic, or Native American, preferred not to answer, or selected Other. This indicates that White Caucasians were overrepresented compared to African American/Black and Asian participants.

I used descriptive statistics regarding the mean of in-service secondary mathematics teachers' ages. The study included 27 of 41 teachers with a mean score of 43.59, indicating their ages from 21 to 62. 19 teachers, with a mean score of 16.58, had taught secondary mathematics for five to 28 years. 70.7% responded that they had taught secondary mathematics in a classroom, 58.5% answered yes as a prominent mathematics teacher, 12.2% were not a prominent mathematics teacher, and 29.3% did not reply.

Interview Participants

There were a total of three interview participants; 33.3% of the participants identified as male, and 66.7% were female of the total respondents. A 29-year-old male was White Caucasian and had taught for over seven years. A 53-year-old female was White Caucasian and taught for more than two decades. The last participant was a 38-year-old White Caucasian female who taught for over 17 years. This indicates that female participants were more represented than male participants. No participants identified with any other racial/ethnic category, preferred not to answer or selected Other. This indicates the underrepresentation of other racial/ethnic groups in the interview.

Data Sources

The sequential explanatory case study included a survey and participant interviews with those who volunteered. Both of these instruments were used to learn more about effective instructional practices. The survey was developed to explore the use and knowledge of effective instructional practice data on effective instructional practices. The survey questions were constructed from a literature review of NCTM's eight effective instructional practices related to the research question.

Description of Survey

The survey was divided into three blocks with a skip option. The first section gathers information about the participant's background characteristics, such as race and gender. Then, the participants are taken to the views of current teaching section, where they respond to questions about their teaching practices.

The participants responding to this section were those who have been teaching secondary mathematics. In-services teachers used a slider to record their answers on the survey. The slider's range was from zero to one hundred. Zero indicates never, and one hundred means always. With a slider, in-service teachers rated how often they have used effective instructional practices in daily instructions. In addition, in-service teachers reported on how frequently student-friendly goals were established to explain the lesson's objectives. Additionally, the focus was on making instructional decisions using daily objectives and connecting the concepts to real-world tasks, which allowed students to use multiple representations and think deeply using problem-solving strategies throughout the lesson.

The next section of the survey focused on facilitating the tasks using different strategies and encouraging students to use precise mathematical language to explain their mathematical reasoning. In this section, in-service teachers rated how often they have selected tasks that allowed students to choose visual, symbolic, verbal, and contextual representations. Finally, the survey asked the in-service teachers how frequently they have facilitated group discussions and had students work in groups of different skill levels.

In the next section, in-service teachers rated how often they have used students' prior knowledge to introduce new concepts and procedures, followed a logical sequence of mathematical ideas, and provided students the opportunity to explain their conceptual understanding. The survey also asked about their lesson planning experience and how often they have considered and developed questions to assess and advance students' thinking to adjust the instructions during a lesson. The survey asked in-service teachers how frequently they allowed students with similar mathematical abilities to work in groups. It also provided feedback to address the misunderstanding and reinforce the mathematical concepts. Next, the in-service teacher reported on their experience with equity. These items assessed how often they made instructional decisions focusing on individual students' needs, providing instructions responsive to students' backgrounds, and implementing the rigorous curriculum. Finally, it asked the in-service teachers how often they encouraged students to express their mathematical ideas and provided tasks with multiple entry points to demonstrate competence.

In the next section, the in-service teachers reported on their experience with technology. For example, items asked them how often they used technology tools like GeoGebra, Sketchpad, virtual manipulatives, Desmos graphing calculator, and algebra tiles. The survey item asked in-service teachers how often they used Google Suite, Microsoft Apps, virtual meetings, and web-based applications and how frequently they created digital interactive lesson activities and online assessments. Lastly, survey items asked in-service to indicate the range of experience with learning management systems like Schoology and Google Classroom.

At the end of the survey, in-service teachers answered open-ended questions about their experience of instructional practices. The first question asked the in-service teachers to describe their confidence in using NCTM's eight effective instructional practices after their student teaching. The second question asked about their thoughts on preparing the prospective secondary mathematics teachers of the 21st century.

Description of Interview

The study's second phase occurred after examining the survey's open-ended questions. Again, the participants interested in the research and who volunteered to be interviewed were contacted via the emails they provided in the survey. In addition, I scheduled a virtual interview on Zoom. Finally, I chose semi-structured interviews for in-service teachers, as described below.

The interview started with a question on effective instructional strategies at the secondary level. With prompts, the next question asked in-service teachers how often they use specific or different instructional practices. The following prompt question asked in-service teachers how frequently they check for understanding during teaching.

After asking questions about instructional practices, the following interview question was about social justice issues. The question had prompt questions starting with how do you address the gender, ethnic, and social class differences in students' math performance? How often do you adjust your instructions to meet the needs of students? Next, how do you address this issue in your teaching to make instructional decisions? Next, questions were on the lesson planning, including co-planning and selecting the appropriate strategy for each lesson. Then, keeping the interview flow, the next set of interview questions was about their experience with the technology. The question has prompts on technical knowledge, what kinds of technology do you use, and how much technology did they learn about in teacher preparation coursework? Next, I asked about their experience with remote learning, focusing on effective technology strategies they may have learned to engage students in remote learning.

Lastly, the questions were on their teacher preparation program. How do you compare your in-service experience with your coursework? Finally, the interview will end with a question: What changes will you make if you want to change your future teaching?

Procedures

I collected data using a survey on Qualtrics with additional semi-structured interviews. I was the only one who administered the procedures. The setting was on the Internet. The data was collected through Qualtrics, and interview data was recorded during a Zoom meeting.

I submitted an external research application to a district in a midwestern state to get permission to collect data from in-service mathematics teachers at the secondary level. The survey was available to participants via email with a brief description of the study, and they were given a choice to participate or not. If they chose not to participate, they did not take the survey.

Survey Data Collection Process

I contacted the district's program analyst and the Office of Research, Evaluation, and Analytics of the midwestern state to ask permission to collect data from the secondary mathematics teachers on effective instructional practices and their knowledge of technology. After receiving the consent, I sent out the recruitment email that included the link to the survey using a blind copy. After sending two reminders, I destroyed the email list using the Avast computer program.

I emailed the survey to 50 in-service teachers, and 41 in-service teachers submitted the survey. The final question on the survey was if the participants were interested in being interviewed, they would provide their email. Three participants were interested in this study and volunteered for the interview to share their teaching experiences. I sent an individual email to the participant to be interviewed and set a date and time on Zoom to schedule the interview.

Interview Process

The only identifiable information for the interview was the participants' contact information collected from the survey. This contact information was used to make an individual connection to plan for the interview and became the master list for the interview coding. I transcribed the recording using code names- teacher 1 (T1), teacher 2 (T2), and teacher 3 (T3) instead of actual participants' names. The coded list of participants was kept in hard copy only in a locked file drawer in my home. I destroyed the coding list once the member check had been completed. Likewise, the Zoom recording was deleted after the information was transcribed with codes.

Data Analysis

The interviews were transcribed, coded, and themed to capture the experiences of the current secondary mathematics teachers with technology. Creswell (1994) stated that "get a sense of the whole" (pg. 155). In this dissertation, I used exploratory coding by creating an Excel sheet to find the most descriptive words, reduce the collected information twice, and develop the categories and themes. Initially, seventeen codes were generated.

Table 3.1
List of Codes and their Meanings

Codes	Meaning
Adaptive	To maximize student learning, adjust instructional approaches to meet individual learning needs by differentiating tasks, integrating technology, scaffolding, and supporting productive struggle to assist students in mastering mathematical concepts.
Challenging	In daily practice, making instructional decisions requires students to engage deeply with mathematical concepts, think critically, and solve problems with higher-order thinking skills with a depth of understanding.
Comparative	Multiple representations (graphical, algebraical, tabular, and contextual) are used to compare the results of mathematical concepts and relationships of quantities to find the similarities and differences in patterns.
Comprehensive	A comprehensive approach encourages students to master conceptual understanding rather than memorizing the procedures that connect the mathematical concepts to real-world applications, differentiate instructions to assist the diverse learning needs and integrate technology.
Conventional	The conventional approach is lecture-based instruction and textbook-based learning with procedures. The teacher delivers direct instructions and learning activities to assess student progress. Students have limited opportunities to explore mathematical concepts and collaborate with peers.
Efficient	The instructional practices promote students' problem-solving skills, clear and concise communication of mathematical concepts, and procedures to minimize confusion, and strategically select technology tools.
Enduring	Mathematical concepts include the knowledge of number sense, arithmetic operations, algebraic reasoning, geometric properties, and statistical analysis. The mathematical knowledge that students are required to apply across mathematical topics and real-world applications with their critical thinking, problem-solving skills, logical reasoning, and mathematical communication.

Table 3.1 (continued)

Codes	Meaning
Enriching	Learning of mathematics allows students to explore and understand concepts profoundly and promotes critical thinking and problem-solving skills. Visualize the mathematical concepts with technology to advance their mathematical skills.
Equitable	Ensure that all students have high-quality mathematics education regardless of Their background, race, or gender. An inclusive learning environment that Provides access to all resources, including technology and accommodations for English Language Learners and students with disabilities.
Exploratory	The instructional approach allows students to explore mathematical concepts using inquiry-based or problem-based tasks collaboratively to deepen their conceptual understanding, which promotes critical thinking and problem-solving skills. With technology, students can connect and visualize concepts in the real world.
Holistic	Instructional strategies encourage students to use multiple representations-visual models, diagrams, symbolic notation, and verbal explanations to assist students in understanding mathematics. Connect mathematics in authentic situations to understand the relevance of mathematics in everyday life.
Inclusive	Creating an inviting, supportive learning environment for all students with access to all resources to differentiate instructions with response to culture to share mathematical ideas with peers.
Innovative	In the digital age, innovative mathematics instructions involve adopting new Strategies and technologies to challenge conventional practices. Project-based, problem-based, and inquiry-based learning promote students' active participation in exploring mathematical concepts. The teacher facilitates and guides students in the exploration of new mathematical ideas.
Integrated	Integrated instructional strategies combine mathematical skills and concepts from different mathematical domains- numbers, algebra and functions, statistics and probability, and geometry and measurement- to connect the mathematical concepts in real-world applications, making mathematics more meaningful with multiple representations and technology.
Interactive	The interactive approach engages students and allows them to collaborate and actively participate in meaningful discussions to explain their thinking and justify their reasoning.
Structured	Structured teaching starts with learning objectives, sequential progression built on prior knowledge, explicit instructions with concepts and procedures, problem-solving strategies, and differentiated instructions with clear expectations and guidelines.
Transformative	The instructional strategies that transform students' perception of mathematics And inspire them to become lifelong learners and critical thinkers by engaging In mathematical learning with active participation.

These codes were then integrated and analyzed, resulting in four themes. The final themes were student engagement with teaching secondary mathematics, access and equity practices in teaching secondary mathematics, technology knowledge and integration in teaching secondary mathematics, and transformation required in teaching secondary mathematics. Table 3.2 shows the themes, my definition of each theme, and an example quote for each theme.

Table 3.2

Description of Themes from Interviews

Themes	Definition of Theme	Example Quote
Student engagement with teaching secondary mathematics.	Student demonstrates active participation and interacting with collaborate with peers and communicate mathematical ideas to justify their reasoning using critical thinking and problem-solving skills in the the learning process of mathematics	How can we engage students make mathematics-relevant and increase their critical thinking, and problem-solving skills?
Access and equity practices in the teaching secondary mathematics	Create inclusive learning environment to ensure that for all students, regardless of their backgrounds or abilities have an equal opportunity without any barriers to participate in learning to succeed in mathematics.	Identify which students need help. why they need help.
Technology knowledge and integration in teaching secondary mathematics	Secondary mathematics teachers strategically understand various technological tools available for teaching mathematics, such as educational software, interactive whiteboard, graphing calculator, and online platforms. Teachers must be knowledgeable in selecting appropriate technology tools to effectively integrate technology in teaching mathematics.	How can we include more technology? I learned new technology tools during COVID-19. Learning technology tools were a significant learning experience.
The transformation required in teaching the secondary mathematics.	In daily practice to meet the needs of students, there is a need to shift the teaching strategies with a focus on integrating technology and inclusive and culturally relevant mathematical\ tasks to build a conceptual understanding by connecting real-world applications to apply critical thinking and develop problem-solving skills.	I want to teach the skills that makes it more meaning.

I used an explanatory sequential case study, which allowed me to collect qualitative and quantitative data from in-service secondary mathematics teachers. This study will assist the teacher candidates in adopting a technology pedagogical approach. I used descriptive statistics with mean to analyze the collected data. The results will be discussed in the next chapter.

CHAPTER FOUR

RESULTS

This dissertation's primary focus was exploring the effective teaching practices of in-service secondary mathematics teachers and their knowledge of technology. Data was collected from a district in a midwestern state. This chapter presents the results of the collected data to address the research question.

> How prepared do secondary mathematics teachers feel to employ effective teaching instructions in the technological age?

The following four questions were associated with the research question to explore the teaching experience in depth. Each question is connected with the primary research question to gather the depth of the experiences of secondary mathematics teachers in teaching mathematics.

1. To what extent do current teachers report engaging in the best practices in mathematics instruction, as identified in Chapter Two?
2. To what extent do current teachers report engagement with equity issues in their mathematics instruction?
3. How much did their teacher preparation program prepare them to teach with technology?
4. What is the current teacher's level of knowledge of technology?

The data were collected from two sources: interviews and a survey. In this mixed-method sequential explanatory study, I will first analyze the qualitative data using themes. I will define each theme, including participants' statements.

Qualitative Data: Interviews

Of the 41 survey responses received, three in-service teachers volunteered to be interviewed. The three teachers are labeled T1, T2, and T3 throughout this study to ensure their identities are not disclosed. The discovered themes described in Chapter Three were student engagement with teaching secondary mathematics, access and equity practices in teaching secondary mathematics teachers, technology knowledge and integration in teaching secondary mathematics, and transformation required in teaching secondary mathematics. The participant's statements associated with themes are described below.

Theme 1: Student Engagement with Teaching Secondary Mathematics

Student engagement is crucial for understanding mathematical concepts and using critical thinking with problem-solving skills. In the digital age, teaching requires lessons encouraging students to participate in group discussions to make mathematical concepts more relatable. Students work collaboratively to solve real-world problems by applying mathematical concepts in applications. T1 stated that,

> *What objective do we want our students to meet? What are our priority standards? You can't teach everything. How are we going to create lessons for specific units? What comes first? What comes second? Do we need more traditional lessons that are hands-on, relevant, and engaging?*

T1 expressed that teachers cannot teach everything within time constraints; it is crucial in lesson planning to identify the essential learning goals and prioritize standards to determine the sequence in which topics will be taught depending on the content and skills. Then, the essential goals are broken down into smaller sections so students can progress in learning.

Student engagement includes several instructional strategies, and T1 articulated that effective teaching only involves traditional methods and hands-on activities to engage students. But T2 specified that,

> *We don't necessarily have to make lesson plans. When we get observed, we present the lesson and all materials from the textbook we will use in class, particularly that day.*

Lesson plans assist in developing an outline for achieving specific learning objectives and standards. Without a lesson plan, teaching and learning are on the fly because lesson plans drive the instruction with activities to engage students, like what and how students will respond during the lesson and how to support the struggling students. As T2 expressed, using a textbook for daily activities indicated that relying on textbook materials without creating detailed lesson plans can be a risky approach to teaching because not all students learn the same way.

Not all lessons will unfold mathematical concepts to deepen students' understanding. Students will be limited to engaging with and exploring mathematical ideas. T3 expressed that lesson planning is essential to teaching: "*I plan my lessons, adjust the curriculum pacing, and make daily instructional decisions.*" Lesson planning allows teachers to ensure alignment with educational standards and prepare in advance for challenges or opportunities for student engagement. It is imperative to adjust the pacing of a lesson by collecting evidence of students' understanding to support struggling students. Evidence-based instructions allowed teachers to make daily instructional decisions. Planning a lesson strategically assists teachers in delivering the lesson with a focus on students' thinking, which helps them reach an established goal. In this theme, student engagement is the primary focus. To engage students in learning mathematics, all the teachers need to plan lessons carefully and design instructional activities, adjust curriculum pacing, and make daily instructional decisions to meet the needs of individual students.

Theme 2: Access and Equity Practices in Teaching Secondary Mathematics

All students, regardless of race, gender, background, abilities, or circumstances, must have equitable access to all academic resources to build their identities with mathematical skills. Access and equity teaching practices focus on eliminating barriers to mathematics learning and promoting inclusive daily instruction in the classroom.

T1, T2, and T3 expressed that access and equity are challenging in day-to-day teaching practice, considering students' race, gender, culture, background, and socioeconomic situations or circumstances. Teachers do not have time for both whole-class instructions and individual or small-group work to ensure that all students can master mathematical skills, which builds a learning gap.

Teachers do not have sufficient time and resources to prepare equitable instruction, which leads students to disengage and a lack of self-confidence in every classroom. All students do not have access to a rigorous curriculum to differentiate instructions to meet the needs of students. When asked about equity, T1 expressed access and equity that:

There is only so much I can do in my classroom other than realize that equality does not mean equitable. As far as ethnicity goes, I notice that there seems to be a disparity with just some ethnicities.

Conferring with T1, addressing the issues in instructional practices requires acknowledging diverse student needs and understanding that equity involves accommodating individual circumstances. Students come from diverse backgrounds and may face different learning barriers to learning, such as socioeconomic status, language proficiency, cultural backgrounds, and personal learning needs. By avoiding imposing unrealistic expectations, diverse educational pathways can better suit these needs, catering to all students' needs.

However, not all the teachers interviewed considered access and equity to outside what the teachers can address; T2 stated,

I tried to notice where kids are and what resources they have outside of class. I do it more on an individual basis. I consider my students more like individual cases and try to get to know them and their academic needs.

T2 expressed that access and equity in instructional practices prioritize understanding individual student needs and their diverse circumstances. It acknowledges the variability of resources and supports systems outside the classroom for each student. T2 actively seeks to build meaningful relationships with the students by getting to know them personally at the academic level. Instead of treating all students the same way, T2 recognized each student's uniqueness and designed the instruction to provide support. Similarly, T3 considered access and equity as a need for every classroom with a statement:

I think just making sure practices are equitable, regardless of gender, race, socioeconomic class, or whatever, just adjusting the lesson to meet their needs, and being mindful while teaching not biased in our lessons.

According to T3, addressing gender issues within instructional practices provides equitable support tailored to individual student needs, irrespective of gender, socioeconomic status, or race, which involves adjusting assistance. Also, it ensures unbiased teaching, content, and support to create an inclusive learning environment. T3 acknowledges that educational practices must be fair for all students rather than adopting a one-size-fits-all approach, and they must also be mindful of the teaching practices.

Equitable instruction for teaching and learning mathematics is challenging with rapid changes in daily life, and time is the biggest constraint in planning lessons to meet the daily needs of all students. When planning a lesson, teachers must consider the elements of equitable instruction, including differentiating instructions, rigorous curriculum, high expectations, and adequate time for learning mathematical skills.

Theme 3: Technology Knowledge and Integration in Teaching Secondary Mathematics

Teaching secondary mathematics with technological integration in the digital age is essential for engaging students to explore mathematical concepts in real life. Teachers must understand the various technological tools and platforms relevant to the mathematics curriculum, which includes software like graphing calculators, interactive whiteboards, educational apps and virtual manipulatives, algebra tiles, and geometric sketchpads to facilitate interactive demonstrations and simulations to promote understanding and retention of mathematical concepts.

Technology provides access to information, interactive learning resources, and educational tools, increasing engagement through multimedia presentations, improved communication, and virtual experiences. T1 stated that,

> *Technology tools were a significant learning experience for me. I made videos associated with lessons and have continued doing that post-pandemic. We have a learning management system called Schoology, where I used to maintain a website for students and parents to view. Now, I have a website where all the others have the same thing, and everything is housed in one place. If my students need to communicate with me, they can email me, and they didn't have that capability before*.

Referring to T1, it had been a significant learning journey in the new digital era, particularly in creating instructional videos, a practice that continued beyond the pandemic. With the adoption of the Schoology learning management system, everything was centralized in one platform. Additionally, the integration of email communication within the system enhanced student-teacher interaction, which they did not have before. T1 described technology tools as a learning experience in which they were actively engaged in the educational context. Overall, T1 specified a positive impact of technology tools and recommended that integrating technology into education can be an inspiring and transformative experience.

The second participant, T2, responded similarly to T1 in housing the instructional material on Schoology. T2 shared that,

> *I used Schoology, a platform where I can post everything, we use that is new, and I know that's my daily routine. I save everything we do on the Smartboard as a*

PDF and post all the handouts. I used apps like Kahoot, Quizzes, web-based games for formative assessments, and an online graphing calculator to demonstrate graphical functions.

Schoology was a primary platform for sharing new and saved Smartboard PDFs with students by uploading instructional resources and making them an integral part of daily routine. Additionally, the teacher incorporated various apps for formative assessments to gauge student understanding and a graphing calculator for visual representation. The integration of technology enhances engagement and supports effective teaching and learning.

In addition to T1 and T2 teaching with technology journey, T3 had a different platform to share mathematical resources with students and used apps to engage students in learning. In a statement, T3 said,

I used Google Classroom to house all daily instructional materials. I uploaded the PDFs of the daily class notes, as well as Google Slides, for the presentation of the lesson. I also used Pear Deck for engagement pieces with students because I could see what they were typing and writing live. The assignments were posted digitally, and I used a digital Desmos calculator for calculations.

T3 relied on Google Classroom, the central hub for organizing and distributing instructional materials, including PDFs of class notes and Google Slides for lesson presentations. T3 used Pear Deck for real-time interaction to enhance student engagement by monitoring students' activities for instant feedback. This comprehensive digital approach facilitated teaching and learning experiences while promoting student participation and understanding of mathematical concepts.

Theme 4: Transformation Required in Teaching Secondary Mathematics

Transformation in teaching secondary mathematics involves shifting from traditional instructional methods to more student-centered, interactive, and technology-enhanced approaches, moving away from lecture-based teaching towards inquiry-based learning, problem-solving, and collaborative activities that promote critical thinking and understanding of mathematical concepts. To enhance instruction and student engagement, it is imperative to incorporate technology tools and digital resources, which provide opportunities for interactive exploration and real-world applications of mathematics.

The in-service teachers T1, T2, and T3 expressed their teaching experiences and agreed that student learning has shifted over time and with technological evolution, but teaching has not shifted much. Students are not engaged in lecture-based teaching but are more interested in learning with technology, providing instant access to explore and elaborate ideas that connect them to the real world. T1 stated that,

> *There was not much technology in my teacher preparatory program, and we were not using technology to teach mathematics. The technology I have used has been introduced to me through in-service professional development here in my district or the Intermediate School District workshop. How can we include more technology? More hands-on things that are relevant and engaging, and give up direct instruction?*

The above statement suggests that T1 highlighted an experience where technology integration was not emphasized during their teacher preparatory program. T1 articulated that they had exposure to technology tools and methods through in-service professional development sessions offered by their school district or workshops organized by the intermediate school district. T1 suggested that it is time to incorporate more technology, hands-on activities, and engaging instructional approaches, such as student-centered learning instruction, instead of teacher-led instructional approaches.

Teachers must have more technology training to transform traditional and digital classrooms to create engaging learning environments. T2 shared student teaching experiences and the teacher preparatory program,

> *During student teaching, I learned how to use a few mathematical software, such as Kuta software and Examview. In my coursework, I used PowerPoint and graphic organizer software. We were more focused on social media. But I probably didn't end up using many things we used in a technology class in college as a teacher.*

The above statement of T2 reflects their experience with technology integration during teacher training. During student teaching, T2 learned skills using mathematical software and general tools like PowerPoint and graphic organizers. T2 stated that coursework emphasized social media tools irrelevant to teaching practices and learning various technologies in college, but I did not utilize them as a teacher. It highlights the discrepancies between the technologies taught in teacher preparation programs and the usefulness of teaching practices.

T3 expressed a similar teacher preparation program experience as T1 and T2. T3 stated that,

> *There was a lot of push for the educational classes and just talking about curriculum designing lessons from standards, but not much technology. The coursework used a Moodle program but did not teach us different programs to*

teach mathematics. The actual technology class did not focus on using technology. I learned on my own during COVID-19.

T3 described the experience with technology integration in educational coursework, with a significant emphasis on traditional educational topics like curriculum design and lesson planning from standards with limited attention to technology. During the coursework, T3 expressed exposure to a learning management system like Moodle but did not provide training on specific technology tools for teaching mathematics. Even the technology class did not focus on using technology for teaching purposes. T3 learned technology skills independently during the COVID-19 pandemic.

The above statements of T1, T2, and T3 highlight a potential gap between the technologies emphasized in teacher preparation programs and those used in the classroom, with a gap in their formal education regarding integrating technology into teaching practices, leading them to seek out and develop these skills independently when faced with the challenges of remote learning. Preparing teacher candidates with more hands-on experience and technology integration instructional strategies is essential to changing the traditional educational program. Districts must offer more professional development to current teachers on integrating technology in teaching mathematics to shift conventional classrooms into digital learning. Due to a lack of technology training with effective instructional practices for in-service and teacher candidates, students are not engaged in learning mathematics. Districts must provide technology resources to improve teacher efficiency and student learning. Teachers must be capable of using technology and well-informed about using appropriate tools in teaching mathematics.

Quantitative Data – Survey

A total of 50 surveys were sent out to in-service secondary mathematics teachers, and 41 in-service teachers completed the survey. I used descriptive statistics around means to quantify data on in-service secondary mathematics teachers' instructional practices and experiences. The collected data has seven categories, and each category had a figure representing the mean of the data. The categories are strategic instructional design, instructional strategies for mathematical conceptual understanding, Prior knowledge and strategic questioning, differentiated instruction in learning mathematics, culturally responsive and adaptive instructional practices, technology integration with teaching mathematics, and post-student experiences in secondary mathematics. I will describe each title and then analyze the data for each figure.

Strategic Instructional Design

Purposeful planning and implementation of teaching strategies and activities to effectively facilitate student learning. Instructional design begins with lessons and activities with learning objectives to ensure that instruction addresses essential content. Integrating real-world applications into instruction helps students connect mathematical concepts to understand the relevance of mathematics. Teachers should create opportunities for students to interact with mathematical concepts, ask questions, make connections, and apply their mathematical knowledge, which fosters a deeper understanding of the concepts. Teachers can create student-centered learning environments by incorporating these elements into instructional design. Figure 4.1 shows the responses to survey items about strategic instructional design in mathematics. Each bar reflects the teachers' average response to using each item on a scale from never (0) to always (100).

Figure 4.1

Strategic Instructional Design

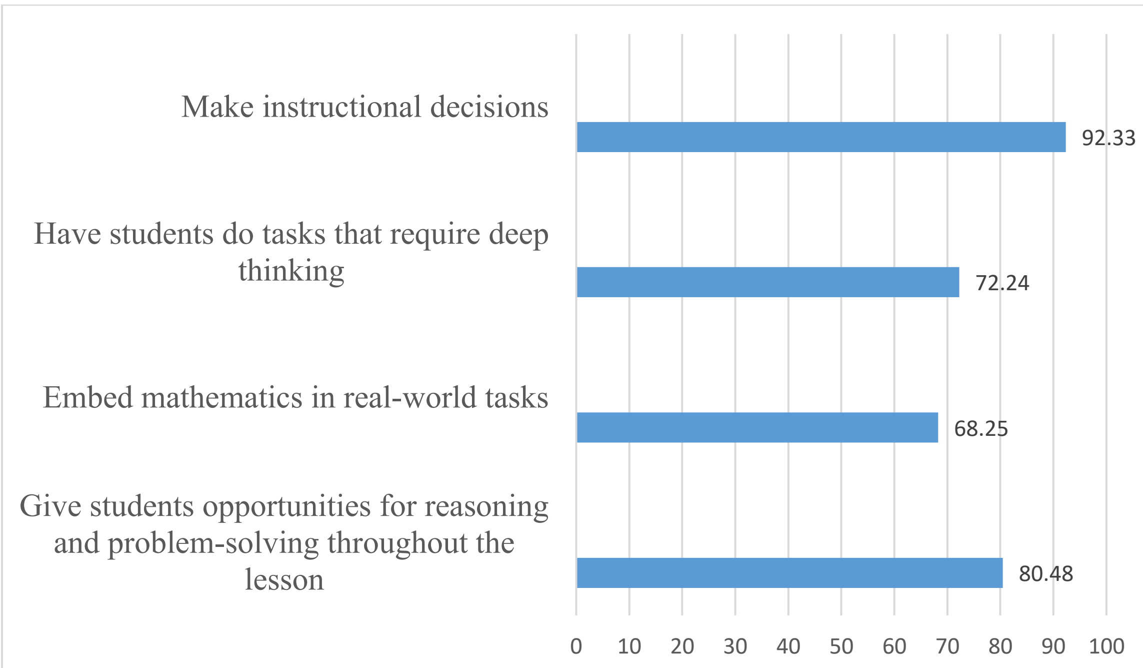

Figure 4.1 shows the highest mean score for the item making instructional decisions, suggesting that secondary mathematics teachers highly valued this practice. The lowest mean score was for the item concerning embedding mathematics in real-world applications, implying that teachers may have difficulty in this area. It is also interesting to note that each item had a response level higher than 50, which was mid-point on the scale.

Instructional Strategies for Mathematical Conceptual Understanding

For conceptual understanding, it is essential to deepen students' grasp of mathematical concepts beyond memorizing the procedures or facts. Throughout strategic instructional planning, it is required to consider several effective strategies allowing students to use multiple representations- numerical, graphical, or symbolic- to develop and understand the underlying concepts related to real-world applications. Using effective questioning techniques to facilitate group discussions and demonstrating visual representations encourages students to articulate mathematical reasoning. Figure 4.2 shows the responses to survey items about instructional strategies for mathematical conceptual understanding. Each bar reflects the teachers' average responses to their usage of each item on a scale from never (0) to always (100).

Figure 4.2

Instructional Strategies for Mathematical Conceptual Understanding

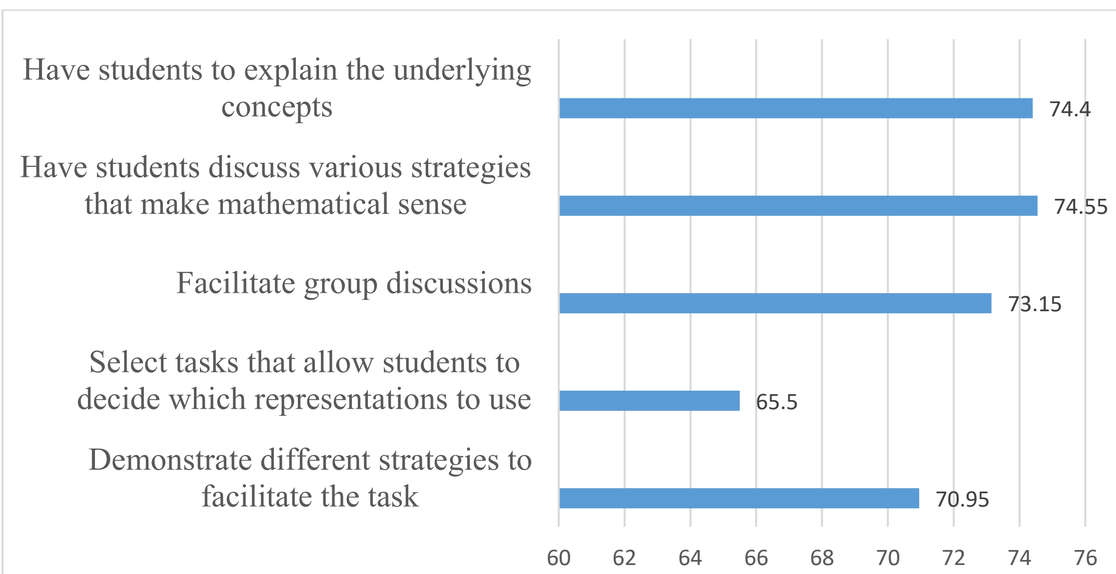

Figure 4.2 represents the effectiveness of different items. The most effective item was having students discuss various strategies that make mathematical sense. Similarly, the item, having students explain the underlying concepts, was almost as effective as discussing various strategies that make mathematical sense. The items on the scale for facilitating group discussions and demonstrating different strategies to facilitate the task had a response level above 70 on the scale. The lowest mean score was for the item on select tasks that allowed students to decide which representation to use, suggesting that it was less effective than other items.

Prior Knowledge and Strategic Questioning

In planning or creating tasks, integrating students' prior knowledge and strategies to facilitate group discussions by asking assessing or advanced questions encourages students to think critically. By building on what students have previously learned, teachers can assist students in understanding complex tasks. Strategic questioning helps and guides students' thought processes and encourages students to think critically. Questions can be used as formative assessments to assess students' understanding in real-time, allowing teachers to provide immediate feedback and adjust instructions. By applying strategic planned questions, teachers can identify and correct any misconceptions that students might have to ensure that students understand the mathematical concepts that make sense in real-world applications. Figure 4.3 shows the responses to survey items about integrating prior knowledge and strategic questioning. Each bar reflects the teachers' average responses to their usage of each item on a scale from never (0) to always (100).

Figure 4.3

Prior Knowledge and Strategic Questioning

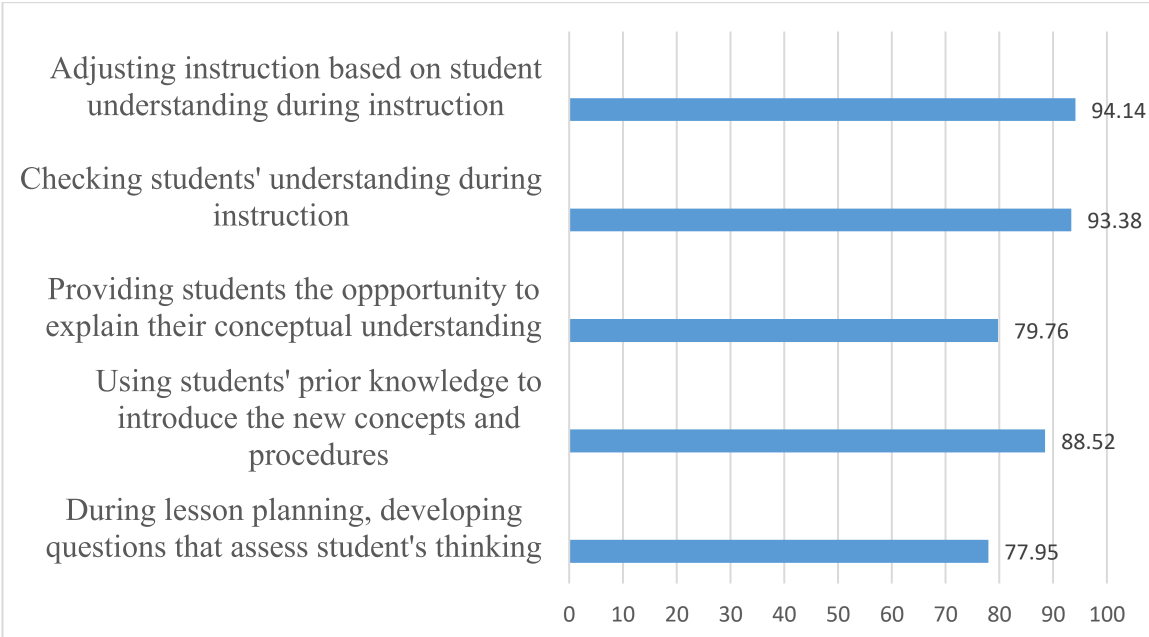

Figure 4.3 compares different items related to student engagement and instruction adjustment based on feedback. The highest mean score on the item shows the effectiveness of adjusting instruction based on students' understanding during instruction. Similarly, a close mean score of the item on the scale was to check students' understaing during instruction. It is also interesting to note that each item had a response level higher than 50. The lowest mean score on the scale was on the item in the lesson planning stage to develop questions that assess students' thinking.

Differentiated Instruction in Learning Mathematics

Differentiated mathematics instruction is a teaching approach that recognizes and addresses diverse learning needs and abilities by acknowledging that students learn in different ways and at different paces. Differentiated instruction aims to ensure that every student engages with the material meaningfully and at an appropriate level of challenge. Teachers use various instructional strategies to accommodate different learning styles, including multiple representations, hands-on activities, technology-based instruction, small-group discussions, and direct instructions. Differentiated instruction empowers students to take ownership of their learning. Figure 4.4 shows the responses to survey items about differentiated instructions in learning mathematics. Each bar reflects the teachers' average responses to their usage of each item on a scale from never (0) to always (100).

Figure 4.4

Differentiated Instructions in Learning Mathematics

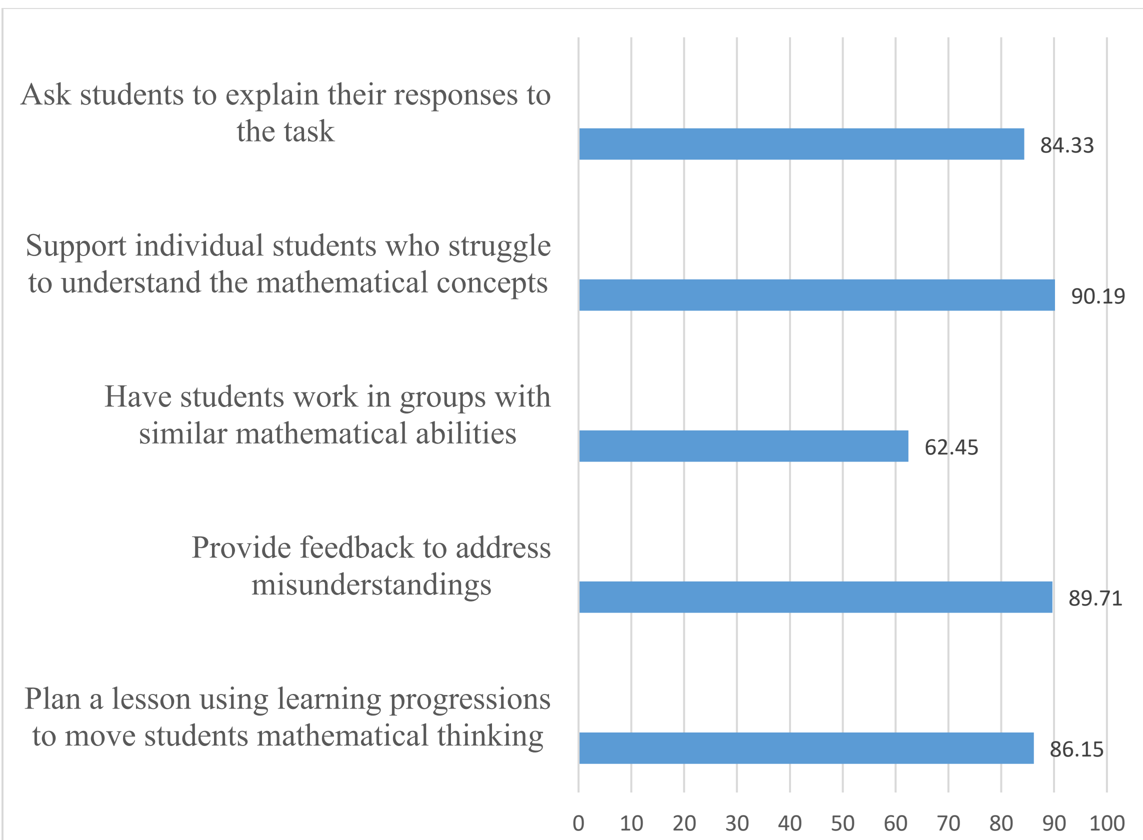

Figure 4.4 represents the items on differentiated instructions in learning mathematics, with the highest score on the scale for the item to support individual students who struggle to understand mathematical concepts. A close mean score for this item was to provide feedback to address misunderstandings. Interestingly, each item had a response level higher than 50, a mid-point on the scale. The lowest mean score was for the item concerning students working in groups with similar mathematical abilities, and teachers have more difficulties in this area.

Culturally Responsive and Adaptive Instructional Practices

Culturally responsive and adaptive instructional practices in teaching secondary mathematics aim to create an inclusive and effective learning environment by acknowledging and adapting to students' diverse cultural backgrounds and learning needs. These practices involve integrating student cultural elements into mathematical tasks to make math more relatable by using examples and problems that reflect the students' everyday lives and cultural experiences to develop mathematical identities. Adaptive instruction includes strategies like differentiating content, process, and students' abilities to their readiness level. Teachers adopt their instruction in response to students' instructional needs to support mathematical proficiency. Cultural responsiveness and adaptive instruction aim to value students' cultural backgrounds in the classroom and promote equity by providing all students access to rigorous and meaningful mathematics learning experiences. Figure 4.5 shows the responses to survey items about culturally responsive and adaptive instructional practices. Each bar reflects the teachers' average responses to their usage of each item on a scale from never (0) to always (100).

Figure 4.5

Culturally Responsive and Adaptive Instructional Practices

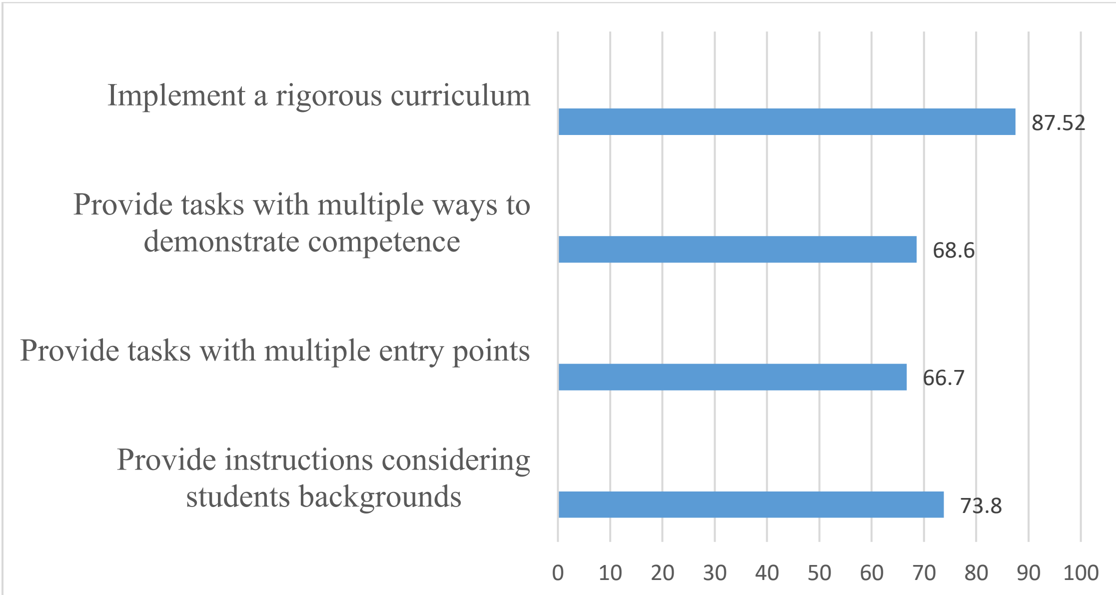

Figure 4.5 shows the highest mean score for the item implementing a rigorous curriculum, suggesting that secondary mathematics teachers highly valued this practice. The lowest mean score was for the item concerning providing tasks with multiple entry points, which means that teachers may have more challenges in this area. It is interesting to note that each item had a response level higher than 50, which was a mid-point on the scale.

Technology Integration with Teaching Mathematics

In the digital age, technology integration involves digital tools, software, and platforms to enhance instruction, facilitate learning, and promote student engagement in mathematics. Teaching with technology supports personalized learning with interactive lesson activities and simulations and offers opportunities for collaboration and exploring mathematics in the real world. Teachers can use web-based applications and platforms for interactive lessons like Khan Academy, Desmos, and Geogebra, with a wide range of interactive mathematical resources. Technology facilitates collaboration and communication among students and between students and teachers. Google Classroom and Microsoft Teams allow teachers to upload assignments, provide feedback, and encourage discussions. Technology integration enhances instruction, engages students, and supports diverse learning needs. Figure 4.6 shows the responses to survey items about technology integration with teaching mathematics. Each bar reflects the teachers' average responses to their usage of each item on a scale from never (0) to always (100).

Figure 4.6

Technology Integration with Teaching Mathematics

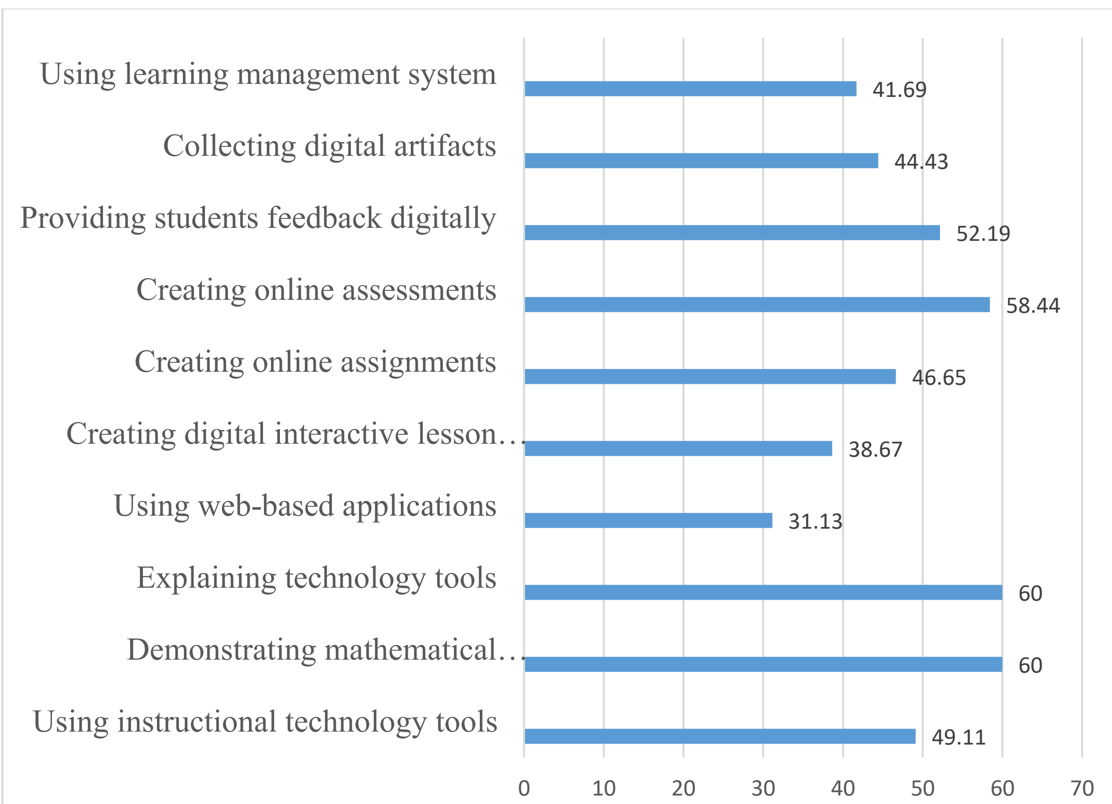

Figure 4.6 shows a few items on a scale of more than 50, which is a mid-point of the scale. The highest mean scores of items were explaining technology tools and demonstrating mathematical concepts using technology. The items were less than 50 on the scale concerning teachers struggling to use technology in teaching mathematical subjects.

Post-student Experiences in Teaching Secondary Mathematics

The last question on the survey was about teachers' experiences after their initial training and education. Post-student experiences are crucial for teachers to grow and adapt their roles, ensuring they can provide high-quality mathematics education to their students. In-service teachers face challenges in managing and teaching mathematics. They try to use the strategies they learned in their teacher preparatory coursework. With insufficient preparation to teach students by delivering high-quality instructions, teachers continue to develop professionally in teaching secondary mathematics, which includes ongoing learning and development by teaching mathematics to students.

The final question of this dissertation was how the current teachers feel about employing effective teaching practices with technology. A mean score of 6.21 represents confidence, which measures the confidence level of using the National Council of Teachers of Mathematics (NCTM) 's eight best instructional practices after their student teaching experience. The data indicates that teachers are not confident implementing effective instruction with technology in teaching mathematics. The data suggests that the teacher preparatory programs must revisit the teaching methods course to prepare teacher candidates to teach mathematics with effective instruction by integrating technology to prepare the teachers for the digital age.

Quantitative and Qualitative Data: Overall Interpretations

The data was reviewed in two phases with themes and categories in a sequential explanatory mixed-method case study. The data was collected to explore effective instructional practices using current secondary mathematics teachers' technology. The results of the data support the primary research question and subquestions.

The combination of data suggests that current secondary mathematics teachers are not trained to use appropriate technology and tools to engage students with non-traditional approaches. The teachers acknowledge that teaching with technology strategies is required in the teacher preparation coursework. Teachers struggled with equity issues in their daily practice to differentiate instruction for students from diverse backgrounds and with different mathematics abilities. Demonstrating lessons with multiple points and using multiple representations is challenging due to a lack of practice and preferring traditional approaches.

The current secondary mathematics students learned technology independently due to the pandemic and now use technology to some extent in teaching mathematical subjects. Also, teachers acknowledge that they need more training on online mathematical tools like graphing calculators and the new PSAT/SAT exams required to use online Desmos calculators. With the rapid technological change, teachers must create interactive lesson activities to allow students to explore mathematics in the real world.

Summary

The data analysis of the survey and the interviews suggested that the current secondary mathematics teachers have some knowledge of technology and tools but not to the full extent that they can effectively implement these into daily practices. This study revealed valuable feedback that there is a need for more technology training required to prepare students for the digital age. The primary concern is that the teacher preparatory program is not preparing teacher candidates to deliver high-quality, effective instruction with technology.

CHAPTER FIVE

DISCUSSION

Introduction

This dissertation explored the perceptions of current secondary mathematics teachers on effective teaching practices with technology. The study emphasizes the importance of understanding teachers' effective instructional practices as crucial in training future teachers. The research focuses on the views of in-service teachers on their experiences with instructional practices and technology integration and their reflections on the preparation they received during their pre-service training.

The primary research question was: How do current secondary mathematics teachers feel about effective mathematical practices with technology as they apply to teach? This question aims to uncover the teachers' attitudes toward integrating technology into their instructional practices and how they perceive its effectiveness. The research on effective teaching practices has revealed that in delivering high-quality, effective instruction in secondary mathematics, it is necessary to educate the teachers with effective teaching strategies with technology (NCTM, 2014; Boston et al., 2017; Harasim, 2017). This study's findings provide valuable insights for improving training programs and enhancing the use of technology in mathematics instruction.

Summary and Implications of Findings

Technology integration into education has recently increased significant attention to enhance teaching and learning experiences. In the context of secondary mathematics education, technology effectively engages students, promotes conceptual understanding, and prepares them for the digital world. However, realizing the potential benefits of technology in mathematics instruction relies heavily on teachers' knowledge and practice. The perspective of current secondary mathematics teachers on effective teaching practices with technology is essential for informing teacher training programs.

The study utilized a sequential explanatory mixed method to investigate and collect data that explored the experiences of current secondary mathematics teachers. This methodology collected quantitative and qualitative elements that comprehensively answer the research question (Creswell & Clark, 2008; Hoy, 2010; & Yin, 2012). The research question explored in-service secondary mathematics teachers' knowledge of effective teaching practices with technology. To investigate the question thoroughly, the researcher also collected data on the reflection of their teacher preparation program.

Several data points were collected from the participants through interviews and the survey. The study's findings reveal important insights into the effectiveness of various strategies. Firstly, the findings highlighted the importance of instructional design in teaching secondary mathematics, explaining underlying concepts as the most effective strategy. The high score for making decisions suggests that teachers value adapting and making choices based on their student's needs and progress. This study suggests that effective teaching is not rigid but flexible and responsive; teachers monitor their students' understanding and adjust their teaching strategies and pace accordingly.

The lower score for tasks requiring deep thinking and real-world application could indicate areas for improvement in mathematics instructions. The results indicated that strategies to select and implement tasks requiring deep thinking and real-world applications are underutilized, or there are challenges in effectively implementing these tasks, which somewhat answers the research question. Tasks that require deep thinking can promote critical thinking skills and a deeper understanding of mathematical concepts. Meanwhile, real-world applications can make mathematics more relevant to students. These findings highlight the importance of a thoughtful and responsive approach to instructional design in secondary mathematics education. The results suggest that some strategies are being used effectively; there may be opportunities to enhance instruction by incorporating more tasks that promote deep thinking and real-world application of mathematical concepts.

The results indicated that in-service teachers may find it challenging to select or create tasks and problems that are engaging and relevant to students and can relate to real-world applications for practical use by applying problem-solving skills. Implementing NCTM's (2014) effective teaching practices allows teachers to establish mathematics goals to focus on learning progression by selecting tasks that promote reasoning and problem-solving skills with multiple entry points, like engaging students in meaningful discourse by posing, assessing, and advancing questions to build procedural fluency from conceptual understanding. As mentioned in the literature review, teachers can collect evidence of the students' knowledge of mathematical concepts to make instructional decisions in daily practice. This study's literature review described how effective instructional practices are connected, which should help the teachers plan and set essential learning goals with each task to promote student engagement and learning mathematics.

The findings for the instructional strategies for mathematical conceptual understanding revealed that teachers reported having students explain the underlying concepts is the most effective. This result could be because explaining the underlying concepts is a fundamental part of teaching mathematics, as it helps students understand the rationale behind mathematical procedures and fosters a deep understanding of the concept. The strategy to have students discuss various strategies had similar levels of positive teacher response. This finding could be due to discussing various strategies allowing students to explore different problem-solving methods.

However, the teachers' responses to promoting flexibility in thinking and problem-solving skills," facilitating group discussions," and "selecting tasks that allow students to decide which representations to use" have lower scores. This result suggested that these strategies are less frequently assigned or perceived as less effective because of the challenges of facilitating effective group discussions and selecting appropriate tasks. The lower scores that teachers gave for facilitating group discussions and selecting tasks could indicate the areas for improvement in instruction. Enhancing these areas could lead to more engaging and effective student learning experiences. Finally, the results answered the research question that in-service teachers select the tasks strategically with an effective multiple-instructional approach that allows students to choose and use one of the representations to understand the concepts and then explain their reasoning.

The results of instructional strategies for mathematical and conceptual understanding are directly related to the literature review of NCTM's eight effective teaching practices. The findings indicated that teachers reported two instructional strategies as effective compared to other strategies - implementing tasks that promote reasoning and problem-solving and building procedural fluency from conceptual understanding are relatively ineffective. As the literature review explains, both approaches aim to deepen students' knowledge of mathematics, not memorizing facts and procedures but understanding concepts, making connections, and developing thinking skills (NCTM, 2014; Boston et al., 2017; Darling-Hammond, 2005). The literature review of this study proposes that implementing these strategies requires strategic lesson planning and pedagogy on the part of the teacher.

The discoveries of teachers' views about integrating prior knowledge and strategic questioning highlight the effectiveness of various instructional strategies in a learning environment, particularly in teaching mathematics. Adjusting instructions based on students' understanding during a lesson is used frequently and effectively. It indicates that real-time modification of teaching methods based on students' grasp of the concept allows for immediate feedback and personalized instruction. The results of using students' prior knowledge to introduce new concepts and procedures provide students the opportunity to demonstrate their conceptual understanding, suggesting that this could enhance learning by making new concepts more relatable and easier to understand to deepen learning by reinforcing knowledge and revealing areas of confusion that need further clarification.

Checking students' understanding was close to the last mentioned strategy that these teachers reported being effective. The interviews revealed teachers felt that regular assessment of students allows teachers to gauge learning progress and identify areas of difficulty, enabling timely intervention and support. Checking for understanding is essential during instruction, and teachers encourage students to explain mathematical reasoning and ask questions to clarify misconceptions. Developing assessments in advance during lesson planning receives comparatively low scores and needs educators' attention to improve instructional strategies. Lesson planning sets the stage for selecting and creating the tasks and assessments using students' prior knowledge. Overall, these findings provide valuable insights for educators seeking to o[optimize their teaching approaches and promote meaningful learning experiences.

In Chapter Two, the review of effective teaching practices explains that establishing mathematics goals focusing on learning targets assists teachers in planning and implementing the lesson, preparing, assessing, and advancing questions to check for understanding, and building procedural fluency from conceptual understanding by collecting evidence of students' thinking (NCTM, 2014; Boston et al., 2017; Daro et al., 2011). The results from this dissertation study indicated that lesson planning was not utilized to the full extent. Teachers must plan the tasks using NCTM's eight effective practices to deliver high-quality instructions and encourage students to use higher order thinking skills. The literature review explained that all NCTM's eight effective teaching practices are connected, so teachers must use them in planning their lessons and during the progression of students' learning.

The findings from this study offer valuable insight into differentiated instructions in learning mathematics. Teachers' positive response to encouraging students to explain their responses to tasks emerges as a highly effective strategy. This emphasized the importance of developing skills and providing students with opportunities to articulate their reasoning. Providing individualized support to struggling students proves to be the most effective strategy. This highlights the importance of addressing individual needs and providing tailored support to students encountering difficulties with specific mathematical concepts. Conversely, grouping students based on similar mathematical abilities received a lower score, indicating potential limitations in its effectiveness. While peer learning can be beneficial, grouping based on proficiency levels may not be adequate to address individual learning needs or promote equitable learning opportunities. Also, these teachers gave a high score on the effectiveness of providing feedback to address misunderstandings garners a high score, emphasizing the significance of timely and constructive feedback in correcting misconceptions. Lastly, planning lessons using learning progression to advance students' mathematical thinking proves effective, emphasizing the importance of scaffolded instruction and designing lessons that build upon prior knowledge to promote continuous learning. These findings highlight the strategy of prioritizing student engagement, individualized support, and feedback.

Supporting productive struggle in learning is an essential element of teaching. It involves teachers thoroughly preparing for a lesson by anticipating areas where students might encounter difficulties. The literature discussed in Chapter Two explained that teachers must consider the complexities of the topic, potential misconceptions, and their students' diverse learning styles (Boston et al., 2017; Darling-Hammond, 2005). Similarly, eliciting and using evidence of student thinking is a teaching strategy that involves students' thoughts, ideas, and understanding and then using the information to differentiate instruction (NCTM, 2014). Deep planning, productive struggle, and eliciting and using evidence of student thinking are strategies to support students to become independent learners. These strategies allow teachers to tailor their instruction to meet the specific needs of their students. The literature review of this study supports the idea that teachers require more practice for students to collaborate in small groups to build conceptual understanding.

In addition, this study's findings highlight the importance teachers place on culturally responsive and adaptive instructional practices in education. They implemented rigorous curriculum results as the most effective strategy, which suggests that teachers value the ability to challenge students and push them to reach their full potential. This underscores the importance of setting high academic standards by providing challenging materials to students and fostering a learning environment that promotes academic excellence. However, teachers gave a lower score to providing tasks with multiple ways to demonstrate competence and multiple entry points, suggesting potential limitations in their perception of its effectiveness. This issue is the area for improvement in instruction. While catering to diverse learning styles is essential, this strategy is challenging for teachers to capture the complexity of students' learning challenges. It highlights the importance of cultural responsiveness and recognizing students' diverse backgrounds and experiences in instructional planning. The results indicate that the teachers felt improving mathematical understanding requires multiple ways to demonstrate the lesson or tasks to make the mathematical concepts relevant to students' abilities and backgrounds. Inclusively, these findings emphasize the need for educators to prioritize a rigorous curriculum while considering diverse learning needs and backgrounds. Additionally, incorporating strategies supporting diverse learning styles and backgrounds can enhance student engagement and understanding, leading to more equitable learning outcomes.

Support for access and equity in mathematics education requires several elements. For example, the teacher must set high expectations with clear explanations for all students, believing in their abilities and challenging them to reach their full potential in mathematics. The literature review of this study supports NCTM's effective teaching practices, focusing on teachers establishing task goals, dividing instructions with adequate time for learning to practice problem-solving skills, and providing opportunities for students to apply their learning in meaningful ways. Equality in education is essential, and it is crucial to prioritize equity to ensure that all students have access to the opportunities and support they need. Equity includes interventions and support services for students with language barriers, accommodations for students with disabilities, and culturally responsive teaching practices that support students' identities and experiences (Aguirre et al., 2013; & Boston et al., 2017). A student-centered approach is embedded with NCTM's effective instructional practices, which allows teachers to prioritize understanding and meeting the needs of all students.

This study's discoveries on technology integration with teaching mathematics provide fascinating insights into teachers' views of the effectiveness of various digital instructional strategies in enhancing learning experiences, an area of concern for teaching. Using Internet learning materials received a relatively low score. This finding suggests that online resources can supplement traditional teaching methods, which do not always fully engage students or address their learning needs. Similarly, collecting digital artifacts had a low score, indicating potential challenges in utilizing digital evidence to assess student progress. While providing feedback digitally was viewed by teachers as slightly more effective, there still may be barriers to delivering personalized feedback to students. On the other hand, conducting online assessments received a relatively higher score, emphasizing the potential benefits of flexibility and accessibility by digital assessment methods. Despite its potential for engaging students, creating interactive lesson activities had a moderate score, suggesting room for improvement in designing activities that effectively integrate technology.

Similarly, creating online assignments received a low score, indicating potential challenges in maintaining student engagement and motivation in the online learning environment. Using web-based applications received the lowest score, indicating the least effective strategy used by the teachers. However, demonstrating mathematical concepts using instructional technology tools emerges as the most effective strategy, which stresses the potential of technology to enhance understanding and engagement by making abstract concepts more accessible. These findings highlight the importance of integrating and designing digital instructional strategies to support student learning in diverse educational settings effectively. The results suggest that the current teachers require more training and practice in technology to adopt appropriate tools for mathematics tasks.

Integrating technology in teaching and learning mathematics can benefit teachers and students. It makes learning more engaging, interactive, and personalized and provides instant data to inform instruction. Technology will equip students with the digital skills they need in the future (Hidayu et al., 2019; Limniou et al., 2017; & Mishra & Koehler, 2006). However, technology integration requires strategic planning, ongoing professional development for teachers, and equitable access to technology for all students. The literature review explains that technology is a tool to support teaching and learning, not a replacement for teaching practices. Teaching mathematics with technology and tools is essential for daily instructional practices to prepare students for future readiness in the digital world. Teachers must use and teach with the digital graphing calculator required for the new digital PSAT/SAT exams. Teachers must learn new mathematical applications that will benefit the students.

In this study, I also collected data from the current secondary mathematics teachers on their learning experiences during their teacher preparation program and their confidence in implementing effective teaching practices with technology. They reported that teacher preparation programs at several Mideastern colleges were the least effective in preparing the potential teachers to use effective teaching practices, and technology was not considered as the curriculum, more focusing on social media or lesson planning, which the teachers did not use in their actual classroom. Teachers said they learned technology independently or through professional development provided by their districts or the Intermediate School District. The findings on technology in this study indicate that teachers are not knowledgeable and confident in technology. As mentioned in the previous findings, teaching with technology can benefit teachers by creating interactive lessons and engaging students effectively. Due to a lack of training on effective teaching practices with technology in the teacher preparation program, the current secondary mathematics teachers face challenges with technology's evolution.

Technology plays an essential role in teaching and learning mathematics. Lack of adequate preparation for secondary mathematics teachers can significantly impact teachers themselves and their students. The literature review suggested that the teacher preparation program must teach the teacher candidates using effective teaching practices with technology. Without proper preparation, teachers may be unable to effectively use different teaching strategies, assess student understanding, or provide appropriate feedback. This can lead to a lower quality of instruction and less effective learning environments.

The interview participants highlighted the role of lesson planning in student engagement. The results emphasized moderate views on lesson planning due to time constraints and curriculum pacing. Lesson planning, teaching, and reflecting are fundamental processes of effective instruction. Planning a lesson is a stage of identifying and establishing mathematical goals to focus learning on implementing tasks that promote reasoning and problem-solving with appropriate instructional strategies and developing assessments. (NCTM, 2014; Boston et al., 2017). During this stage, teachers should employ various teaching strategies to differentiate learning styles and abilities to engage students.

The participants' interview data revealed their access and equity practices in teaching secondary mathematics. The results highlighted the struggle and challenges of access and equity practices. Teachers said they need more training on creating culturally responsive tasks with diverse backgrounds. Access and equity in teaching practices ensure that all students, regardless of their backgrounds or abilities, can learn and succeed (Aguirre et al., 2013; Allen, 2011; & Flores, 2017). Teachers can help ensure that all students can learn and succeed in mathematics by focusing on access and equity. It is about recognizing students' diverse experiences and using them as strengths in learning.

The interview results on the theme of technology knowledge and integration in teaching secondary mathematics were not positive, as the participants expressed, due to the lack of training in teaching with technology. Technological tools can make abstract mathematical concepts more tangible and understandable through visualizations and interactive simulations to engage students with the material (Hefzallah, 2004; Hidayu et al., 2019; & Limniou et al., 2017). Technology tools allow for personalized learning, differentiated instruction, and collaboration among students, allowing them to work together on mathematical problems and projects and increase student engagement. Technological tools can help students demonstrate mathematical concepts' application in real-world situations.

The last theme that emerged from teacher interviews was the transformation of requirements in teaching secondary mathematics, and participants said that it is time to replace non-traditional teaching with digital teaching; the results of this theme were high, which means teachers value the shift from traditional instruction to digital teaching. The transformation in teaching secondary mathematics with technology involves several key elements, such as embracing technology, student-centered learning, connecting concepts with real-world applications, differentiated instruction, inclusive and equitable education, and ongoing professional development on new and advanced technologies (NCTM, 2014; & Boston et al. 2017). By embracing these transformations, teachers can enhance the effectiveness of their instruction and better prepare their students for the demands of the 21st century.

Limitations of the Study

A few limitations occurred in this study; the primary limitation was that only one district in one state in the Midwest was used. With limited access to districts, the study did not collect a holistic picture of the experiences of the current secondary mathematics teachers. A second limitation was the limited number of interview participants. It is important to note that the results of this study were limited to those who volunteered to participate in the interview. However, with a few interview participants, the study produced expressive data on using effective teaching practices with technology. With more interviews of secondary mathematics teachers, further validation of the findings could have been performed.

Another limitation was that the participants assumed they were reporting only about the technology. It was not anticipated, and I did not design questions to probe how they used technological tools. As the study results highlighted, information about their use of technology was limited and did not represent how the technology was integrated into teaching mathematics. The study discovered the minimal preparation to teach mathematics with technology.

Recommendations for Future Research

Additional research topics were collected during this study to clarify how the current secondary mathematics teachers use effective instructional practices with technology. There is a need for further research on effective teaching practices with technology in teaching mathematics, and future recommendations aim to address the challenges of using technological tools. Future research should explore how technology can be integrated into mathematics education to provide students with personalized learning experiences and instant digital feedback and adjust the teaching materials to meet individual needs.

NCTM (2014) introduced the eight mathematical practices, enabling educators to craft assignments that prompt students to exhibit mathematical reasoning. Future studies focus on technological tools and resources that can enhance secondary mathematics teaching in various ways. Integrating technology in teaching and learning mathematics requires teachers to be more knowledgeable about using technological tools. Lastly, this study's results showed that teacher preparation programs prepared current secondary mathematics with minimal or no knowledge of teaching mathematics with technology. Lastly, it is recommended that universities include teaching with technology in the curriculum to improve teacher education programs.

Conclusions

The study explored the interconnection between various instructional practices and how they can be combined to create engaging and advanced learning environments. The topic's critical nature likely stems from the challenges and implications of integrating these pedagogies in today's technology-driven education. The literature review provided insight into the importance of effective teaching practices, access and equity, and the role of technology in addressing the primary research question, "How do current secondary teachers feel about employing effective teaching instructions in the technology age?" Further, four associated questions were created to support the primary question. The study results showed that integrating technology into teaching challenges current mathematics teachers.

Technology brings several benefits to teaching and learning, so navigating digital tools such as graphing calculators and virtual manipulatives is essential to personalize students' learning. Another challenge for current teachers is teaching students of diverse backgrounds and understanding and respecting the unique experiences, values, and beliefs each student brings to the classroom. This approach is crucial in providing equal access to all educational opportunities. Current and potential mathematics teachers require more training on access and equity practices in mathematics, including cultural competence, inclusive curriculum, differentiated instructions, and collaborations with communities.

Finally, improving teaching practices in the digital age involves addressing the challenges of lack of training on technological tools and unpreparedness for synchronous and asynchronous instructions. Current teachers require ongoing training and support to enhance their digital literacy skills and their ability to use technological tools effectively. To deliver mathematical instruction effectively, it is essential to ensure all students have equal access to technology and adapt teaching practices to be inclusive and equitable. Universities must equip potential teachers with the skills to integrate advanced technology into the eight mathematical instructional practices. Practicum experiences as a part of their training, potential teachers could be placed in classrooms that are already successfully integrating technology and eight mathematical practices; this would allow them to observe and learn from experienced teachers.

APPENDIX A

INSTITUTIONAL REVIEW BOARD LETTER

OAKLAND
UNIVERSITY

Institutional Review Board

Date: April 6, 2023

study IRB-FY2023-126

Study Tile: Preparing Secondary Mathematics Teachers for 21 st-Century Technology

Submission Type: Initial

IRB Decision: Exempt

Research Team:
Surinder Sandhu
Julia Smith

Based on applicable federal regulations, the above referenced study has been determined to be Exempt, with the following categories:
Category 2.(ii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

Letter and Consent Document:
This letter along with the IRB approved (date-stamped) consent document can be found in Cayuse in the Submission Details page under Letters and Attachments, respectively. Please make sure to use the most recent IRB approved version of the consent form in consenting participants.

Permission from Research Sites: Please note the following:

- This IRB exemption determination letter means that this research has met one or more of the federal criteria for exemption per 45 CFR 46.104- Exempt Research.
- Before the research is initiated, permission to conduct research at a given site must be obtained from all research locations listed in the IRB submission. You must keep copies of all such permission letters for your files.

- It is the responsibility of each researcher to follow all applicable policies and procedures of any outside institution where the research will be conducted.

Modifications:
Any changes to this exempt project must be reviewed by the IRB prior to initiation by submitting a MODIFICATION request. Do not collect data while the changes are being reviewed. Data collected during this time cannot be used in research.

Record Retention:
Exempt projects will be retained by the IRB office for three years after the last action on the project.

You are approved to start the research. Please retain a copy of this notification for your records.

If you have any questions, please contact the IRB office.

Thank you.

The Oakland University IRB

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