THE ROLE OF ADAPTIVE LEARNING PROGRAMS IN SECONDARY MATHEMATICS: A PHENOMENOLOGY STUDY

by

Shameka Sharae Gray

Liberty University

A Dissertation Presented in Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

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Abstract

The purpose of the transcendental phenomenological study was to discover the role of adaptive learning programs in closing the learning gaps in mathematics for secondary students in Georgia following the COVID-19 pandemic. The theory guiding this study was that of Bandura's theory on self-efficacy, as it highlights how an individual's experience impacts their belief in their ability to complete specific tasks. The central question in this study sought to identify the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic. The participants for the study consisted of 10 to 15 middle school mathematics teachers in Southern Georgia. Through individual interviews, a focus group, and journal prompts, the study revealed the adaptive program's ability to close the learning gaps of secondary math students. Data was analyzed by systematically sorting the transcripts to identify codes for emerging reoccurring themes**.**

Keywords: adaptive learning, secondary students, mathematics, COVID-19, achievement gaps

Dedication

To my mother, who has always supported me and believed that I could do anything that I put my mind to.

Acknowledgments

I would like to take the time to acknowledge those who guided me on this journey to the completion of my dissertation. Those people include but are not limited to my committee chair, committee member, my professors, my family, and my peers that encouraged and supported me along the way.

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List of Abbreviations

Adaptive Learning Programs (ALP)

Association of Christian Schools International (ACSI)

Exceptional Student Services (ESS)

National Center for Education Statistics (NCES)

National Council of Teachers of Mathematics (NCTM)

Northwest Evaluation Association (NWEA)

Standard Deviation (SD)

CHAPTER ONE: INTRODUCTION

Overview

The COVID-19 pandemic led to nationwide school closures due to the uncertainties of the virus and the need for precautions to keep it contained (Schult et al., 2022; Pietro, 2023). School closures caused many challenges in ensuring students received an alternative learning method instead of traditional paper copies (for those without internet access) to virtual learning (Schult et al., 2022). In some cases, the inability to access virtual learning was due to low socioeconomic status, which further impaired this group of students those studies found already possessing less math knowledge before the pandemic (Bang et al., 2023). In some countries, school closures were for a shorter period, and the overall access to the internet was greater. However, learning loss did occur, impacting students with a loss of up to one-fifth of a school year (Engzell et al., 2021).

Although some content areas made gains and altered learning plans to accommodate the lost time to get students back on track, adjustments were not as easy for mathematics due to the foundational structure and the building of the content (Reynolds & Yavuz, 2022). An already difficult task was amplified by the increase in the varying levels of learners in the classroom following the COVID-19 pandemic. Teachers faced additional challenges using differentiation to provide students with personalized learning needed to close learning gaps in mathematics (Bang et al., 2023: Okordi & Molnar, 2022). Therefore, alternative plans had to be created to help with the math learning deficits that were happening worldwide. Each school system varied in the method they adapted to close the learning loss gap; some schools utilize summer school programs, adopt digital programs into the curriculum, or provide math and reading support classes into the curriculum instead of an elective. Within adopting digital programs came

adaptive math programs that allowed for student interaction to take place on their level of learning and the content to build. Therefore, this study focuses on adaptive learning programs and the experiences that have transpired through their use in supporting student's remedial skills. Chapter One will provide the background of the problem, as well as the purpose and significance of the study. This chapter will conclude by introducing the questions guiding the research, key definitions, and a summary.

Background

Before the COVID-19 pandemic, students experienced learning loss with a negative trend in achievement during the gap between the end and start of the school year, known as summer break (Reynolds & Yavuz, 2022). Comparing the summer loss to the COVID-19 pandemic school closures, the average learning loss in math was a standard deviation (SD) of 0.14 (Carlana et al., 2023). After the pandemic, the learning losses increased by 0.07 SD for students who fell within the lower group of learners (Carlana et al., 2023). According to Grewenig et al. (2021), school closures decreased the typical learning day from 7.4 to 3.6 hours. This change impacted the lower-level learners more as they spent no additional time learning the content than the higher-level learners who spent extra time working on the tasks; there was a twelve-week loss of face-to-face instruction. Bansak and Starr (2021) highlight that the disruption in learning due to the COVID-19 pandemic was bound to have setbacks, with a projection of upper-elementary to middle school students being half a year behind grade-level standards.

There have been many approaches to closing the learning gaps following the COVID-19 pandemic, including but not limited to after-school programs, summer programs, and now digital computer-based programs (Garcia et al., 2020; Okordi & Molnar, 2022). Okordi and Molnar (2022) state that the learning gap from the COVID-19 pandemic is higher in mathematics, with

students learning little to no math curriculum during remote learning. With this knowledge, further developments must be made to attempt to impact the three to four months of learning loss found at the start of the school year in 2020 (Okordi & Molnar, 2022). Adaptive learning programs became a tool that could be used both inside and outside of the classroom to assist in closing learning gaps in mathematics; however, a gap in the literature exists on the impact of adaptive learning programs in closing the gap in mathematics for students beyond the primary level.

Historical Context

In 2011, Jones et al. found that the gaps in mathematics further impact student life due to the deficiencies of basic math skills because of its effect on students' ability to reason, analyze, and interpret mathematical content. Fast forwarding seven years to 2018, Nelson et al. highlighted students struggling to meet the proficient level of mathematics content from elementary through middle school. This information showed the need for additional supports to move toward mathematical success (Nelson et al., 2018). The learning gaps in mathematics have been found to begin at the start of middle school as students arrive without a firm hold on the foundational skills, and most of the content is not mastered (Nelson et al., 2018). One year later, Brezovsky et al. (2019) highlighted the use of game-based adaptive learning programs that allow for flexible mathematical thinking through the personalization of the program. Another year later, in 2020, learning loss in mathematics led to the search for alternative methods to assist in closing the learning gaps, such as after-school programs, summer programs, and now digital computer-based programs (Garcia et al., 2020; Okordi & Molnar, 2022).

In 2021, learning loss continued to be studied from various approaches. For example, several studies explored the regression that some students face over the summer months,

unexpected weather days, and absences (Engzell et al., 2021; Kuhfeld et al., 2020; Liu et al., 2021; Reynolds & Yavuz, 2022; Toker, 2022). The impact of learning loss by the COVID-19 pandemic has been studied and revealed that many students made little to no learning gains during remote learning (Engzell et al., 2021). In 2022, the Northwest Evaluation Association map test (NWEA) and other assessment tools helped evaluate student trends in learning. These assisted in determining the impact of using adaptive learning programs in mathematics (Reynolds & Yavuz, 2022). The data collected was then used to predict the learning loss resulting from COVID-19 school closures. Today, the increase in learning loss or gaps in learning resulted from the COVID-19 pandemic and its disruption in the school system (Petillo, 2023). While Hilz et al. (2023) acknowledge the rise of digital learning, there is yet to be consistency in the results of the implementation of such. Hilz et al. (2023) address the impact of individual characteristics on computer-assisted learning programs.

Social Context

Significant efforts have been made to close the learning gap for secondary students in mathematics due to the impact of COVID-19, which spiked interest in technology as a support for learning (Ydo, 2021). Dai et al. (2023) address using digital learning games to support solving math problems but emphasize the importance of embedded learning support into the task. According to Moroz (2023), the role of an educator is to create responsible and productive citizens that will positively impact the economy in the twenty-first century. It describes a person able to interact and utilize technology while possessing basic math skills (at the lowest) (Scott & Quinn, 1996). The NCTM (National Council of Teachers of Mathematics) emphasizes using technology to solve problems, which is apparent with adaptive learning programs (Scott & Quinn, 1996). Hardships of COVID-19 allowed for exceptions to be made, and students were

promoted to the next grade level having not mastered the content taught to them in mathematics, amongst other content areas.

As a result, this led to the creation of a wide variation of learners in the classroom, causing it to be difficult for the needed individualized support to be given (Bang et al., 2023: Okordi & Molnar, 2022). In accompaniment, students arrive at middle school from primary with little to no basic math skill retention (Nelson et al., 2018). Later, these same students enroll in college, taking remedial math classes to prepare for the start of college-level math courses (Jones et al., 2011). For those who did not choose the path to college, employers cannot obtain employees with the necessary skill set to perform the position's duties requiring additional training (Scott & Quinn, 1996). This lack of skills impacts the student's ability to obtain employment and survive in the real world (Moroz, 2023). Therefore, educators may utilize the findings of this research to accommodate the learning gaps in mathematics and increase student understanding and performance in mathematics through the impact of adaptive learning programs in mathematics. Students and parents can benefit from the study's findings on the effects of adaptive learning programs when utilized with fidelity if it is revealed to be a tool for closing the learning gaps in mathematics. Through the findings of this study, it may lead to the identification of the success of adaptive learning programs in closing achievement gaps in mathematics and in what manners of application is such success taking place.

Theoretical Context

With 90 to 94 percent of the student population worldwide being impacted by the closing of schools due to the COVID-19 pandemic, the use of adaptive learning programs will allow for the gaps in learning to be addressed (Carlana et al., 2023; Gore et al., 2020; Grewenig et al., 2021). Reynolds and Yavus (2022) highlight using the risk and resilience framework in

correlation with reducing summer learning loss. Bandura's (1977) self-efficacy correlates to using adaptive learning programs through the pending factor of the effort put forward and the persistence despite obstacles. As students work to complete individualized leveled work, the belief is that their confidence in mathematics will grow as their foundation builds to cause an increase in their self-efficacy. Sweller's (1988) cognitive load theory correlates to using adaptive learning programs to assist in transferring material into one's long-term memory. Through the inner workings of the brain, Sweller's (1988) theory is applied through the leveling of the content to allow students to build an understanding and progress in their abilities in mathematics. Chu et al. (2021) addresses the use of adaptive learning programs in the enhancement of student achievement as well as self-efficacy.

Huang et al. (2019) address gender roles in correlation with math anxiety and self-efficacy at the middle school level. At the same time, Tarkar et al. (2022) found that students with high math anxiety avoided challenging math problems. Miller and Bernacki (2019) describe the adaptation piece of learning as the process of questions within the program that determine student knowledge and narrow down what the student is ready for when it comes to learning within the program. As the program conforms to the student level, the confidence factor should increase as students will be more efficient at completing the leveled content. McMullen et al. (2023) highlight the success of using a game-based adaptive learning program at a primary level to solidify rational numbers. Few studies have researched how adaptive learning programs impact closing the learning gaps in mathematics at the secondary level.

Problem Statement

The problem is that there is a significant learning gap in mathematics for secondary school students, which progressed following school closures due to the COVID-19 pandemic.

With the pandemic being something, many had no experience of or ways to analyze the possible effects, Toker (2022) compared the school closures for COVID-19 to unexpected weather days. Toker (2022) highlighted that student achievement decreased by an average of 2.6 percent per day that a student is out for an unplanned snow day in Colorado. Another comparison is that of Liu et al. (2021), who found that when missing ten class days, the result is about a four percent decrease in performance on the end-of-year assessment in both middle and high school. With fear of regression in learning in mind, many aspects of education had to be reconstructed to offer ways for learning to continue in a virtual environment. For students who were not reaching mastery during the period of school closures or the following year through optional virtual learning, alternative methods and resources were needed to help get learning back on track. In some school systems, the use of after-school programs and summer learning became the tool created to assist in closing learning gaps in all content areas, as grade-level learning was still the focus inside the classroom (Garcia et al., 2020). Mathematical literacy is an essential component in student success in society today, and with many students leaving primary school with deficits in basic math, there is a specific challenge for secondary school teachers (Hilz et al., 2023).

Purpose Statement

The purpose of this transcendental phenomenological study is to explore the experiences with adaptive learning programs that address the learning gaps due to the COVID-19 pandemic for middle school teachers in Georgia. At this stage in research, adaptive learning will be generally defined as online learning programs provided by the school district to supplement learning. The theory guiding this study is Bandura's theory of self-efficacy. The self-efficacy theory is a theory of motivation that finds that an individual's belief in their ability can actually impact that ability.

Significance of the Study

The following section explains the study's influences on the field from *a theoretical, empirical, and practical perspective*. Following the COVID-19 Pandemic, learning loss in mathematics has been prevalent and has been taken into focus in the realm of education. Although there are many contributing factors to student success, as Vuletich et al. (2019) highlight when discussing the achievements of the parents of students, my study will focus on the use of adaptive learning programs and whether the implementation of these programs will allow for the success in closing the learning gaps of secondary students in mathematics after COVID-19.

Theoretical

Bandura (1977) highlighted that a person's psychological experience will impact the level of self-efficacy that one withholds upon the result of a given event. Through this study, we can examine if the utilization of adaptive learning programs where students can receive personalized learning of mathematical content will build student self-efficacy in the content area of mathematics by reaching them on their level of learning. Sweller's cognitive load theory uses an instructional design approach to provide education to transfer content into learners' long-term memory (Sweller, 2020). As the mathematical content is offered to students on their level and the content will progress on pace with student understanding, it should be able to move into long-term memory.

Empirical

The current literature reveals that mathematics learning gaps are at the top, with adaptive learning as a tool for change. This literature focuses in on the achievement of elementary aged students, with little to no guidance for secondary students. Bang et al. (2023) addresses the

importance of early math success as it will lead to long-term success; however, there is no support in the continuation of this practice at the secondary level. There is a need for further research on adaptive learning in mathematics for secondary students to allow for the implementation of adaptive learning programs to make similar gains to that of their younger counterparts. Even with the improvements at the lower level, research has shown the decline in math performance within the transition from elementary math to middle grades mathematics (Theis et al., 2020). Kim and Parks (2021) addressed that in comparison to elementary school, middle school students' academic work is more rigorous, leading to an increase in failures than at the elementary level. This study will address the need for the use of adaptive learning programs at the secondary level through the experiences of teachers which will allow us to see the commonality in the feelings of success or unsuccess in result of the utilization of adaptive learning programs. Van Seters et al. (2012) found that the use of digital adaptive learning platforms have been found to be beneficial, but the answer of the way the work is individualized is still a mystery to most. With many unknowns within the use of adaptive learning platform, this study will help to resolve unknown components of the benefits of implementations in math classrooms at the secondary school level.

Practical

Adaptive learning allows students to learn content at their level of need. Through this study, an examination of level-based work will enable the content to be obtained and applied in mathematics. Nelson et al. (2018) addresses the matter of a lack of achievement in math for elementary and middle school students in recent years. At the same time, adaptive learning systems have been found to be a tool used to grow mathematical learning (Sun et al., 2021). Through the collection of data in reference to the use of adaptive learning programs in

mathematics, stakeholders within the realm of education will be able to determine the possible benefits of implementing adaptive learning programs in mathematics at a consistent basis.

Research Questions

The following questions will guide this study.

Central Research Question

What are the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic?

Sub-Question One

What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics.

Sub-Question Two

What do secondary math teachers perceive as challenges of using adaptive learning programs to address learning gaps in mathematics?

Sub-Question Three

How do secondary math teachers perceive the impact of adaptive learning programs on their self-efficacy and confidence in teaching middle school math?

Definitions

The following terms have been defined to understand the significance of the subject matter in this study.

1. *Adaptivity* - The task difficulty changes to match the learner's individual ability level (Hilz et al., 2023).
2. *Cognitive Load Theory* – The implementation of visual and audio elements in a manner not to overwhelm or distract the learner (Bang et al., 2023).

3. *Foundational* – Concerning the study, this describes the base level of math knowledge (Reynolds & Yavus, 2022).
4. *Learning gap* –The missing information or learning that one should have based on age and grade level; gap in learning (Grewenig et al., 2021).
5. *Mathematics anxiety* – A feeling of worry, fear, or discomfort towards mathematics that impedes mathematics performance (Huang et al., 2019, p. 622).
6. *NWEA map test* – Norm-referenced test administered to students in a group setting (Reynolds & Yavuz, 2022, p. 55).
7. *Secondary* – Regarding students or schools, any level above primary but below college (Blasko et al., 2022; Grewenig et al., 2021).
8. *Self-efficacy* - Concerning the study, this describes one's beliefs in one's abilities (Reynolds & Yavuz, 2022).

Summary

Mathematical literacy is an essential component in student success in society today, and with many students leaving primary school with deficits in basic math, there is a specific challenge for secondary school teachers (Hilz et al., 2023). This phenomenological study will address the problem of the immense learning gap in mathematics for secondary school students, which progressed following school closures due to the COVID-19 pandemic. The study aims to discover the impact of adaptive learning programs in closing the learning gaps in mathematics for secondary students in Southern Georgia following the COVID-19 pandemic. Mathematical literacy is an essential component of student success. Many students leave primary school with deficits in basic math, leaving specific challenges for secondary school teachers.

CHAPTER TWO: LITERATURE REVIEW

Overview

A systematic review of the literature was conducted to explore using adaptive learning platforms to close gaps in student learning. This chapter reviews the current literature related to the topic of study. First, the theories of self-efficacy and cognitive load will be discussed. This is followed by a review of recent literature regarding the purpose and structure of adaptive learning programs in terms of the development and integration into mathematics classrooms to assist in closing the learning gaps for students enlarged due to the unforeseen challenges created by the COVID-19 pandemic. Finally, the need for the current study is addressed by identifying a gap in the literature regarding the impact of adaptive learning on the performance of middle schoolers in mathematics which also impacts additional secondary levels.

Theoretical Framework

This research has a theoretical framework based on Bandura's (1977) work on self-efficacy and Sweller's (1988) cognitive load theory. These theories assist in understanding the role of adaptive learning platforms in education as a means of closing student learning gaps in mathematics. The views of Bandura and Sweller provide a framework for exploring student perception toward adaptive learning platforms and their ability to comprehend previous and current grade level content to close learning gaps in mathematics.

Theory of Self-Efficacy

Bandura (1977) identified four principles in which personal efficacy are said to be derived: performance accomplishments, vicarious experience, verbal persuasion, and physiological states. Through these four principles, Bandura explored individuals' behavioral changes, which can impact their belief in their abilities. Although each of these principles can

work independently, all principles equate back to the cognitive level of the individuals and their perspective of their abilities (Bandura, 1977). Through Bandura's study, he discovered that with an emphasis on the term self, a person's performance is determined by various factors, from the effort put forward to the experience of the task being participated in (Bandura, 1977). Bandura (1977) highlighted that it is the psychological experience that a person has that will impact the level of self-efficacy that one withholds upon the result of a given event.

Olivier et al. (2019) saw many of the same results as Bandura, as they highlighted that self-efficacy is one of the main factors that impact academic achievement (Zimmerman, 2000). Lee et al. (2022) implies that is through one's self-efficacy, the conviction of one's performance to obtain the desired outcome is determined. Although other theories exist about the impact of "self" on student achievement, it can be noted that a repeated result of failure can negatively impact student belief in their performance of such a task in the future as highlighted through Ford et al.'s connection of self-efficacy and mastery experiences (2022). The use of Bandura's theory of self-efficacy correlates to the topic of study through the connection of student struggles in mathematics. Many students find themselves experiencing a plethora of adverse outcomes when it comes to showing their understanding of the mathematic content. Such experiences lead to a negative outlook on the subject area and lower students' sense of self-efficacy when it comes to interacting with the content. Lee et al. (2022) addresses the broad impact of self-efficacy in math through student's interest in the content area (Rottinghaus et al., 2003), their goals that they are pursuing in the subject matter (Lee et al., 2014), and their aspirations in achievement (Bong, 2009) amongst other things.

In connection to adaptive learning platforms for math, these platforms were created to meet students where they are in their mathematical abilities. These personalized learning

platforms have positively affected student learning outcomes (Major et al., 2021). As a student progresses on through their mathematical levels, positive behavior becomes associated with mathematics. The personal successes and failures occurring within the completion of the programs can be connected to Bandura's (1977) belief in one's overcoming of a challenge by their own hand increasing the experience within the course of mastery. This is due to positive student interaction with mathematical content on a given student's cognitive level due to the hopes of success as the learning builds and adapts based on student needs. With the broad range of leveled learners that sit within mathematics classrooms today, adaptive learning time provides a positive outlook on mathematics for those below grade level as the focus turns to their abilities. Bandura addressed the matter of failure, whose impact varied based on the number of times it occurred (Olivier et al., 2019). Adaptive learning programs in math were developed to assist in decreasing the number of failures one experiences in math due to the leveling of the student's ability as the starting point within the assignments. This starting point provides positive interactions with the content increasing the student's self-efficacy through positive experiences which is expected to lead to closing the learning gaps of students below grade level.

Cognitive Load Theory

Sweller (1988) discovered the value of problem-solving skills by implementing a series of puzzle-type problems in experiments. Sweller deducted that although participants could sometimes solve the problem, they only sometimes understood the rules (Sweller, 1988). This led to the development of the cognitive load theory, which has progressed to be known as an understanding of the inner workings of human cognition (Sweller, 2020). The cognitive load theory focuses on the architect of the mind and its interpretation of learning (Mavilidi & Zhong,

2019). This theory is used when technology-based instruction is presented to learners to ensure a high level of effectiveness (Sweller, 2020).

Cognitive load theory takes on an instructional design approach with the intention to provide education to transfer content into learners' long-term memory (Sweller, 2020). The use of cognitive load theory correlates to the topic of study as it targets the acquisition of secondary knowledge (Sweller, 2020). The cognitive load theory development explains why there should be success in using adaptive learning programs to close student learning gaps in mathematics, which in most cases is serviced through a digital platform. Sweller (1988) addressed the understanding that through problem-solving skills, schemas are created to help in problem-solving. Students are instructed on their mental level to gradually progress and move the knowledge from their short-term to long-term memory.

This knowledge is secondary, which Sweller (2020) addressed as needing explicit instruction for it to be acquired. To achieve such tasks, school systems develop intervention plans to provide students with the instruction through avenues to instill the content knowledge at hand through various methods and strategies that may not always be feasible due to class sizes (Dietrichson et al., 2021). Through adaptive learning programs, students are explicitly instructed, provided with practice, and assessed on their understanding of mathematics. As with cognitive load theory's focus on the architecture of the mind, adaptive learning must be constructed to fit the various leveled reasoning skills within a classroom to provide the content on each student's level to drive toward understanding and long-term retention of learning (Sweller, 2020). In cases of individuals with math anxiety, mind wandering can occur due to their perceived beliefs in their abilities in math which lowers the interest of learning (Mesghina et al., 2023). Adaptive learning assists in providing students with explicit instruction and skills check on each individual

student's level of cognitive ability which should lead to the closing of learning gaps for middle school students in mathematics.

Related Literature

Within the last few years, education has had many setbacks, with the COVID-19 pandemic being one that caused a loss of learning time for many students of all ages. During the quarantine period of the pandemic, 2019-2020 and a year's time following, school systems offered virtual direct instruction due to the mandated lack of being able to meet face-to-face followed by a precautionary window optional for parents to elect to keep their students at home (Bailey et al., 2021). At the start of the pandemic, many began gauging the gaps in learning that were about to transpire due to school closures (Bailey et al., 2021). With the lack of training and the gap in technology access across the country, not all teachers and students were successful (Kuhfeld et al., 2020). As COVID-19 required an immediate transition from traditional methods to the immediate implementation of distance learning, in which many public-school educators were not versed in (Bystrenina & Nikitin, 2022). Abled school systems and communities provided access to a digital platform for students and teachers to utilize to hold classes, while others of less fortunate circumstances, were only given access to online assignments to equate the teaching and learning due to not having access to a virtual platform for direct instruction, but no matter the platform or procedures created to continue the learning process, all students did not attend or attempt learning during the pandemic (Ark, 2021; Meeter, 2021). Some students were not fortunate to have internet access an instead received paper packets of content to complete. For those that were able, even when given multiple opportunities or sources of learning, many students did not partake in the endeavors and mentally fell behind grade levels as their academic learning regressed; Kuhfeld et al. (2020) highlighted that even when the components of the

virtual learning were placed online for students to access at their own convenience, many did not take the initiative to even go and look over the content nevertheless complete it.

This can be argued because of the lack of parental enforcement, which could have been due to multiple reasons from being an essential worker to succumbing to illness at this time in question. While in the bind of trying to ensure student learning, many school systems parents were asked to provide educational supports, but nonetheless, students fell behind in all aspects of education which caused for national deficits (Serverino et al., 2021). Students within lower socioeconomic status environments were not able to access educational opportunities during the pandemic with over 50% being non-accessible (Huang et al., 2023). This combined with students that were facing other obstacles such as family illness (Sattem et al., 2022). The achievement gap also varied based on race and ethnicity with those more vulnerable to the COVID-19 pandemic suffering more learning loss than others (Kuhfeld et al., 2022). The National Assessment of Educational Progress reports that only 34% of eighth graders in the United States performed at a level of proficiency in mathematics in 2019 with that haven been the results after a decline since previous years (Codding et al., 2022). In Texas alone, 40 percent of students were not successful on the mathematics exam in 2021; many students were not on grade level at the start of the 2021/2022 school year (Sattem et al., 2022).

Because of this pandemic time being governed as a hardship, most students, if not all, were promoted to the next grade level whether mastery of their learning was shown, or learning was attempted because of the situation being unable to be controlled. The matter of promoting all learners caused a widening in the learning gaps where grade level content was expected to be taught and to the increase in the ranges of learners that sat within the same classroom setting because of the lack of mastery from previous grade levels. Kuhfeld et al. (2020) describes the

time of the pandemic as an extended summer break in which studies have shown to be a time when academic achievement slows or declines. The same concept was highlighted by Toker (2022) who found that learning loss in math based between 15 months to 2.5 years within Turkish scores. Most of the decline in mathematical learning occurred in the initial months after school closures (Kuhfeld et al., 2022). In accompaniment with the setbacks caused by COVID-19, research shows that there already existed a decline in academic achievement and mastery after students' transition to middle school (Theis et al., 2020).

The setbacks caused by the pandemic and the loss of performance from the transitioning period to middle school contributed to students possessing learning gaps that need intervention to help them to be able to reach on grade level content and gain mathematical literacy, which Hilz et al. (2023), Claessens and Engel (2013), and Parsons and Bynner (1997) address to be essential to participate in modern day society highlighting how the impact of mathematical literacy is not only impacting the young learners now, but will continue to impact their futures if the matter is not addressed. For many middle school students, mathematics is seen to be a difficult subject whether it is from having to compute the answers of complex multistep problems or decipher the needed steps to solve word problems (Donolato et al., 2020; Kikas et al., 2020). Due to a lack of buy in from learners and their inability to be persistent in working toward the solution during the pandemic, mathematics suffered more learning loss than reading, educators must seek ways to increase student engagement as well as their performance from such participation (Kikas et al., 2020; Sattem et al., 2022). Bilgin (2021) described math as tool that is involved in all aspects of life and emphasized the need for mastery of the basic skills. It is the goal of educators to determine the best methods to enforce such knowledge obtainment. Over the course of time, education has sought out ways to close the learning gaps of students that were not performing on

level from the acknowledgement of low student achievement through the plan to improve learning through education reform (Matsumura et al., 2008).

Sun et al. (2021) identified the increase in learning through technology increased following the pandemic where many were forced to see its vitality as a learning tool. The push for technology led to the need for clarity through the process of which such instruction was to be conducted and the guidance for the methods in using effective tools was evident (Bai et al., 2023). A traditional classroom setting pressured students to be able to complete tasks outside of their understanding for those below grade level which was something that some of the technology aspects lacked (Rohrkemper & Corno, 2022). Through the incorporation of mini lessons and embedding skills in which the gaps lie, students may be able to learn on level through the support of lessons that fit to their needs (Sattem et al., 2022). Education today is turning toward technology to assist in catching underperforming students up to grade level and in many cases that job is being assigned to computer programs and it is because of such that many of these problems are taking a turn in the right direction (Bai et al., 2023). For some that innovation arose the use of digital tools like interactive graphs, calculators, and electronic simulations of the mathematic concepts, but for others that was not enough (Moliner et al., 2022). Over the abundance of research today, it is apparent that technology within education through the channels of online learning has the potential to amount to great things for mathematics achievement (Brasiel et al., 2016).

This study aims to evaluate the role of adaptive learning in closing the learning gaps in mathematics for middle school students in public school settings. In connection to the matters addressed by Zivkovic et al. (2022) when highlighting that middle school changes in several ways through the higher level of expectations, grading systems, and performance that comes

through a simple shift from elementary to middle school, the need for math support is vital. This literature review is the product of research conducted through scholarly databases on adaptive learning in school, which resulted in peer-reviewed academic articles on the topic. The study revealed the inclusion of adaptive learning platforms in many school settings, the gamification of these platforms, and their impact on student motivation and achievement in mathematics. Even with the abundance of articles on adaptive learning, there is a lack of research on the impact of adaptive learning to close learning gaps for students who are grade levels behind in mathematics at the middle grades level.

Adaptive Learning

Through the gathering of literature, it is apparent that adaptive learning has been around for some time. Sun et al. (2021) brings attention to the fact that the United States of America has addressed the use of adaptive learning systems to assist in the growth of education within the national technology plan. For this reason, many today are more aware of adaptive learning through its digital presentation, but for some it dates to a time when it only took on three different forms: differentiation, personalization, and individualization which are ways that are still utilized within the classroom setting through the teacher's identification and management of leveled assignments for student learning support (Sottilare, 2019). Through these forms of adaptive learning changes to the instructional approach or objective are made based on the needs of the student to obtain understanding of the content, as one must maintain student interest through the avoidance of repetitive activities (Sottilare, 2019; Lee et al., 2022). Wullschleger et al. (2023) highlight the use of adaptive learning in grades a low as preschool through a play-based learning situations that bring connections the content in which is being taught. It has also been said that through adaptive learning the gaps created by traditional teaching methods may be

avoided through the digital process (Wu et al., 2023). Wang et al. (2020) describes adaptive learning systems through their use of algorithms and artificial intelligence that support in the personalization of the learning. These algorithms use gathered data to direct the course needed for students' instruction and assessment as they work through the program (Lim et al., 2022).

Research has gone a step further with multiple studies that have been conducted on the neural networks of the brain and its ability to obtain information to alleviate some of the demand through technological assistance. The findings have included that students see an increase in their achievement scores when a cognitive-based approach is taken that allows for the use of visuals moving from concrete learning to abstract (Myers et al., 2021). These studies have continued to make their way to connect to the use of adaptive learning and student acquisition of content. Wong and Wong (2021) set out to discover the impact of motivation on student success with adaptive learning practices; these components of motivation make up the acronym ARCS, which entails attention, relevance, confidence, and satisfaction. All things that students need to be successful in a mathematics classroom. Matayoshi et al. (2021) set out to improve adaptive learning using the understanding of the brain's neural networks. In fact, through the analysis of adaptive learning platforms, Matayoshi et al. (2021) were able to deduce that many of the adaptive learning platforms are already constructed with such frameworks. McMullen et al. (2020) addressed the matter that the need for mathematics to have flexible and applicable knowledge is connected to the term of adaptive expertise, which have been deemed useful in reaching such goals. The obtainment of these goals could also be a result of the motivated learner that researcher has proven will be more actively engaged in completing the given tasks and learning (Lim et al., 2022).

Smith (2018) and Matayoshi et al. (2021) describe how an adaptive learning platform works with student answer choice for the asked question being the determiner of what is asked of the student next; however, there are also two types of approaches, the student-centered approach, and the assessment-centered approach, in which Matayoshi et al. (2021) highlights are attractive in comparison but contain the same number of features. Through the incorporation of adaptive learning platforms, we can see students gain an understanding of the usefulness of math (Wong & Wong, 2021). The use of consistent practices within the classroom will assist with restoring some normalcy for those drastically affected by COVID-19, which can equate to the time and days in which such programs are used (Crosby et al., 2020). With a plan set into place, the impacts of the use of the adaptive learning programs will be able to be determined more efficiently. Arroyo et al. (2014) highlights the improvements made to students understanding engagement, and results in math using adaptive technology. Another component of adaptive learning programs is the feedback component.

As addressed by Hilz et al. (2023), due to the challenge of the work, math programs provide both feedback and adaptivity. Depending on the software the feedback walks the user through correct processes and answer to allow for an understanding of the correct method to solve the problem to be seen. As students work through the task, he or she can obtain information on the correct methods and answer for the problem if missed which correlates to Mesghina et al. (2023) when highlighting that in accordance with the cognitive load theory (Sweller, 1988), worked examples reduce the workload and allow for availability to emerge within the working memory. Iannacchione et al. (2022) highlight something similar when discussing student's ability to request hints through the learning program to guide students in the right direction to solve the given problem. Liu and Wu (2021) highlight the IXL program that is

categorized as an adaptive learning program because it can be adjusted based on the students' progress throughout the completion of a skill. At the start of completion of a skill, students are provided with beginner questions that are easier to solve, but as they continue the practice, the skill increases in difficulty (Liu & Wu, 2021). For the incorrect responses students are provided with feedback and videos to guide them through the correct process that would be taken to answer such problems with a lowering of their "smartscore", but as their understanding improves and more responses are correct, their "smartscore" also increases (Liu & Wu, 2021). Adaptive learning platforms provide additional features to support the student in their mastery of the content as well as presenting the work for each problem presented, and even with such benefits, one must also seek the plan that allows for secondary students to obtain increase math performance with their emotional and cognitive levels in mind (Zivkovic et al., 2022). The use of adaptive technology also assists teachers in the role of determining what supports the multiple levels of students within the classroom need to have a stronger understanding of the content through its ability to self-regulate the needed level of question students need as the skill of practice is continued (Arroyo et al., 2014).

Adapting Confidence

Along with students' ability to learn and acquire information comes their ability to overcome anxiety and failure in mathematics (Boaler, 2016; Taylor & Fraser, 2013). This fear of mathematics and the emotional rollercoaster that many students associate with math dates to primary school for many through their lack of confidence in approaching tasks and including challenging math problems (Moon & Ke, 2020). For some students, their sense of belonging dictates their level of motivation and engagement to the learning process (King-Sears & Strogilos, 2020). The sense of confidence in one's abilities in math has been deemed math self-

concept in which Kikas et al. (2020) highlight to be the term for a student's competence in their ability in mathematics. This self-concept, competence, and/or self-efficacy correlates to the student's ability to successfully perform to obtain the desired result (Lee et al., 2022). Ford et al. (2022) identified this as a student's self-set which includes that students own set of perfectionism standards toward getting things correct and being successful.

Even through that perspective of one's own need for perfection, self-efficacy is still closely linked with math anxiety (Huang et al. 2023). Just as Zivkovic et al. (2022) found a connection between math anxiety and math performance at the middle grades level. Watkins and Middleton (2021) highlight that mathematics has acquired most of the attention in the United States of America with a magnification on student competence. This competence is then impacted by the student's belief in his/her own ability. That belief in their own abilities then lead to their persistence or lack thereof to complete tasks when obstacles arise, which Fang et al. (2017) denotes to a result in their intrinsic motivation. Nielsen and Moore (2003) present that those that possess a high self-efficacy outperform those with a low self-efficacy, and in some cases, it could be topic specific when it comes to the math content.

Due to their belief in their own abilities, students persevere and move forward no matter the difficult of the task. In the math curriculum, there are various topics of study that involve various skills to be successful. Nielsen and Moore (2003) highlight that one can be strong and have a high sense of self-efficacy in algebra and then have a low sense of self-efficacy in Geometry. When a lack of belief in one's ability is present, Federici et al. (2015) and Iannacchione et al. (2022) found that the higher the anxiety, the less mastery of content is obtained, and an increase in requesting for teacher assistance. Studies have found that around 17 percent of the population experience math anxiety and 31 percent of 15-year-olds find math to

make them nervous and feel powerless while completing a task (Doz & Doz, 2023). Bilgin (2021) found that in accompaniment to the math failures is the inability to mastery skills needed for this technology-based society in which we live.

Even aware of the struggles, Newman (2008) found that students that have a high rate of struggles in math tend to deter from asking for help when they need it. In some cases, these struggles have turned into learned helplessness in which students do not bother to try to work through the tasks, but immediately express a lack of ability complete any components of it due to previous failures (Kroeger & Kouche, 2006). With the complexity behind the lack of student performance in mathematics, the need for reassurance in the intervention processes to allow for student gains in the areas of mathematics is important. Mesghina et al. (2023) and Vanbecelaere et al. (2021) found that students that possessed math anxiety were impacted negatively in areas of both procedure and concept in mathematics impacting their performance. Lee et al. (2020) highlight that the source of student's fear in mathematics is not always derived from previous failures in the content, but from the words of their teachers, peers, and parents that are discouraging in their abilities in mathematics which affects their self-efficacy.

In accompaniment with the anxiety of learning mathematics comes the fear of not being successful on assessments which then impacts students' ability to show their mathematical capabilities (Kazelskis et al., 2000). Bandura found the strongest impact on self-efficacy is to be that of mastery experiences (Bandura, 1977; Watkins & Middleton, 2021). Research shows that students with high academic achievement have higher competency in both problem-solving and evaluating results (Katranci & Sengul, 2020). To follow the findings of Bandura, the use of adaptive learning has been found to allow for the increase in performance as students are working at their level to obtain mathematical understanding as highlighted by Hilz et al. (2021)

when stating that the program meets the ability of the individual's ability level (Liu & Wu, 2021). The strengthening of student foundations in mathematics allows for the building of self-efficacy and guidance toward a growth mindset (Im & Park, 2023; Lee et al., 2020). One thing to avoid when it comes to self-efficacy is providing students with easy tasks that one will know success is bound to be obtained, doing this can lead to a false sense of self-efficacy which Woodward and Brown (2006) note is not a good way to manage it as challenges will arise when such student encounters a difficult task.

The concept of the growth mindset became popular in education just like the power of yet with a strong focus on the content area of mathematics (Huang et al., 2019; Im & Park, 2023). For most students, their number one source of discouragement is intrinsic, whether it is from the previous failures in math or the fear of making a mistake, many set out with the belief that he/she is not capable of being a successful math student/learner; however, Park et al. (2023) highlights the possibility of it such discouragement coming from outside factors through the role of unwarranted parent involvement. Students that are assisted/controlled through their work completion by parents have exhibited a decline in motivation (Park et al., 2023). In other cases, parental support is a guiding factor in the engagement of students in the mathematics classroom (Sagkal & Sonmez, 2022). As educators become aware of such, the use of parent involvement through set parameters may be encouraged just as the power of yet to assist in students taking on a growth mindset and building their self-efficacy to believe that they too will one day be successful and understand. Through the instillment of positive phrases and statements toward the understanding that not everyone will be right all the time, students are able to accept the chance of failure and move toward the actions of taking risks in their learning of mathematics before

accepting the notions that he/she will never be able to learn the concepts (Huang et al., 2019; Im & Park, 2023).

Huang et al. (2019) highlight that one's self-efficacy in math not only impacts their education at young ages, but also when declaring a major in college; those that have anxiety and a fear of mathematics steer clear of majors that require such components. Burns et al. (2012) address math proficiency which like Huang et al. (2019) addressed can impact student futures beyond the classroom. Those that struggle with complex math problems are typically lower performers in the basic areas of mathematics (Burns et al., 2012). Due to such, many students that may have been a vital part in areas in which math was a requirement, avoided the pursuit because of their self-efficacy. Ford et al. (2022) presents that a component of one's self-efficacy is developed by multiple factors including social cues from the environment. Such social cues can come from parents through their words of encouragement and support as students work through challenging work and problems (Sagkal & Sonmez, 2022). These social cues can also evolve from the teacher's own self-efficacy toward the topic. McGee and Wang (2023) address the matter of teacher's self-efficacy in which the teacher displays his/her confidence in solving math problems; along with the other perspective of self-efficacy for teaching mathematics, which highlights the teacher's confidence in his/her ability to present the content to students to obtain understanding. Beyond the aspects of encouragement, the work that students practice and build their understanding of mathematics with can also serve as a guiding factor into their success. And as their success becomes more prevalent, their self-efficacy increases leading to stronger work ethic and higher levels of achievement (Sagkal & Sonmez, 2022).

Through the utilization of adaptive problems, Skaalvik (2018) highlights that students can overcome their fear of mathematics; Mesghina et al. (2023) highlights that allowing students to

be accompanied by a worked example of the program during the lesson is an effective tool. Adaptive learning strategies strengthen students' content achievement, which in turn should ease the anxiety and fear (Skaalvik, 2018). The more adaptive learning in place, students are less likely to avoid mathematical tasks, as previously seen, due to their lack of confidence in the content area as they will be learning at their level of understanding and building on it until mastery is shown (Liu & Wu 2021; Skaalvik, 2018). Skaalvik (2018) addresses adaptive learning strategies, which are supplemental in assisting in ridding students of their anxiety toward mathematics. Adaptive learning programs allow for students to self-regulate their learning through the completion of the tasks (Kikas et al., 2020). Tasks that level out to students understanding of the mathematical skill being practiced allows for students to gradually gain an understanding off the more complexed skills, but to also be able to self-regulate their learning without the required support of an adult that may not be as equipped to assist in such a skill if completed outside of the classroom walls. Bilgin (2021) found the use of computers to be the most efficient way to address the difficulties in mathematics with self-efficacy if the proper materials are utilized.

The Adaptation of Mathematics

When it comes to the use of adaptive learning in mathematics the goal is to obtain the ability to personalize learning for students and meet them where they are (Shechtman et al., 2019). The question that remains is to what extent is the learning personalized? In many adaptive learning platforms, students must first master a skill before progressing to the next level (Smith, 2018). The benefits of the use of personalized instruction were evident prior to the pandemic as it became the topic of many conversations that revolved around data-driven teaching and learning (Major et al., 2021). Personalized instruction allows for the work to be more personable, through

the content that was selected specifically for the student. Using adaptive learning programs students are also able to obtain opportunities for success and those that require effort as highlighted as necessities by Woodward and Brown (2007). Adaptive learning environments increase the effectiveness of the instruction as it allows for the prerequisite content to be addressed to ensure the foundation of learning to guide the understanding (Koskinen et al., 2023).

Although it may not be personalized to the exact means of student ability, the content is leveled out in a personalized manner based on student input. In a setting where teaching math is a challenge with the variety of learners and needs, the adaptive learning approach allows for engagement and interest to assist in the building of mathematical reasoning (Kroeger & Kouche, 2006). Adaptive learning has grown as a source of problem-solving practice for many students in primary grades, as highlighted by Bang et al. (2023) and Brezovszky et al. (2019). Bang et al. (2022) highlight the use of a digital adaptive learning platform in kindergarten and first-grade mathematics, while Brezovszky et al. (2019) underlines the use of adaptive learning in grades four through six. Within the study, Bang et al. (2023) set out to see the ease of use by teachers and the ability of the platform to increase student performance in mathematics when the platform is used as a supplemental tool for learning.

Through the implementation of the program, Bang et al. (2023) were able to see significant improvement in student performance in mathematics. Teachers also ended with a positive perspective on the utilization of adaptive learning for supplementary support (Bang et al., 2023). Brezovszky et al. (2019) highlighted the use of adaptive learning as having long-lasting value. In some cases, adaptive learning platforms are utilized in manners that serve as tutoring and even through that usage, gains were reported to having been made within over 100

middle and high school students in seven states within the United States (Wang et al., 2022). Wang et al. (2022) highlight that over a two-year period, the use of adaptive learning grew students' performance in mathematics 8 percentile points; however, the extent in which the adaptive learning platform was used was not given, which leads to the need of further research.

Integration of Adaptive Learning

Research has presented the idea that the installment of fear toward mathematics for many students has continued to increase through the methods of teaching that many have used in the past (Doz & Doz, 2023). In fact, it is found that the lack of math achievement due to math anxiety can be seen before and after the COVID-19 pandemic; however, with the unprecedented arrival of COVID-19, the methods of teaching and learning, especially from that time forward has changed to include a shift of the involvement of technology (Doz & Doz, 2023). The use of distance learning had to be placed into public school around the United States, in which many still were not fully engaged in the use of technology in the classroom, but as the need rose, the use became dire, and methods were evolved to reach students that possessed learning gaps. Teachers identified that using the adaptive learning platform allowed students to be motivated to complete challenging work and questioned the students on their cognitive level of development (Bang et al., 2023). The research of Bang et al. (2023) and Brezovszky et al. (2019) provides beneficial information about positive experiences from the use of adaptive learning platforms. Wu et al. (2018) highlight that within a classroom, there are an abundance of differences that impact each individual child's learning.

Knowing such, the use of adaptive learning programs allows for each student to be reached and learning to transpire. Moltudal et al. (2020) address the way adaptive learning is integrated into the classroom through the platform used. For example, when using the vendor

within this article the vendor of the platform suggests 60 minutes per week without teacher assistance was the given guideline for the use of the adaptive learning platform (Moltudal et al., 2020). The reasoning behind the lack of teacher assistance is due to the possible impact it will have on students' abilities which will in turn affect the adaptiveness of the program to reflect the student abilities (Moltudal et al., 2020). Focusing in on the use of digital software in the learning of fractions on an elementary level, Bush (2021) highlights that the use of digital software providing supplemental instruction was only moderately successful. Both grade levels in the study made gains in learning using adaptive learning (Bush, 2021).

Most of the content addressing adaptive learning focused in on primary levels with little content explicitly addressing middle school math students and the use of adaptive learning programs. In comparison to the results of the pre-assessment, Bush (2021) found that those that did well on the pre-assessment had less gains than those that did not perform well initially. Adaptive learning is making gains in the realm of education within the specific areas of mathematics curriculum (McMullen et al., 2022). Just as the findings of Doster and Cuevas (2021) found that the use of technology in mathematics as an integral part of learning, as it is a method that allows for all students needs to be met. The incorporation of technology is also vital in connecting learning to the society that students will one day inhabit as adults; technology provides the ability to reason mathematically, express mathematics in a multitude of ways, develop problem solving skills, and deepen communication skills (Sabuncu et al., 2021).

Even with that being the case, the proper usage of technology is vital for such matters to be obtained. The technology usage in math allows for the individualization of lessons making the learning not only adaptive and differentiated for students but such learning methods are more attainable for teachers (Doster & Cuevas, 2021). A digital aspect also allows for easier

assignment of functions like read-as-loud and chunking to be prevalent for students with such accommodations within their IEPs. Burns et al. (2012) highlight the use of an adaptive computer program for math intervention with the results of students gaining understanding in completion of presented math skills. Wu et al. (2018) present the comparison to traditional classroom learning when highlighting that the use of adaptive learning systems allows for student focused, student paced, and unlimited access to the material.

This last component is vital through the lack of notetaking and responsibility that many middle grades students possess, so having the ability to access resources to support learning through the adaptive platform will be of great benefit for all learners. Research presents positive findings from the use of adaptive/e-learning that allows for content to adapt to the level of student understanding and guide them to the mark in which one hopes for student understanding to land (Wu et al., 2018). All of these improvements to mathematical learning with technology can be the case when educators are provided with the needed professional development to ensure such is capable of being provided to student as highlighted by McClain and North (2021) when addressing the need for trainings to provide teachers with the right methods for technology integration. Along with the right training, teachers also need to know the right manners in which to incorporate digital learning to avoid student burnout and boredom which in turn will decrease motivation and engagement (Braisel et al., 2022).

Adapting Through Game Mode

The use of adaptive learning programs to ensure retention of content learning and student ability to apply learning in various situation is also a benefit of its use (Moon & Ke, 2020; McMullen, 2023). In the same respect, the use of games to accomplish learning goals has taken a rise within the last decade (Plass et al., 2013). As students age increase, one thing has been found

the same, and that is their love for games (Shute et al., 2021). Through the incorporation of adaptive learning practices and game-based learning, McMullen (2023) addresses the ideal outcome of connecting exiting knowledge to various concepts and procedures, which is a struggle for most math students. The use of adaptive learning through a game has been found to increase engagement in learning that students exhibit due to such modifications as well as its ability to increase student interest in mathematics; with the notion that engagement is known to some as a prediction of student future retention of learning the use of game-based learning becomes even more valuable for mathematics (Moon & Ke, 2020; Stohlman, 2021).

The engagement component also derives from the utilization of the various game modes that spark student interest beyond the simple understanding of mathematics (Plass et al., 2013). There is also the element of active engagement piece that although learning mathematical content, students are invested in the tasks of the gameplay to allow for learning to transpire (Shute et al., 2021). Vanbecelaere et al. (2021) highlights the ability for adaptive learning programs to help with the training of early numeracy in children. Javora et al. (2021) highlights digital game-based learning as an enhancement for learning experiences and outcomes. The process of learning through an adaptive platform in a game-based theme is known as gamification as addressed by Jagust et al. (2018) which state that it is when a non-game context is input into game elements. This method of adaptive learning allows for learners to be encourage, motivated, and engaged to improve to be successful in the game mode presented while mastering the content being taught (Jagust et al., 2018; Moon & Ke, 2020). Shute et al. (2021) describes a flow state in which the student is absorbed into the game that time is lost, and learning continues to take place.

To accomplish this task, research on game elements must be done and combined with a learning model for the given age group to ensure the capturing of their attention (Gocheva et al., 2022). There are several components of game-based learning that can contribute to positive motivational outcomes (Gocheva et al., 2022; Koskinen et al., 2023). These components include the various game model, the game techniques, and the educational components (Gocheva et al., 2022). Chu et al. (2021) addresses how the use of game-based learning through adaptive practices has benefits of increasing learning engagement, higher order thinking, and self-efficacy. As students worked to complete the game-based adaptive learning program, little to no anxiety was shown (Chu et al., 2021). Through the study conducted by Moon and Ke (2020) they found that the use of in-game help to support math understanding and problem solving was beneficial to reaching students that were struggling with the concepts within the adaptive learning game. Through in-game learning students were able to utilize mathematical thinking while applying the concepts to various elements within the game world; students were also able to receive an enhanced understanding of the variables of mathematics in action through their roleplay (Moon & Ke, 2020). An additional study by Moon and Ke (2020) found that the separating gameplay from peer interaction is the best way to obtain positive results from student utilization of game-based adaptive learning.

When it comes to secondary level students, there is a decline in the interest in mathematics because of the lack of variation that is used through presentation at the higher level of learning. Game-based learning for middle school allows for students to be reeled back into the concept of mathematics being something “fun” to learn through the engagement of the process of learning (Stohlman, 2021). With game-based learning, research has found significant improvement in students adapting a growth mindset toward their abilities in the mathematics

classroom (Stohlman, 2021). Of course, game-based learning is not the end all be all, but it is a tool that educators can use to incorporate the interest factor into student learning in mathematics while students are developing their understanding of mathematical concepts. For this method to have a positive result on student learning in mathematics, it is important that students are reflective of their learning throughout the process (Moon & Ke, 2020; Stohlman, 2021).

Through their interaction with the game, students need to be able to understand the problem within the situation and reason through with the ability to explain and justify the solution (Atnafu et al., 2021). Plass et al. (2013) highlight the component of collaborative play in some game modes that acquire student engagement in support to the learning of the math content through game play. Even with the plethora of research that present game-based learning through adaptive platforms as beneficial, one must consider students with special needs (Fengfeng & Abras, 2013). Depending on the platform, the use of in-game tools may allow for such students the ability to interact and learn. In accommodation with the use of adaptive learning games, additional scaffolding may suffice in the obtainment of learning for students with the need of additional supports (Fengfeng & Abras, 2013).

Education Practices

Mistakes are a part of learning, as highlighted by Soncini et al. (2022) through the discussion of Vygotsky's view on how the learning process occurs when learners are working on tasks beyond their level of mastery. These mistakes are addressed as errors in the eyes of Loehr et al. (2020), who state in agreement that they are a part of the learning process. From these mistakes, learners can adapt through the struggle, but that is also set by the environment the teacher has created toward error. Soncini et al. (2022) highlights that error can lead to self-regulation which can help or hurt the situation of the student continuing to learn. For some, the

resilience will allow for them to push forward and make gains, but for others, the lack of self-efficacy will hinder their progress. Through the remembrance of the errors made within the completion of problems Loehr et al. (2020) states it will allow for future correction. In mathematics, there are many skills that are to one's success in later mathematical programs as well as life such as fractional knowledge (Zhang et al., 2019). Most mathematics teachers have a goal to support their students through the learning process through equitable actions and the acceptance of diversity (Ruppert et al., 2022). Safavian (2019) highlights how the expectations that one has impacts their performance, the amount of effort put forward, and the time put into the task for some, but for others there is no impact. Educators goal is to get to know the student and their ways of learning to combat the previous insecurities toward math and support their growth within the content area. Such awareness of the learners can be found within classrooms that have developed a positive learning environment. Matsumura et al. (2008) highlights that in all successful environments there must be a balance of positivity with academic demand.

Along with the need to combat insecurities are the need to increase student engagement. Watt et al. (2017) highlight the emphasis on engagement in learning that has been made prevalent for education today. It has been found that when students are engaged in the lesson, learning takes place (Watt et al., 2017). With this knowledge, many have set goals that allow for student interest to be peaked and involved in the attainment. When it comes to in classroom practices, the teacher's attitude toward the content and learners impacts the progress or lack thereof in the success of the students. Watt et al. (2017) address levels of students that make up the classroom through the terms engaged, disengaged, and compliant. With each term, the level of effort put forth in the understanding of the content can be foreseen if engagement is not within the classroom experience.

For some educators, taking a step back into their own ways of learning allows for the adaptation of new methods of learning to be more relevant and susceptible. Ruppert et al. (2022) highlights the impact of reflection on the manners in which learning for the teacher took place as well as how it is impacting their teaching methods. Through this reflection, educators are aware of their own experiences as a learner and can revisit the methods in which he/she may be approaching the learning to become more accessible for all learners. This too can correspond to the way math problems are solved, allowing for students to make a connection to the problems and build an understanding of the way the problem is solved (Katranci & Sengul, 2020). Herbel-Eisenmann (2007) discussed the use of textbooks to acquire understanding of varied leveled students. Through such a practice, with the one shoe fits all mindset, reaching students with varied levels of capabilities within the math classroom is hard (Herbel-Eisenmann, 2007). With adaptive learning, educators drove toward customizing learning to allow for students to gain understanding of the content.

Although adaptive, the encouragement to work through the task must be prevalent to allow for lower confident individuals to work through the tasks as the difficulty level progresses. For such work through to take place, students must increase their ability to reason as such skills are important in the learning of mathematics as the content progresses into abstract concepts (Atnafu et al., 2021). Nelson et al. (2018) addresses the matter of a lack of achievement in math for elementary and middle school students in recent years. When testing student ability, Nelson et al. (2018) discovered the similarities in the areas of weakness of the lower grades were consistent with that of the middle school students. Schools are moving toward providing students with the needed supports (Nelson et al., 2018). Outside of the adaptive reactions toward skills beyond the student level, Knapton (2022) highlights a transition from differentiation to adaptive

teaching that is taking place in business and economic classrooms today; however, the adaptation elements that are difficult for students may not assist in ensuring motivation to work through the task due to the level of difficulty the student is facing within the work (Koskinen et al., 2023). Blyman (2023) highlights through the work of Bulter (2015) that beyond the method of teaching a concept, one should strive to embed the curiosity of mathematical learning into the student so that the learning will continue beyond your classroom and the current school year.

In the past, differentiation was the go-to term to highlight teacher strategies to provide students with leveled tasks based on their needs. To accomplish such a task, the teacher must acquire the needed information on each student during instruction or the work session for that day to ensure that the needed adjustment is being made to student learning. This task highlights that presented by Jin (2023) which addresses the demanding work in all aspects from physical to social-emotional that a teacher must endure daily. Hilz et al. (2023) highlights that providing instruction that reaches each individual student has always been a challenge in math with the various levels of prior knowledge that students possess. Knapton (2022) is presenting the new term of adaptive teaching, where teachers are provided with the understanding that students learn at different rates while in the preservice program instead of being introduced to the concept while out in the field. The awareness of adaptive teaching allows for preservice teachers to become experts on balancing multiple levels within one classroom with the expectation of getting everyone to cross the same finish line.

Prediger et al. (2022) described adaptive teaching in a way the teacher takes on the responsibility of identifying the need and addressing the individual learning difference of the student. Adaptive teaching in mathematics is a little more complex with the leveling of students from their foundational skills upward. Prediger et al. (2022) highlight the use of adaptive

teaching by using adaptive learning systems when it comes to mathematical practices. The use of adaptive teaching is to guide students along their route toward common learning goals; however, with the abundance of starting points that exist through the varied foundational skills adaptive learning systems provide the more efficient method to ensure student learning is individualized for their skill level when it comes to mathematical practices (Knapton, 2022; Prediger et al. 2022). Doster and Cuevas (2021) found that the use of adaptability is the key component in computer-based programs for mathematics, as the goal is to provide personalized learning experiences for the students.

Although the practice is not restricted to mathematics, the apparent rise in the use of adaptive teaching is evident through the utilization various content areas and studies that emerge with data on adaptive learning within the primary age group for students. The use of digital learning will become more prevalent as time progresses (Bystrenina & Nikitin, 2022). The need for research in adaptive learning platforms in middle school mathematics to allow for proper utilization. Miller and Bernacki (2019) findings showed that many college level students are having to obtain remediation for mathematics upon entrance into higher education institutions. Petillo and Anuszkiewicz (2023) highlight that the aftermath of COVID-19 has been an impeding factor on the number of students that are arriving to college unprepared. From this information, there is emphasis placed on the need of mathematical progress for the United States of America to close the learning gaps for students in mathematics. With this need, there are a multitude of considerations that must be taken seriously when determining the best approach to support all levels of learners within a middle school environment.

Summary

Technology in the classroom has become a norm in schools across the country from internet access, one-to-one device access, and to hybrid learning on days where students work asynchronously, and teachers are in professional development (Ark, 2021). With the increasing number of students falling behind multiple grade levels in their learning, many educators have turned to technology as a source of assistance in closing student learning gaps through utilizing adaptive learning programs that accommodate each student at their level and move them upward in their understanding. In the past, the classroom teacher has served as the expert in the classroom with the need to differentiate learning and identify the gaps in learning and accommodate the areas in which students are falling short. For example, a seventh-grade math student is expected to learn to solve problems within the standards of a seventh-grade math class that the seventh-grade math teacher is expected to teach; however, the part that many are not initially aware of is that this seventh-grade math student is on a fourth-grade level. The expectation is that this student can complete and master seventh grade tasks, but the question is how? As the teacher one would be doing a disservice to provide the student with seventh-grade mathematics without any set of tools such as scaffolds to fill in for the missing concepts that were not mastered.

The problem that arises is the dilemma of who or what is to serve as the expert to teach lower-level math content to the seventh-grade math student that is not on grade level, along with the notion of when such learning is to take place. As time has progressed it has become apparent that simply including technology into curriculum and instruction is not enough to improve student performance in mathematics (McClain & North, 2021). In fact, the need for mathematical reasoning is crucial to student life opportunities and the needed supports to achieve

on level learning is vital to allow for the obtainment of secure jobs (Huang et al., 2023). This is where the utilization of adaptive learning programs for mathematics serves a crucial role in supporting students learning for those that have fallen behind or even enriching those that need to move ahead.

The continuous improvement of adaptive learning programs and platforms has been the solution, but even through that research, like the realization of Lee et al. (2021) and Zivkovic et al. (2022) this area of students (middle school students) is underrepresented in educational research as most research is strongly focused on primary and elementary aged students. In fact, Zivkovic et al. (2022) highlights that research has found that little to no research is focused in on middle school students and these students differ in comparison of elementary and high school student's developmental needs physically and emotionally as well as in terms of academics. Although these programs have advanced from once instructor-guided programs to digital media with minimal teacher interaction, there is still research needed to accommodate the proper presentation of such programs for maximum success and achievement on the middle grades level. Additionally, recent literature supports the role of adaptive learning in closing student learning gaps in mathematics. Through the study of the use of IXL and MobyMax at the elementary level, gains were seen in student achievement in their problem solving and motivation to complete math related problems at the elementary level (Doster & Cuevas, 2021). The use of adaptive learning programs has been studied, but not in comparison to students' understanding of on-grade-level content through simultaneous learning, which is the practice of most school systems.

By examining student learning of on-grade-level content while completing adaptive learning to close their learning gaps, educators can better understand the method/procedures

needed to be taken to close student learning gaps during the instructional year while also preparing them to master on grade level content. Sun et al. (2021) highlights that effects of the program may be based on the way in which it is used, which correlates to Dietrichson et al. (2021) when highlighting the need for further understanding of why and how some interventions work better in comparison with others. The program may be used alone as a means of providing students with all the needed instruction or in conjunction with additional direction instruction from the teacher (Sun et al., 2021). As one embarks on the task of utilizing adaptive learning programs, one must ask, does one devote 60 minutes a week for adaptive learning time without teacher interaction during the school day, or does one aid in moments of confusion on previously leveled content to increase the speed of closing the gap and present teacher purpose? These questions go unanswered when researching the use of adaptive learning programs in middle school math, which for many falls in conjunction the unresting battle of homework and whether it should be assigned at the middle school level.

In education systems across the country, it is pertinent that teachers are provided with the needed skills and methods to be able to effectively incorporate technology into to the classroom to improve student mathematics performance (McClain & North, 2021). Just as the belief that a math teacher should have a strong understanding of the content in which they teach, that same consideration should be taken in terms of the implementation of technology in which they must oversee (Shechtman et al., 2010). This elemental piece of education for the educators will allow for the utilization of adaptive learning amongst other tools within the realm of technology to be more effective. Through my study, I will absolve the unawareness of the best ways to utilize adaptive learning programs for students at the middle grades level to close learning gaps in mathematics while obtaining mastery of their on-grade level content.

CHAPTER THREE: METHODS

Overview

The purpose of this transcendental phenomenological study was to explore the experiences with adaptive learning programs that address the learning gaps due to the COVID-19 pandemic for middle school teachers in Georgia. Adaptive learning, generally defined as online learning programs, shifts the content to the student's level of understanding as they work through the program. This study explored teachers' perceptions of using adaptive learning programs for grade-level mathematics content and the possible implications of such programs for future use. This chapter presents the research design, which highlights the approach in which the research was conducted, the research plan, the way data was gathered, the framework that drove the research, and the procedures utilized when conducting the study.

Research Design

"In Qualitative studies, research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems addressing the meaning individuals or groups ascribe to a social or human problem" (Creswell & Poth, 2018, p. 41). Creswell and Poth (2018) also highlight that qualitative research is necessary when a problem needs to be explored. As students' learning gaps widen, the ability to reach them within the content areas where skills are weak becomes more complex, "talking directly with people, going to their homes or places of work, and allowing them to tell the stories unencumbered by what we expect to find or what we have read in the literature," is essential (Creswell & Poth, 2018, p. 45). Qualitative research offers the ability to explore the impact of adaptive learning programs in mathematics, which will be identified through the accounts of those with firsthand experience and interactions.

Moustakas (1994) highlights many interpretations of the term phenomenology; these interpretations range from the appearance of knowledge to one's consciousness to the concept of something showing up and appearing, leading to new knowledge. As I strive to meet the purpose of my study, which is to discover the role of adaptive learning programs on middle school students in Southern Georgia following the increase of learning gaps caused by the COVID-19 pandemic, I will take on the transcendental phenomenological approach. Creswell and Poth (2018) highlight Moustakas' interpretation of transcendental phenomenology as a study focused on a descriptive experience of the participant with little focus on the researcher's perspective. Through my research, the human problem revolves around the learning gaps within middle school youth and whether the continuous use of adaptive learning programs like IXL would benefit them. Moustakas (1994) describes the researcher who takes on this approach as one who "…engages in disciplined and systematic efforts to set aside prejudgments regarding the phenomenon being investigated to launch the study as far as possible free of preconceptions, beliefs, and knowledge of the phenomenon from prior experience and professional studies," (p. 21). This research method is most appropriate for this study as it is Moustakas' belief that, "any phenomenon represents a suitable starting point for an investigation," (1994, p. 26)

Research Questions

This phenomenological study takes a transcendental approach focusing on participant experiences in using adaptive learning programs in mathematics. One central research question and three sub-questions were designed to present the phenomenon of lived experiences.

Central Research Question

What are the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic?

Sub-Question One

What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics?

Sub-Question Two

What do secondary math teachers perceive as challenges of using adaptive learning programs to address learning gaps in mathematics?

Sub-Question Three

How do secondary math teachers perceive the impact of adaptive learning programs on their self-efficacy and confidence in teaching middle school math?

Setting and Participants

The following section aims to describe the study's setting and the participants' profile that contributed to the research. A rationale for the setting and criteria for participation are included in the sections below.

Setting

The setting for this study was middle schools that serve grades 6-8 with a minimum of 300 students. The middle schools within this study are in Georgia. The focus on middle school students was due to the findings of a higher percentage of low achievement due to many students leaving primary school with deficits in basic math, increasing the challenge for secondary school teachers (Hilz et al., 2023). The leadership within this setting contains the superintendent for the district, the assistant superintendent of curriculum and instruction, the principal, and a small group of assistant principals, as well as department chairs for grade level and content. Underneath the administrator roles are those of the curriculum and instruction directors for the given content areas within the Georgia schools.

Participants

The participants of this study consisted of 10-15 (Creswell & Poth, 2018) middle school mathematics teachers who have experienced teaching following the time frame of the COVID-19 pandemic. Participants were middle school mathematics teachers that experienced teaching math in middle school following the COVID-19 pandemic. The participants had to also have experience with the phenomenon (Moustakas, 1994) of using adaptive learning programs for math instruction post-COVID-19. The goal was to have a diverse sample of male and female participants of various ethnicities and experience levels. Teachers were selected based on their experiences teaching math after the pandemic and their use of adaptive learning programs for student progress, success, and growth.

Recruitment Plan

The rationale for selecting a criterion sampling method was that it would allow the researcher to identify participants based on specific criteria that meet the goal of the study (Creswell & Poth, 2018). The goal of this study was to explore the experiences of secondary mathematics teachers, to identify perceived strengths and weaknesses of the use of adaptive learning programs in math instruction to address learning and achievement gaps occurring due to learning loss from the COVID-19 pandemic. The sample pool for this study contained mathematics teachers who have taught in public schools in Georgia following the COVID-19 pandemic. The research study had 10 to 15 participants (Creswell & Poth, 2018). The participants were selected through purposeful and criterion sampling. All participants completed an informed consent form before the start of the study (See Appendix A). Participants understood that participation in the study was voluntary and would not cause them to be placed at any undue risk upon participation (Creswell & Poth, 2018).

Researcher's Positionality

Having served as a middle grades' mathematics teacher in the state of Georgia prior and following the COVID-19 pandemic, I have had the opportunity to see the shift in students' level of preparedness as they travel to and from the seventh grade. With the need for student learning gap closure across the board, I took on this study to not only hope to find evidence of methods that will assist my students in their success in mastery of the content, but all students at the middle grades level. Within this section, you are provided with the frameworks and assumptions that guided this study.

Interpretive Framework

The research on teachers' perception of adaptive learning in mathematics will be viewed through the lens of the social constructivist framework. As described by Creswell and Poth (2018), social constructivism is another perspective in which understanding is gained through the interaction with others and their experiences. The online environment sets the stage for students to interact with needed content during the mathematics learning process. The researcher can view the study through the lens of the participants into their experiences with the technology through the online environment as they implement the math strategies with the adaptive learning programs. These programs seek to bridge the learning gap and increase mathematics proficiency in middle school students through the ways in which teachers implement them within the learning process. Through the shared experiences, researchers can connect the abundance of information into categories and then narrow it down (Creswell & Poth, 2018). The information is reduced to establish one true reality within the means of the data collected.

Philosophical Assumptions

Within a qualitative study are multiple philosophical assumptions that provide the reader

with various views on the topic (Creswell & Poth, 2018). A piece of the study can be related to the participants and the researchers through each type. The perspective of the want for growth from students below grade level in math can be seen through the presentation of such individuals.

Ontological Assumption

Creswell and Poth (2018) describe ontological assumption as the nature of reality (p. 19). Through this assumption many realities are uncovered within the span of research and narrowed down to obtain the commonalities. The ontological assumption within this study revolves around the various perspectives on the role of adaptive learning programs. Through the phenomenological lens, the participants' experiences would be connected to the concept of "multiple realities" (Creswell & Poth, 2018, p. 20). Although we live in only one true reality, which can be seen through the words of Hebrews 11:1, "Faith is assured expectations of what is hoped for, the evident demonstration of realities that are not seen" (English Standard Version, 1971/2001). I believe that the ways in which we see the one true reality evolves through the trials and tribulations in which we face individually as we interact with the various elements in our daily life.

Epistemological Assumption

Creswell and Poth (2018) also provide guidance on epistemological assumption by describing this assumption to be when the researcher takes a close interest on the subject in which the study is revolving and narrows down the distance between himself/herself and the subject (p. 20). Through my role as a secondary mathematics teacher, I would benefit firsthand from the findings of this study. I am genuinely close to the information revealed through this study in pursuit of the best way to help all students within middle grades mathematics achieve

mastery of both previous and current content. My epistemological assumption finds teachers' self-efficacy of implementing adaptive learning strategies in the classroom offers different realities of each teacher based on their previous experiences.

Axiological Assumption

Through the axiological assumption, researchers present their values within the study (Creswell & Poth, 2018). My axiological assumption is presented through my personal experience with adaptive learning programs as it will be revealed within the study to provide perspective. By discovering the altering abilities of adaptive learning programs, I will consider my success in incorporating adaptive learning programs in my classroom and bracket off my personal bias. Through such separation, I will be able to assess the change presented through the personal accounts of participants and seek out the truth in the findings of the incorporation of adaptive learning programs in secondary mathematics.

Researcher's Role

As a researcher in this study, I am a human instrument. I am connected to the phenomenon in that I have lived experiences implementing adaptive learning strategies in middle school mathematics classrooms (Patton, 1987). As a current educator with eight years of experience and having served all eight as a middle school mathematics teacher prior and following the COVID-19 pandemic, I have observed the decline in students' abilities to be successful in secondary mathematics. Although I will abstain from allowing my personal experiences to impact my findings within the study, my experiences will allow for me to implement that epistemological assumption through the impact that the findings will have on the success of future students. I will collect, analyze, and determine the findings of the study based on the data presented by the participants with clear evidence of separation from my personal

interactions with adaptive learning through the documentation and evidentiary findings of the study within the research.

Procedures

The following section details the methods of data collection and analysis strategies. Within this section, you will see the manner in which I will remain unbiased as I complete this research study to conclude if the use of adaptive learning platforms is successful in closing the learning gaps for secondary students. Data will be collected through various methods from secondary mathematics educators that have utilized adaptive learning programs in math following the COVID-19 pandemic.

Data Collection Plan

A significant goal of this research is to find the commonality behind the experiences of multiple individuals who have encountered the same phenomenon (Creswell & Poth, 2018). With this purpose in mind, like most qualitative studies, one of the most known data collection processes for this method is interviews. Moustakas (1994) highlighted the intensiveness of the interviews that are taken within this research method, which allow for the full experiences of the participants to be considered and utilized by comparing other participants' transcripts that experienced the same phenomenon. The goal of this qualitative research study is to obtain the experiences of secondary mathematics teachers in Georgia that have experiences the decline in student success following the enlargement of the learning gaps in mathematics. These educators will have expressed their use of adaptive learning programs in mathematics following the COVID-19 pandemic and will set out to present their experiences with student learning success or lack thereof as a result. Through this phenomenology study, these educators’ experiences will be obtained through interviews, discussed within a focus group, and described through

journaling. As described by Creswell and Poth (2018) focus groups will allow for the original findings within the interviews to be further dissected through group feedback and refinement. Using journaling, van Manen (1990) found that it allowed for a more wholistic approach to be taking through the reflection of the participant. Participants are given additional time to reflect on their experiences. The data collected will be analyzed through a triangulation method to determine the role of adaptive learning programs in secondary mathematics (Creswell & Poth, 2018). In this section the data collection methods will be further described, rationale for each will be presented, and the manner of obtainment will be presented.

Individual Interviews

The main approach within qualitative research is the interview method; as Moustakas (1994) highlights, “typically in the phenomenological investigation, the long interview is the method through which data is collected on the topic and question” (p. 114). Within this method, there are variations of manners in which the interviews can be conducted. For the sake of my research on adaptive learning programs' role in closing the gaps in learning for middle grades students in Georgia, I will utilize the semi-structured interview process through the Teams platform to allow for digital meetings to transpire. Participants will be made aware that through the Teams platform is secure and only those invited will be able to view the meeting (researcher and the single participant will be the only participants within the video conference) (Cankaya & Durak, 2020). Through this process, I will open the interview in a friendly, unstructured manner to let the participants feel at ease as we journey into the discussion of the phenomenon. I will introduce myself and read through the participants full name at the opening of the interview. As the interview process continues, I will utilize open-ended questions and probes to spark deeper conversation in the correct direction as the interview continues. These methods fall in line with

that of Moustakas (1994), who states, “The phenomenological interview involves an informal, interactive process and utilizes open-ended comments and questions” (p. 114). The interviews will be slated to be within the time frame of 30 minutes to one hour. For many educators, their planning periods fall within this time range, so if the interview must take place during the week this will allow for the meetings to take place within their time where no students would be present. Within the consent form discussed earlier that can be found in Appendix A, participants would have agreed to complete the Teams meeting with their cameras on and consented to the meeting being recorded with both video and audio as well as a digital transcription program. The use of such will allow for additional information to be gathered through body language and verbal cues that are outside of the typical responses. Upon the return of that consent form, teachers would have received an email with a Google form listing the dates and times available for the interview to take place with a response time of 24 hours to allow for other participants to be scheduled. This Google form will also serve to gather any additional information required for the benefit of the study, such as demographics. With the receipt of their availability, a digital invite will be sent with the date, time, and time frame for the interview. Through this method, I will be able to obtain the full findings of the phenomenon and probe to achieve further detail. The utilization of the recordings will allow for future access to the interviews as needed throughout the data analysis of the study.

Table 1

Individual Interview Questions

1. Please describe your educational background and career through your current position (Opening Question/Build Rapport).
2. Describe your challenges when working with students in mathematics post COVID-19.

(Build Rapport)

3. What adaptive learning programs do you use in your mathematics classroom? CRQ
4. Describe how prepared you feel you are in understanding how to use adaptive learning programs in your classroom for math instruction/learning. CRQ, SQ3
5. Describe successful practices you use when working with the adaptive learning programs in mathematics with students in your classes. SQ1
6. What professional development experiences have you had that prepared you to work with adaptive learning programs in mathematics? CRQ, SQ3
7. What do you perceive are the benefits of using adaptive learning programs in your math classroom? SQ1
8. Describe how you perceive these adaptive learning programs impacting the increase in mathematic achievement and lessening learning gaps in mathematics. CRQ, SQ1, SQ2
9. Describe the challenges you have experiences as a teacher when working with adaptive learning programs in your mathematics classroom. SQ2
10. Describe challenges your students have encountered using adaptive learning programs in the mathematics classroom. SQ2
11. Describe how you assign/allot time for students to work on the adaptive learning program. CRQ
12. What determines how often you allow the students to interact with the adaptive learning program? CRQ
13. When working with adaptive learning programs in math, describe the impact the programs have on your understanding of specific math content. SQ1, SQ3
14. Describe the process you use for measuring the progress of the use of the adaptive

learning program. CQR, SQ1

15. What impact do you feel that adaptive learning programs have had on your confidence in teaching specific math skills in the classroom? SQ3
16. What additional information would you like to provide on the adaptive learning program or its use in your classroom? CRQ, SQ1, SQ2, SQ3

To ensure the quality of my research questions for the study, I will acquire the review of experts within my field to assist in case my questions need adjustments prior to starting research. I will also utilize the assistance of peers within the education career in determining the clarity of the questions through a mock interview upon IRB approval. The initial questions for the interview (1 & 2) will serve as openers to allow for some background on the participant to be presented and a soft opener. Questions 3, 4, 6, 8, 11, 12, 14, and 16 correlate to the central research question in providing information that will direct the study in learning the methods that secondary teachers use when implementing adaptive learning programs into the mathematics classroom. Questions 5, 7, 8, 13, 14, and 16 addresses the benefits that secondary math teachers see from the inclusion of adaptive learning programs into instruction. Questions 8, 9, 10, and 16 address the challenges that come along with the use of adaptive learning programs into the mathematics classroom. Questions 4, 6, 13, 15, and 16 provides information on the perceived impact of adaptive learning through the self-efficacy and confidence of teachers in their abilities to teach middle school mathematics.

Focus Groups

Focus groups allow for additional feedback to insight the refinement of data (Creswell & Poth, 2018). Focus groups are successful in providing participants with the ability to discuss their perception of the issue at hand in accordance with or against that of the additional participants.

Focus groups help to solidify the findings outside the small window of time provided for individual interviews and present extensive information through the participants ability to converse with others about the matter (Creswell & Poth, 2018). Focus groups are an excellent tool in assisting in the development of a consensus over the lived experiences of people find to be the shared interpretation (Katz-Buonincontro, 2022). For this study, a focus group will be conducted through the team's platform to allow for an expansion on the data gathered through individual interviews to be further discussed. Participants will follow similar protocol to that of the individual interview process in which a Google form will be utilized to obtain consent for their participation in this portion of the study. Within this form, participants will be made aware of the use of recording software, both visual and audio, for future use of the dictation of the information gathered to be further analyzed for themes and commonality in comparison with the other data collection within the study.

Table 2

Focus Group Questions

1. Introduce yourself and add any information you would like to share with the group.
2. Describe the challenges you face in teaching after the COVID-19 pandemic.
3. What specific challenges did you see your students experiencing after returning to the traditional classroom, personal and academic?
4. What preparation was offered to you by the administration when returning to the traditional classroom? SQ3
5. What adaptive learning tools are used in your mathematics classroom? CRQ
6. Describe how you perceive these tools helping or hindering students' achievement in mathematics. CRQ, SQ1, SQ2

7. Describe how the use of adaptive learning tools has impacted the way in which you understand mathematics content. SQ3
8. What are the benefits of using adaptive learning strategies and tools in the classroom? SQ1
9. What do you perceive are the most significant challenges of using adaptive learning tools in the classroom for students? For teacher? SQ2
10. What else would you like to share about adaptive learning tools used in the mathematics classroom? CRQ, SQ1, SQ2, SQ3

Questions 1, 2, and 3 serve as soft openers to allow for teachers to become comfortable in sharing out their experiences with students following the COVID-19 pandemic school shutdowns. Questions 4, 7, and 10 correlate to the impact and preparation that teachers felt in providing students with the proper learning strategies needed for their success in secondary mathematics. Questions 5, 6, and 10 focuses in on the incorporation of adaptive learning programs in participants' classrooms. Questions 6, 8, and 10 allow for participants to zone in on the benefits of the utilization of adaptive learning platforms or lack thereof.

Journal Prompts

Journal prompts are another form in which data can be collected as addressed by Creswell and Poth (2018). Through this method of data collection, participants will have the ability to spend more time reflecting on their use of adaptive learning programs than they would in a typical interview. The completed journal prompts will lead to a textual account of the experiences of the participants with more extensive detail. Participants will be given six prompts that can be completed in reference to the use of adaptive learning programs; however, if time is a constraint the option to select four of the six prompts will be noted to allow participants with

minimal time to focus in on four of the prompts to allow for more depth in each of the provided responses.

Journal Prompt Questions

Describe a time when the use of adaptive learning programs in mathematics had a positive outcome. Describe a time when the use of adaptive learning programs in mathematics had a negative outcome. Describe additional elements that impact the use of adaptive learning programs in mathematics. Describe a typical day using adaptive learning in your classroom. What is the flow of the lesson, including whole group, small group, and more? How do you decide who works with adaptive learning and when? What data do you pull from the adaptive learning tool and how do you use it? (Please attach the lesson plan when you return the journal prompts).

Data Analysis

Data collected through the three avenues of this study, individual interview, focus groups, and journal prompts, will be utilized to present the findings of the overall phenomenon of implementing adaptive learning programs in mathematics to close the learning gaps for secondary students. By analyzing the data for commonality amongst the various avenues, educators will be able to determine if the use of such platforms is worth their time through the participants' lived experiences. Although the impact of adaptive learning will not be presented within these findings, the lived experiences will reveal to what extent participants experienced a positive or negative change in the mathematics experiences of their students. The study will reveal the teacher perception of using adaptive learning programs in mathematics from the commonalities found through the three data collection methods. The transcript from individual interviews will be analyzed to obtain a common theme amongst the interviewees. This theme

will allow for a universal understanding of the use of adaptive learning program experiences to be presented. Upon completing the individual interviews, the process of Horizonalization will begin. This process, as described by Moustakas (1994), consists of comparing each participant's responses to one another in search of expressions within the content of the phenomenon. Through this approach, one will remain objective and void of any judgments until what is true comes to light through the revelations found within the research through the method of suspension known as epoche (Creswell & Poth, 2018). Once all the correlating expressions have been identified, a reduction process will take place that allows for statements that are not valuable to the study to be eliminated (Moustakas, 1994). From the remaining statements, themes are then created to cluster the data into labels that go through a validation process based on the level of explicitness needed for the understanding to be transferred to the readers (Moustakas, 1994). Finally, a construction of individual- and textual- descriptions begins to allow for the phenomenon to be experienced from the participants' minds (Moustakas, 1994). In accompaniment with the interviews, participants will have also sent in their responses to the journal prompts to provide more reflective responses to the use of adaptive learning platforms in mathematics. The process for analyzing the data from the journal prompts will follow the same process as the interviews as a commonality within the responses will be sought out to determine the underlying theme. Lastly a focus group will be conducted to address the commonalities within the use of adaptive learning platforms in mathematics allow for the discussion of the central pieces to be expanded upon.

Trustworthiness

Adler (2022) found the purpose of qualitative research to be the search to understand the meaning of data through the analysis of words and observations instead of quantifiable

measurements. Through said research procedures, Creswell and Poth (2018) address the ideas of Lincoln and Guba (1985) who saw the degree of trustworthiness of a study to be determined through the credibility, transferability, dependability, and confirmability of a study. Within this section, the processes taken to meet the criteria of Lincoln and Guba (1985) will be presented.

Credibility

Adler (2022) addresses the matter that many find qualitative research to be less credible. Due to such question of credibility, which Stahl and King (2020) highlight where the research presents the connection to the findings and their relevance to reality, one must utilize methods to show credibility within the research. Credibility within my research study will be achieved through triangulation and member checking. To practice triangulation to determine the validity of your findings, Lather (1991) described it as the analysis of multiple data points in which the theories and constructs that are evident are identified. Through member checking, Creswell and Poth (2018) highlight the benefit of the inclusion of participants in the data analysis process.

Transferability

Shenton (2004) addresses transferability to establish the additional contexts in which the research at hand can be utilized in other areas. The thick and rich descriptions that I used to illustrate the utilization of adaptive learning programs in math can be used to determine the effectiveness of such a tool in other content areas. Creswell and Poth (2018) highlight that readers can transfer the findings to other areas outside of the original context through the details presented within a study. Qualitative studies are not meant to be duplicated (Stahl & King, 2020); however, transferability to the information and findings can be used to connect with other aspects of reality.

Dependability

Lincoln and Guba (1985) see dependability as the root of trustworthiness (Stahl & King, 2020). Dependability also rises with peer feedback, like peer scrutiny (Stahl & King, 2020). To obtain dependability, I will write my research out in detail to allow the information to be easily followed and understood. I will also reflect on the data that is returned through peer observation and address the findings of peers and those within the research by the dissertation committee and the Qualitative Research Director of Liberty University.

Confirmability

Confirmability is the ability to get as close to objectivity as possible (Stahl & King, 2020). In this process, researchers rely on the input of other researchers as well as precision in obtaining an objective reality (Stahl & King, 2020). The techniques that I used to ensure confirmability within my study included triangulation and audit trails. Through triangulation, I confirmed that the data presented was unbiased by comparing the findings to those of others and the critique of peers. Audit trails allow the researcher to retrace the steps taken to the end of the study (Creswell & Poth, 2018). Through the audit trails, the original can be revisited to ensure that objectivity was used when delivering the findings.

Ethical Considerations

Any ethical considerations or implications of the research should be discussed along with all permissions required for the research.

Permissions

Before data collection, a series of permissions must be granted. I will obtain IRB approval (Appendix B), allowing the research study to take place. This process consists of approval of the proposal for this study followed by the completion of the IRB application. Upon the retrieval of this letter of approval, data collection will begin. Informed consent (Appendix A)

will be obtained from research study participants.

Other Participant Protections

Through the approval of the IRB (see Appendix B), consent forms are presented as a digital option to allow for a more convenient and accessible method for participants to be utilized. Data was stored in a password-protected digital file. Any paper copies of the digital resources utilized during the study will be stored within a locked cabinet at home. The anonymity of the participants, site, and data collected will be secured throughout the study with pseudonyms given upon the start of the study. Participants may withdraw from this research at any time without penalty, and there will be confidentiality of the participants at all times.

Summary

Through the ability to speak directly with people involved in using adaptive learning programs, a qualitative phenomenological research study will allow for this topic to be explored. Within the study, interviews and a focus group with teachers who interact with adaptive learning programs will be conducted. Additionally, journal prompts will be collected from each participant. The collected data will then be analyzed through the process of triangulation and horizonalization in which the content will be sorted and analyzed for common themes. Each of these processes will provide the information needed to guide the understanding of incorporating adaptive learning programs in closing the learning gaps in mathematics as it is analyzed and critiqued to find the common theme presented amongst the data.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this transcendental phenomenological study is to explore the experiences with adaptive learning programs that address the learning gaps due to the COVID-19 pandemic for middle school teachers in Georgia. This chapter presents the data collection results regarding integrating adaptive learning programs into the classroom of 10 educators. Participants for this study were chosen by surveying the educators in Georgia public schools containing middle grades. Ten participants were selected based on their responses to the survey (INSERT APPENDIX) and agreement to participate. Through individual interviews, journal prompts, and focus groups, I set out to capture the perspectives of educators on their use of adaptive learning programs in secondary mathematics. The following research questions were explored: Research Question 1: What are the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic? Research Questions 2: What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics? Research Question 3: What do secondary math teachers perceive as challenges of using adaptive learning programs to address learning gaps in mathematics? Research Question 4: How do secondary math teachers perceive the impact of adaptive learning programs on their self-efficacy and confidence in teaching middle school math?

Participants

The participants of this study were selected based on their meeting the requirements and their willingness to continue the study process through the completion of journal prompts and individual interviews, as well as the possibility of being selected for a focus group. Anyone who

did not respond to the initial request for further study participation was eliminated. Within the survey, participants were questioned on their use of adaptive learning programs in their mathematics classroom. Of the participants meeting the requirements, 10 participants from public schools across the state agreed to participate. The journal prompts, individual interviews, and a focus group provided a collection of data that was further analyzed to highlight the phenomenon. This data was then used to create a narrative to relay the participants' experiences using adaptive learning programs in secondary mathematics classrooms. Below are details of the participants' work experience and training in connection to the content of the study. All quotes are verbatim to provide a clear picture of the individuals, allowing their personalities to be present through their dialect and grammatical ways.

Bailey

Bailey, who has been teaching for a total of six years, has taught at both the early childhood and secondary levels. She has a master's degree in education policy. Bailey spent her beginning years in education out of the state of Georgia; however, her secondary math teaching experiences have all occurred since being in Georgia. She serves as a sixth-grade mathematics teacher this year and has incorporated multiple adaptive learning programs into her classroom instruction. Bailey stated that "post-COVID-19, students have lots of gaps in their understanding of number sense, and also gaps on like how to be a student" (Bailey, Individual Interview, February 05, 2024). With mathematics content building and students having missed a portion of that foundational content without direct instruction and application due to the pandemic, Bailey spoke on students' inability to retain information and carry the information from one day to the next.

Caroline

Caroline has taught mathematics at the secondary level for the last five years of her career. Prior to middle grades, Caroline served as an elementary education teacher for 20 years. She is currently serving as a seventh-grade math teacher for her 25th year of education. Caroline has her master's degree in educational leadership. Caroline utilizes adaptive learning programs in her classroom to support student learning and understanding. Post COVID-19, Caroline observed a spike in students' interest in the digital aspects of the world, "they are addicted to their video games and their social media, anything but schoolwork" (Caroline, Individual Interview, February 15, 2024). This behavior impacts the use of adaptive learning programs because some students are unable to remain on the provided platform.

Danielle

Danielle holds a master's degree in education. She is in her second year of education and has served both of those years at the middle school level, teaching mathematics. This year, Danielle is teaching seventh-grade math. Danielle did not have certified experience teaching students prior to the COVID-19 pandemic, but she observed many differences in student learning and application during her time as a middle schooler and a college student. Danielle highlighted that students today have "an overreliance on like videos and like computer, which can be good and bad, but I think it's caused kind of a shortened attention span for things and also this kind of mentality that everything can be done at home or on the computer when that is not always the case," (Danielle, Individual Interview, January 29, 2024).

Grace

Grace has been teaching for 20 years. Within the span of Grace's teaching career, she has taught math across various grade levels and ventured out to teach social studies, but eventually

made her way back to mathematics. Grace currently teaches eighth-grade math and has taught this content for the past six years. When describing the changes seen in students following the COVID-19 pandemic, Grace stated, “I feel that students have just really gotten to the point where they had a little bit more leniency, and it wasn’t as structured like in the classroom” (Grace, Individual Interview, February 26, 2024). Due to this feeling of being able to take their time to complete tasks, “the motivation and just the constant battle with technology is something that has been a struggle that I’ve seen from year to year since” (Grace, Individual Interview, February 26, 2024).

Howard

Howard holds a bachelor’s degree in middle-grade education, followed by a master’s degree in curriculum and instruction. Howard started out in the realm of education as a seventh-grade mathematics teacher. Then, he transitioned to the role of a co-teacher, which he still serves in middle school mathematics classrooms. When discussing the changes seen in students post-COVID-19, Howard stated that “the major thing that I have seen as far as challenges are concerned is the apathy within students that I felt like I didn’t necessarily see before COVID-19” (Howard, March 12, 2024). This apathy then impacts students’ ability to be successful students because, as Howard states, “it seems like they forgot how to do school” (Howard, March 12, 2024).

Jordan

Jordan has been teaching for the last 13 years. He began his career outside of Georgia in early childhood education. In Georgia, he has been teaching at the middle grades level, starting in English language arts, but currently serving as a seventh-grade mathematics teacher. When questioned about the differences seen in students following the COVID-19 pandemic, Jordan

stated, “I think one of the biggest things is just the attention span and their desire, you know” (Jordan, February 16, 2024). For many students, the buy-in to the learning is the only thing that will keep them involved in their learning and provide them with the momentum to try.

Kayla

Kayla has completed 24 years in education. She began her education career in Texas, serving for four years, and later relocated to Georgia. She has earned her master’s degree and is currently serving as a seventh-grade science teacher, for which she holds a plethora of certifications. Prior to moving over to science, Kayla taught sixth-grade mathematics. When asked about what challenges she observed in students post-COVID-19, Kayla commented on the lack of foundational skills that students possessed that were necessary to understand and be able to apply the content at the seventh-grade level, “foundational skills for your level, skills that they should know,” (Kayla, February 13, 2024).

Kelsi

Kelsi has a master’s degree in education and has worked in education for seven years. She has the certifications to teach both mathematics and sciences at the fourth through eighth-grade levels. She is currently serving at the seventh-grade level as a science teacher, having just moved from teaching mathematics. When describing the challenges posed post-COVID-19, Kelsi stated, “I can tell that there are more deficits and there are a lot of gaps in their learning. What they’ve, I guess, missed during that time” (Kelsi, February 22, 2024). Kelsi went further to describe the matter of the students in the classroom now, although on the same grade level, are not truly due to “where they were doing COVID,” whether it was in the classroom, hybrid, or completely online (Kelsi, February 22, 2024).

Kristina

Kristina continued her career in education for 32 years. She possesses a specialist degree in curriculum and instruction and has the certifications to teach mathematics at the fourth-eighth and ESS (exceptional student services formerly known as special education) levels from kindergarten to 12th grade. She is currently serving as a middle school mathematics curriculum coach, having just left the classroom at the seventh-grade level. When speaking on the challenges that were apparent following the COVID-19 pandemic, Kristina stated, "I think the struggle with teaching mathematics is to get students to want to learn mathematics, and they have a mindset in mathematics that is where a lot of kids don't like math because it's harder for different reasons," (Kristina, February 20, 2024).

Mallory

Mallory holds a master's degree in education and is certified to teach special education, English language arts, and mathematics. This year, Mallory has taken on the role of the math intervention teacher in which she teaches sixth-, seventh-, and eighth-grade students. When asked to describe the challenges she faces in the classroom post-COVID-19, Mallory stated,

> Uh, it seems like they're coming further behind, but it also started seeming like that a little bit before COVID. I don't think that it's just really post-COVID, but I do feel that mental health is a great issue. Mental toughness seems to be a little bit weaker, and absenteeism is higher than before COVID (Mallory, February 16, 2024).

Table 3

Teacher Participants

Teacher Participant	Years Taught	Highest Degree Earned	Content Area	Grade Level
Bailey	6	Masters	Mathematics	6th
Caroline	25	Masters	Mathematics	7th
Danielle	2	Masters	Mathematics	7th
Grace	20	Masters	Mathematics	8th
Howard	5	Masters	Mathematics	7th
Jordan	13	Bachelors	Mathematics	7th
Kayla	24	Masters	Science, Mathematics	7th
Kelsi	7	Masters	Science, Mathematics	7th
Kristina	32	Specialists	Mathematics and Special Education - All Content Areas	6-8th
Mallory	14	Masters	Mathematics and Special Education - All Content Areas	6-8th

Results

The selection of participants was made through the obtainment of data collected from surveys. The identification of themes was completed through a process that followed the data collection and analysis of the 10 participants' individual interviews, journal prompts, and a focus group interview. Those three sources were transcribed, coded, and analyzed using the processes

described by Moustakas (1994). Below is a detailed description of the process used to identify the data's themes and the answers to the research questions.

Theme Development

During the data collection and the analysis portion of the study, the individual interviews, journal prompts, and a focus group interview were utilized. The data that was collected in each portion of the study was transcribed. Moustakas (1994) highlighted that the purpose of themes is to allow for the data to be clustered into labels that go through a validation process based on the level of explicitness needed for the understanding to be transferred to the readers. The following section describes the process of identifying the themes and findings in alignment with the answers to the research questions.

Table 4
Themes & Subthemes

Theme	Subthemes	
Lack of Professional Development	Teachers Are Self-Learners of ALP	Time Usage
Adaptive Learning Programs Are Beneficial	Personalized Instruction	Immediate Feedback and Progress Monitoring
Adaptive Learning Program Success	Teacher Support	Classroom Connection

Lack of Professional Development

Teachers set out each year with the awareness of the standards that they are required to teach within the course of the year and a proposed finishing date set prior to state testing. To accomplish this goal, many tools and platforms are utilized; however, following the COVID-19 pandemic, there was a heightened need to support not only grade-level learning but that of the

previous grade levels due to learning gaps that were expanded after school shutdowns in which many systems turned to adaptive learning programs. When discussing professional development to understand how to utilize the given adaptive learning programs, Bailey stated, “Oh yeah, pretty much went in blind. I tried it out, you know? Put my kids on it, looked at their screens to figure out what it did for them, and how to best use it in my classes” (Bailey, February 05, 2024). Seven out of the ten participants stated that they had never had professional development on the adaptive learning programs used in their schools.

Teachers Are Self-Learners of Adaptive Learning Programs

Although many individuals outside of education believe that teachers have it easy with a Monday-Friday job and Summers off, they fail to see the work that must be done outside of work hours to provide students with the best education and allow for the content to be absorbed. When speaking about the confidence and how she figured out how to use the adaptive learning platform provided by her school, Danielle stated,

> So I feel great now, but it was a lot of me just going in and figuring it out myself. When I first started, they gave me the resource and said, ‘Oh, here it is’, but I had to learn along the way the different things. I learned from other teachers and stuff (Danielle, January 29, 2024).

Howard followed the same path as Danielle; in fact, when asked about professional development for adaptive learning programs, he stated that he had “zero; I have gone and asked colleagues how to like you know, you do certain things. Like, hey, how can I do this on this program” (Howard, March 12, 2024)? Seven out of the ten participants agreed that this was the process that was used to understand adaptive learning programs.

Time Usage

With adaptive learning programs being a tool to meet students where they are, the lack of professional development sparks the question of how long one can utilize the tool in a class period and how long it would take to see the results. Although the students are arriving with gaps in their learning, Bailey states, “The time you still had to get all of the standards in is the same amount of time that you had the year before (Bailey, February 05, 2024).” When discussing the benefits seen as a result of the adaptive learning program, Kelsi stated, “According to the curriculum and the pace, I can’t necessarily or I’m not supposed to necessarily stop and go back and do it, but I felt like I really would kind of help or did kind of help bridge some of those gaps that were missed in previous grades or even during COVID (Kelsi, February 22, 2024).” Bailey also highlighted the matter of time through her statement,

> A challenge could also be like, I know a lot of times the administration or whatever will be concerned about like how you’re using your time as the teacher in the room, and so I know sometimes when you use those adaptive programs, they can be looked down upon like you just had them on the program all day or something like that (Bailey, February 05, 2024).

Adaptive Learning Programs Are Beneficial

Upon the reopening of schools across the state, many students came in with a different outlook and perspective on learning, which threw a curveball for many educators as students returned with learning gaps, creating a variation of levels amongst the students that sat within one classroom. When discussing the benefits of adaptive learning programs in his mathematics classroom, Howard stated, “The adaptive learning programs make it like extremely easy for me as a teacher to differentiate” (Howard, March 12, 2024). Kristina also addressed numerous ways in which adaptive learning programs have been incorporated in her school, “so for remediation,

for practice, preparation for tests, and for quizzes (Kristina, February 20, 2024)."

Personalized Instruction

Differentiation is one of those key terms that many educators have heard a plethora of times during their careers. However, when it comes to education post-COVID-19, it holds many afloat as they try to teach on-grade level content to a seventh-grade math class with students ranging from a 4^{th}-8^{th} grade level in math as described by Howard. This was one of the benefits that Grace highlighted about adaptive learning programs when she made the statement, "individualized instructions, so meeting them at the level of where they're at, but still making those applications to current content to help close those gaps (Grace, February 26, 2024)." Jordan felt the same way when discussing his students, "their number sense just isn't there. And so, you know, without that, it's like they spend a lot of time just on simple things that should be really quick. The main thing is the programs can help students practice at the level that they are specifically at (Jordan, February 16, 2024)." Overall, the participants felt that the use of adaptive learning programs in mathematics allowed for all students, no matter their current level of learning, to make progress in closing the learning gaps while grasping some understanding of the grade level content.

Immediate Feedback and Progress Monitoring

Many participants agreed that two of the key benefits of adaptive learning programs outside of its ability to meet students where they are is the ability to provide students with immediate feedback and teachers with a means of progress monitoring. Caroline highlighted the positive impact of adaptive learning programs in her class by stating, "You see a correlation between students who are doing their adaptive learning work and students who are successful in my classroom. And those who are not doing their adaptive learning work are not doing well on

their formative (Caroline, February 15, 2024).” Danielle agreed through her statement, “Their scores are better because they’re getting that practice in. I’ve seen the results in the scores and, just like, observations (Danielle, January 29, 2024).” With adaptive learning programs, participants were able to observe a positive change in student performance in mathematics.

Adaptive Learning Programs Success

Even with the positive connotation of adaptive learning programs, teachers still feel that alone is not enough; as Mallory states, " It’s not an independent program (Mallory, February 16, 2024).” Kayla follows: "I don’t think that just adaptive learning by itself would close the gap (Kayla, February 13, 2024).” Adaptive learning programs can serve the role of providing the means of closing learning gaps, but teachers must interact with both the programs and the students to ensure that both are interacting in a manner that would result in success.

Teacher Support

Most participants agreed that the adaptive learning program is beneficial, but not without teacher support. Bailey highlighted that “as a teacher, like actually using it as a way to learn not just getting them on the program, but checking in with them while they are working on those assignments or looking back and saying, ok, you didn’t do well on this assignment (Bailey, February 05, 2024).” Which falls in line with Mallory’s belief as well who stated, “and that’s what I have trouble getting different people to see is it’s not a, we can’t just put a kid on the computer and say, go do it. It has to be conferencing and helping the students when they feel stuck and frustrated (Mallory, February 16, 2024).” From these accounts, amongst others, it is apparent that the use of adaptive learning programs is beneficial as long as teachers supply students with guidance and feedback as the process continues.

Classroom Connection

When it comes to solving problems in mathematics, there are typically more than one way to arrive at the answer. Most participants agreed that the connection of the adaptive learning tool to the classroom content is beneficial to the program's success in assisting with student's mathematical achievement. Bailey addressed that, "sometimes the way the adaptive learning program is teaching something or showing something is different, and so they don't connect that they've actually learned it already, because it is explained differently or shown differently (Bailey, February 05, 2024)." For the matter, Danielle highlights that, "you need to use it more as a tool (Danielle, January 29, 2024)." By allowing students to be privy to multiple ways to solve problems, students are bound to find a method that will allow them to arrive at the correct solution.

Outlier Data and Findings

The following sections explore any unexpected findings and themes that did not align with the research. The data analysis revealed only one outlier. The outlier discovered that the participants found a significant change in their students following the COVID-19 pandemic.

Students Norms

Four of the ten teachers in this study acknowledge a change in students. Through their observations, students no longer have the drive to try and perform to obtain success and instead operate on an understanding of which school is irrelevant. Caroline offered, "They are addicted to their video games and their social media and anything but school work." Howard suggested, "The major thing that I have seen as far as challenges or concerns is the apathy within students (Howard, March 12, 2024)." Bailey stated, "Students have gaps in how to be students (Bailey, February 05, 2024)." Although these observations do impact the success of the use of adaptive learning programs, the research for this matter would need to address the mental aspect of

development that has altered student norms. The research would need to determine if this problem arose because of the pandemic or if the pandemic caused an increase in the number of students who lack motivation.

Research Question Responses

The research questions were answered using the three themes developed during this study. The three themes that were identified during the data analysis process were (a) lack of professional development, (b) adaptive learning programs are beneficial, and (c) adaptive learning programs success.

Central Research Question

What are the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic? Participants indicated that the use of adaptive learning programs play an overall positive role in addressing the learning gaps following the COVID-19 pandemic. Danielle stated, “I had a student who was struggling with math and really wanted help outside of school. I convinced her to just do the practice that I was assigning her in class, specifically the weekly tasks on the adaptive learning program. She began doing them and committed to doing them, and her understanding was apparent in her actions and in her results (Danielle, January 29, 2024).” Jordan stated, “That’s when you know the benefit, especially of assigning some, for working on outside of the classroom really helps students to not only keep those in mind, but then they can also explore new topics as they get prepared for them. They may even be ahead of where they currently are (Jordan, February 16, 2024).” Using adaptive learning programs both inside and outside of the classroom, there has been growth in the learning of mathematics, which participants have shown as evident to both the students and teachers.

Sub-Question One

What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics? Participants agreed that the use of adaptive learning programs is a way learning gaps can be addressed in secondary mathematics classrooms. Grace stated, “Adaptive learning programs can provide a level of support to students that need extra practice because they provide immediate feedback and instructional support through the use of written and video explanations. I had a student who was struggling with a particular concept; after classwork, questions, and tutoring, the student was still struggling. Long story short, skill-specific additional practice was recommended through an adaptive learning platform, and when the test was given, the student walked away with an A (Grace, February 16, 2024).” Kayla's perception was similar when stating the following about adaptive learning programs, “it allowed me to quickly identify struggling students. Not only did it allow immediate feedback for all students, but it also gave lessons that addressed prerequisite skills. Addressing the prerequisite skills allowed students to make better scores once given a similar initial assignment (Kayla, February 13, 2024).” Adaptive learning programs’ ability to provide users with immediate feedback, individualized lessons, and support are among the reasons why participants find that adaptive learning programs are beneficial.

Sub-Question Two

What do secondary math teachers perceive as challenges of using learning programs to address learning gaps in mathematics? Participants highlighted numerous challenges that impacted the use of adaptive learning programs from time to technology issues or access. Jordan said, “During class, much of it can be time-related and also behavioral needs of the class. For the use of them outside the classroom, it comes down to motivation and internet access (Jordan,

February 16, 2024).” Kayla identified another challenge, “umm, that might be a generational thing because I’m older, and so just using technology in the classroom and math is kind of it is fairly new (Kayla, February 13, 2024).” Bailey addressed another challenge with using adaptive learning programs through the means of the students when stating, “students need to be self-directed learning in order to do it (Bailey, February 05, 2024).” There are challenges that can arise with the use of adaptive learning programs, from elements that can be controlled and others that may have uncertain results.

Sub-Question Three

How do secondary math teachers perceive the impact of adaptive learning programs on their self-efficacy and confidence in teaching middle school math? Participants revealed that by using the adaptive learning programs, they have come across various methods to teach a skill and provide them with confidence in their own teaching. Mallory stated, “I’ve noted a couple of times that the examples will match up perfectly with exactly, you know, the way that I would teach it. Exactly the way they’re learning it in the sixth-grade classroom and how I was taught. And then other times where it doesn’t match up with what they’re doing. It’s also another way to look at it, and I think that helps with me and the kids (Mallory, February 16, 2024).” Bailey stated, “The only thing I can say is knowing that I have the adaptive program (Bailey, February 05, 2024).” The ability to see the methods of teaching provided through another means, as well as having a tool that will allow for instant differentiation through the individualized lesson, are reasons why participants found adaptive learning programs to have an impact on their self-efficacy and confidence.

Summary

The themes identified through the analysis of the data in this study were a *lack of*

professional development, adaptive learning programs are beneficial, and *adaptive learning program success*. Participants in this study found the use of adaptive learning programs beneficial in closing the learning gaps in mathematics following the COVID-19 pandemic; however, not all believed that the program was sufficient on its own. Due to a lack of adequate professional development, the door to teacher interpretation and usage is opened. Teachers were fearful of the administration walking in and negatively documenting the students' usage of the adaptive learning program due to time. Teachers were fearful of not meeting all of the standards on grade level that needed to be covered because of using time toward previous content, and teachers were not certain they were providing the full effects of the adaptive learning program due to not being fully aware of the software.

Even with the unknowns, teachers still found the use of adaptive learning programs to be beneficial in secondary mathematics classrooms. Many participants highlighted the program's capabilities to individualize learning to meet students where they are with a connection to the current level content being taught within the classroom. Participants also noted that the adaptive learning programs boosted their confidence as teachers through their awareness of having the program available when needed as a tool for differentiation and to remind them of content that came before or after the current level to help them support their student's learning both inside and outside of the program.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this transcendental phenomenological study was to explore the experiences with adaptive learning programs that address the learning gaps due to the COVID-19 pandemic for middle school teachers in Georgia. Chapter Five presents a brief discussion of the research that took place in this study as well as a summary and interpretation of the findings of Chapter Four. The discussion portion that follows contains the observed conclusion based on the data analysis. After the discussion, you will find the study limitations, delimitations, and recommendations for future research. The participants in this phenomenological study consisted of 10 secondary mathematics teachers who have served within the state of Georgia and agreed to discuss the role of adaptive learning programs in closing learning gaps following the COVID-19 pandemic.

Discussion

Each year, teachers are aware of what grade level content they will be teaching the following year: 6th-grade math curriculum, 7th-grade math curriculum, or 8th-grade math curriculum. However, when it comes down to the students that will be within the classroom, that grade level may not be on the student's actual level of understanding. Following the COVID-19 pandemic, the learning gaps due to many students not having a consistent learning experience during and following the school shutdown increased. According to research, students are arriving in middle school several grade levels behind, which brings the need for a tool to help close the learning gaps: adaptive learning programs (Sun et al., 2021).

Through the research of this study, the use of adaptive learning programs has been deemed beneficial and determined to play a role in closing the learning gaps for students in

secondary mathematics following the COVID-19 pandemic. With a lack of standard training and guidance on the use of adaptive learning programs across the board for secondary teachers, many have not found the most efficient ways to incorporate the tools into the class; however, the benefit of their presence is apparent. Time plays a huge role in determining how much in-class time teachers can provide students in working on the adaptive learning programs to assist in the closure of learning gaps due to the need to teach students grade-level content prior to state testing within the same time frame. Teachers are also unaware of administrators' perceptions of adaptive learning programs and the results of their observations of students interacting with the programs during instructional time. Teachers who are aware of the benefits of adaptive learning programs still run into issues with their use in closing the learning gaps when students are not utilizing them to the necessary need to obtain the support that is being provided. Adaptive learning programs can assist in closing the learning gaps of secondary math students when utilized with efficiency and effectiveness.

Summary of Thematic Findings

Teacher perceptions on the role of adaptive learning programs were analyzed regarding the following research questions through individual interviews, focus group interview, and an analysis of journal prompts. The central research question was: What are the experiences of secondary math teachers who use adaptive learning programs to address learning gaps in mathematics following the COVID-19 pandemic? Sub-Question One: What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics? Sub-Question Two: What do secondary math teachers perceive as benefits of using adaptive learning programs to address learning gaps in mathematics? Sub-Question Three: How do secondary math teachers perceive the impact of adaptive learning programs on their self-

efficacy and confidence in teaching middle school math? The themes that emerged from the analysis of collected data include *lack of professional development*, *adaptive learning programs are beneficial*, and *adaptive learning program success*. The subthemes that emerged from the analysis of collected data include *teachers are self-learners of adaptive learning programs*, *personalized instruction*, *teacher support*, *time usage*, *immediate feedback and progress monitoring*, and *classroom connection*.

Professional Development is Necessary for ALP Success

In the interviews and focus group, most participants expressed that no formal professional development was provided within their school on the use of the school-adopted adaptive learning programs. Participants often utilized their own time to look further into the programs and their offerings to determine how they would best serve the students. To see the student view, participants observed their students' interactions with the programs to see the similarities of the teacher side of the program to the student view.

To determine whether professional development was provided to the participants and in what capacity, I analyzed the transcripts from individual interviews, the focus group interviews, and the journal prompt responses. The transcripts revealed that some participants who were within the same school system stated they received a session on the programs upon its initial adoption, but others who came later were not given that opportunity. Participants identified that professional development would allow the program to be utilized at its highest capacity, given that teachers are aware of all it offers. Nevertheless, participants explored the programs on their own and utilized them to the best of their ability to supplement student learning. Training is needed to provide teachers with the right methods for technology integration (McClain & North, 2021).

Teachers Find ALP Beneficial for Student Success

In the interviews, focus group, and journal prompts, teachers provided glowing reviews of the results from the use of adaptive learning programs within their secondary mathematics classroom. Participants often acknowledge the multitude of aspects of adaptive learning programs to allow for student success. Participants also revealed a variation in how the adaptive programs were utilized in their classrooms.

To identify the benefits presented to teachers using adaptive learning programs, data was collected through transcripts from individual interviews, transcripts from the focus group interviews, and journal prompt responses. The transcripts revealed that overall, adaptive learning programs improved student performance in on grade-level mathematics content. For most participants, adaptive learning programs served as a tool for differentiation to close the gaps of past content and bring students to the current content in relation. Students were able to utilize the videos and written explanations presented upon and incorrect responses to provide further in-depth teaching for previous or current content skills being completed. Teachers also utilized the diagnostic portions of the programs to identify all learning gaps and create individualized learning plans within the programs to assist in closing student learning gaps. Adaptive learning programs are a method to allow for the retention of content learning at student ability levels in various situations (Moon & Ke, 2020; McMullen, 2023).

ALP as Teacher Support

In interviews and the focus group, teachers acknowledge the positive impact of adaptive learning programs but identify them as a tool in helping close learning gaps. Teachers addressed that in accompaniment to the adaptive learning programs, teachers need to assist students in understanding the content being presented within the program if a problem arises. Teachers

indicated that being aware of the proper method to use the adaptive learning program would be one of the critical factors in its success.

Data was collected and analyzed from individual interviews, and the focus was to determine the manner of teacher support that should be incorporated with the use of adaptive learning programs. The transcripts revealed that although students are provided with video and written explanations, there are times when teacher assistance in understanding what is presented is needed. To supplement such individual learning, teachers should set forth a procedure for conferencing and goal setting with the students to hold them accountable for their own learning progression in closing their gaps. They also present the understanding that the teacher will serve as a support person when needed. Teachers need to know the proper manner to incorporate digital learning to avoid student burnout and boredom (Braisel et al., 2022).

Implications for Policy and Practice

The implications presented in the following section result from this phenomenological study's findings. These implications have been categorized into two sections: (a) implications for policy and (b) implications for practice.

Implications for Policy

Following the COVID-19 pandemic with school shutdowns around the world, many students have demonstrated a lack of retention from previous grade levels. With the broad spectrum of learning levels that exist within one classroom, teachers are struggling to reach students with on-grade-level content due to their lack of mastery and retention of previous grade levels. Recent changes have been made to Georgia standards; however, there is no policy in place statewide to provide regulation on the process that needs to take place based on a student’s lack of mastery. Policy needs to be adjusted to allow for students to utilize adaptive learning

programs and reach their grade level to successfully complete the course of publication education and progress into society.

Implications for Practice

The use of adaptive learning programs has positively impacted the understanding of mathematics for many secondary mathematics students in Georgia; it may also be effective in assisting in closing learning gaps for all students. To ensure this is possible, it is evident that numerous factors are addressed for the most success to be obtained from the implementation of adaptive learning programs. Teachers need professional development to ensure an understanding of the proper manners in which to utilize adaptive learning programs from various aspects of time to process. Additional training can be provided for parents to allow for the closing of previous learning gaps to take place outside of the grade level classroom to prepare students for immediate success.

Empirical and Theoretical Implications

The implications presented in the following section result from this phenomenological study's findings. The implications in this study have been categorized into two sections: (a) implication for empirical and (b) implication for theoretical.

Empirical Implications

The data obtained through this research study directly supports the literature of previous research within the areas of mathematics performance following the COVID-19 pandemic. As highlighted by Bailey et al. (2021), participants recalled a broad range of learning gaps that transpired because of school closures due to the pandemic. One participant mentioned that some of the learning gaps were occurring prior to the pandemic; however, it was apparent that the number of students with learning gaps increased due to the pandemic. This increase in the

learning gaps was due to the lack of internet access for many, which, as provided by the participants, is still an issue when attempting to provide adaptive learning programs for outside-of-school usage. Jordan (February 16, 2024) highlighted that when attempting to get students to work on adaptive learning programs outside of teacher supervision, it comes down to two things, "motivation and internet access." Other factors make an impact on the productivity that students have outside of school as well as highlighted by Severino et al. (2021) when addressing the need for parental support during the times of the pandemic. Danielle (January 29, 2024) highlighted the issue of time and discussed the role of the parent when stating, "I think when students are given the opportunity to use them and also when parents kind of know and recognize like oh, here's this tool that you can use to take advantage of an opportunity to fix those gaps." Bailey (February 05, 2024) also addressed the matter of parental use when stating that,

> Parents are always asking what we can do. And I, you know, they complain about not being able to help them with the current work so it's like if you could just help them fill those gaps that would go probably really far.

As adaptive learning programs today are digital based, the push for using and understanding technology is apparent, as Sun et al. (2021) highlighted the increase in learning through technology following the pandemic where many were forced to see its vitality as a learning tool. This correlates to the need for professional development for teachers to properly utilize adaptive learning programs or even technology, for that matter, as Kayla (February 13, 2024) highlighted when mentioning the older generation of educators and their interaction with technology. With the hopes of reaching students on level, this study correlates to the needs highlighted by Satten et al. (2022). Participants corroborated that of Lim et al. (2022), highlighting that the students motivated to learn are more actively engaged in the learning

process. Caroline (February 15, 2024) provided an account of a student who was not within her enrichment (accelerated) group but consistently worked on the adaptively learning program to get a better understanding of the content, even when it reached the 8th-grade level of content because she wanted to understand and improve instead of stopping at 7th-grade content.

Theoretical Implications

Within this study, two theories were focused upon Bandura's (1977) theory of self-efficacy and Sweller's (1988) cognitive load theory. Upon the conclusion of this study, it is apparent that both of these theories take part in the understanding of the role of adaptive learning platforms in education; however, when it comes to Bandura's (1977) theory, a shift in the focus from teacher to student may provide further detail to the true implications of adaptive learning programs. This study revealed that all teachers are willing to utilize programs to assist their students in closing their learning gaps in mathematics in hopes of mastering the current grade-level content. Although the research proves that the use of adaptive learning programs does play a positive role in teacher self-efficacy through the confidence boost obtained from knowing that their methods of teaching are validated by the program's similar methods within the content or even in some cases where it provides assurance that there is a tool that can be used to help differentiate learning to meet students where they are. Mallory mentioned that there were times when the examples matched perfectly with the exact way she was teaching the 6th-grade content, and it reassured her about her performance as a teacher. Bailey highlighted that knowing there was a program that she could use to provide each student with the needed remediation on the same skill brought her confidence in knowing she had the means to reach her students. As for Sweller's (1988) cognitive load theory, it was apparent through the participant's recollection of students' ability to get some aspects of the skills correct without truly understanding the concept

and lacking the foundational skills. Students are taught at their level through this theory, which is congruent with adaptive learning programs. They gradually progress in the content, allowing the knowledge to move from their short-term to long-term memory. Through the implementation of teacher support to assist students in understanding the importance of the work through goal setting and conferencing, as suggested by participants, this theory correlates to students' work with adaptive learning programs impacting their success in mathematics.

Limitations and Delimitations

When it comes to research, two categories cannot be avoided. Limitations consist of any possible weakness that is out of the control of the research, and delimitations consist of the selected limitations chosen by the researcher(s) (Theofanidis & Fountouki, 2018). The following section outlines the limitations and delimitations of this phenomenology study.

Limitations

In conducting this research study in a qualitative manner, the data was captured through interactions with participants as opposed to a method of collecting numerical data. Due to this, there were many cases in which those eligible to participate in the study were unable to do so due to the possible conflict with their availability. Some participants began the process of working through the entrance of the study but later backed out due to other obligations within their personal or work lives, with it being during the final semester of the school year. The majority of the participants in this study were female educators (eight participants) due to the smaller index of male educators (two participants) who were willing to participate.

Delimitations

The delimitations for this study are composed of the criteria set for participation. The study set out to analyze teachers' perspectives on the impact of adaptive learning programs in

closing the learning gaps for secondary mathematics students, focusing on the middle school level in Georgia. To be eligible to participate, participants had to have taught mathematics at the middle school level in the state of Georgia during the COVID-19 pandemic. The sample was set to be a small number of participants to allow for in-depth interviews and the analysis of individual journal prompts to fully understand their views on the impact of adaptive learning programs.

Recommendations for Future Research

The findings of this research study corroborate the awareness of learning gaps following the COVID-19 pandemic as well as the impact of digital learning through the positive results recounted by the participants in their use of adapted learning programs within their classrooms. Future studies could build on these findings and expand the use of adaptive learning programs beyond the state of Georgia and into other grade levels outside of the middle school setting. Another possible research opportunity is for researchers to determine the avenues to best obtain parent and student buy-in to closing their learning gaps with adaptive learning programs outside of the school setting to alleviate the time factor many educators face.

Conclusion

The purpose of this transcendental phenomenological study was to address the problem of the significant learning gaps in mathematics for secondary students, which progressed following school shutdowns due to the COVID-19 pandemic. Qualitative evidence was presented within this study to suggest that the use of adaptive learning programs closes gaps for secondary mathematics students in the state of Georgia when implemented by the teacher. The participants in this study (ten middle school teachers) offered insight through individual interviews, focus groups, and journal prompts. The data indicated that there are numerous constraints that are

impacting the effectiveness of the use of adaptive learning programs in the classroom. This implication was determined through the analysis of individual interviews, focus groups, and journal prompts. As an educator with the hopes of providing each student with the best learning experience, each participant took it upon themselves to determine how to implement the program within their classroom to obtain a success rate in their student's level of understanding for on grade level content. John Sweller's (1988) theory is apparent through students' ability to comprehend components of the content without a full understanding of all parts. Through student progression of the adaptive program, participants confirm that student achievement and performance increased within the content area as the program allowed for those parts that were not fully understood to be learned through individualized plans built within the adaptive program. This study also revealed that through the use of adaptive learning programs, self-efficacy and confidence in participants' teaching abilities increased through the awareness of being in possession of a tool to assist in the process of differentiating learning that would be more personable to student abilities as well as a tool to provide reminders through video and explanation of the processes of the content that is outside of their grade level for both students and teachers (Bandura, 1977).

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Appendix A

Informed Consent

Consent

Title of the Project: The Role of Adaptive Learning Programs in Secondary Mathematics
Principal Investigator: Shameka Gray, Doctoral Candidate, School of Education, Liberty University

Invitation to be Part of a Research Study

You are invited to participate in a research study. To participate, you must be a Georgia educator who has taught secondary mathematics following the COVID-19 pandemic and have utilized adaptive learning programs in your classroom. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

What is the study about and why is it being done?

The purpose of the study is to discover the role of adaptive learning programs in closing the learning gaps in mathematics for secondary students in Georgia following the COVID-19 pandemic.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following:

1. Complete six 3-5 sentence responses to given journal prompts. The prompts will take you no more than 30 minutes to respond to digitally in writing.
2. Participate in a virtual video and audio-recorded interview that will take no more than 1 hour.
3. Participate in a virtual video and audio-recorded focus group that will take no more than 1 hour.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include the awareness of how the use adaptive learning programs impact mathematics for secondary students.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

I am a mandatory reporter. During this study, if I receive information about child abuse, child neglect, elder abuse, or intent to harm self or others, I will be required to report it to the appropriate authorities.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses will be kept confidential by replacing names with pseudonyms.
- Interviews will be conducted in a location where others will not easily overhear the conversation.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other members of the focus group may share what was discussed with persons outside of the group.
- Data will be stored on a password-locked computer. After five years, all electronic records will be deleted.
- Recordings will be stored on a password locked computer five years and then deleted. The researcher will have access to these recordings.

How will you be compensated for being part of the study?

Participants may be compensated for participating in the study. At the conclusion of the study, participants will be entered into a raffle to win one of five $20 gift cards.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Shameka Gray. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at phone number and/or email. You may also contact the researcher's faculty sponsor, Rachel Hernandez.

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the IRB.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record/video-record me as part of my participation in this study.

_____
Printed Subject Name

_____
Signature & Date

Appendix B

IRB Approval

Date: 6-21-2024

IRB #: IRB-FY23-24-974
Title: The Role of Adaptive Learning Programs in Secondary Mathematics
Creation Date: 12-5-2023
End Date:
Status: Approved
Principal Investigator: Shameka Gray
Review Board: Research Ethics Office
Sponsor:

Study History

Submission Type	Review Type	Decision
Initial	Limited	Exempt - Limited IRB

Key Study Contacts

Member	Rachel Hernandez	Role	Co-Principal Investigator
Member	Shameka Gray	Role	Principal Investigator
Member	Shameka Gray	Role	Primary Contact

Appendix C

Individual Interview Questions

Individual Interview Questions

1. Please describe your educational background and career through your current position (Opening Question/Build Rapport).
2. Describe your challenges when working with students in mathematics post-COVID-19. (Build Rapport)
3. What adaptive learning programs do you use in your mathematics classroom? CRQ
4. Describe how prepared you feel you are in understanding how to use adaptive learning programs in your classroom for math instruction/learning. CRQ, SQ3
5. Describe successful practices you use when working with the adaptive learning programs in mathematics with students in your classes. SQ1
6. What professional development experiences have you had that prepared you to work with adaptive learning programs in mathematics? CRQ, SQ3
7. What do you perceive are the benefits of using adaptive learning programs in your math classroom? SQ1
8. Describe how you perceive these adaptive learning programs impacting the increase in mathematic achievement and lessening learning gaps in mathematics. CRQ, SQ1, SQ2
9. Describe the challenges you have experiences as a teacher when working with adaptive learning programs in your mathematics classroom. SQ2
10. Describe challenges your students have encountered using adaptive learning programs in the mathematics classroom. SQ2
11. Describe how you assign/allot time for students to work on the adaptive learning

program. CRQ

12. What determines how often you allow the students to interact with the adaptive learning program? CRQ
13. When working with adaptive learning programs in math, describe the impact the programs have on your understanding of specific math content. SQ1, SQ3
14. Describe the process you use for measuring the progress of the use of the adaptive learning program. CQR, SQ1
15. What impact do you feel that adaptive learning programs have had on your confidence in teaching specific math skills in the classroom? SQ3
16. What additional information would you like to provide on the adaptive learning program or its use in your classroom? CRQ, SQ1, SQ2, SQ3

Appendix D

Focus Group Questions

Focus Group Questions

1. Introduce yourself and add any information you would like to share with the group.
2. Describe the challenges you face in teaching after the COVID-19 pandemic.
3. What specific challenges did you see your students experiencing after returning to the traditional classroom, personal and academic?
4. What preparation was offered to you by the administration when returning to the traditional classroom? SQ3
5. What adaptive learning tools are used in your mathematics classroom? CRQ
6. Describe how you perceive these tools helping or hindering students' achievement in mathematics. CRQ, SQ1, SQ2
7. Describe how the use of adaptive learning tools has impacted the way in which you understand mathematics content. SQ3
8. What are the benefits of using adaptive learning strategies and tools in the classroom? SQ1
9. What do you perceive are the most significant challenges of using adaptive learning tools in the classroom for students? For teacher? SQ2
10. What else would you like to share about adaptive learning tools used in the mathematics classroom? CRQ, SQ1, SQ2, SQ3

Appendix E

Journal Prompts

Describe a time when the use of adaptive learning programs in mathematics had a positive outcome. Describe a time when the use of adaptive learning programs in mathematics had a negative outcome. Describe additional elements that impact the use of adaptive learning programs in mathematics. Describe a typical day using adaptive learning in your classroom. What is the flow of the lesson, including whole group, small group, and more? How do you decide who works with the adaptive learning and when? What data do you pull from the adaptive learning tool and how do you use it? (Please attach the lesson plan when you return the journal prompts.)