A Mixed Methods Study of the Math Workshop Model of Instruction in Middle School

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Abstract

Proficiency in math continues to be a success indicator for students who graduate from high school. Research has shown that many students drop out of school, due to a lack of understanding in math foundations. State and national data show a deficiency in math understanding among elementary, middle, and high school students. Over the years, states have modified their math standards to be more aligned with the necessary content knowledge and skills that are needed to be mastered by students for each grade level.

The purpose of this study is to determine if the type of instructional approach used in math affects the success outcomes in math. The two instructional approaches examined in this study are the lecture model of instruction and the math workshop model of instruction. The math workshop model of instruction utilizes student motivation, differentiation, and engagement to meet students where they are and to help create a learning path that is conducive to understanding the foundations and applications of mathematical principles and skills. The data for this study was collected through pre- and post-assessment scores, survey data, and focus group data. The data combined will offer insight as to whether one type of instruction is more effective than the other regarding students' achievement in math.

The data suggests that the math workshop model of instruction is effective in teaching mathematics to middle school students. The overall performance of workshop students was significantly higher than lecture students across multiple assessments. Although the perceptions of students in both the workshop and lecture model students were similar among most of the survey domains investigated, workshop students did perceive their classrooms as being more controlled, or better managed, than the lecture students.

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Chapter I

INTRODUCTION

Educators have observed many middle school students scoring below the proficiency level in math. The 2016 Georgia Milestones math assessment results showed that 35.6% of sixth graders, 37.2% of seventh graders, and 36.9% of eighth graders scored at the proficiency level or above (Georgia Department of Education, 2016). The percentage of middle school students who are failing in math is concerning. The 2024 Georgia Milestones math assessment results showed a similar trend in middle school math deficits. The 2024 results showed that 35% of sixth graders, 38% of seventh graders and 44% of eighth graders scored at the proficiency level or above (Georgia Department of Education, 2024). Why are some middle school students successful in math and others not? This issue is resulting in many students leaving middle school without a firm mathematical foundation.

According to the National Center of Education Statistics (2023), 15% of students who enter ninth grade will never graduate high school. This dropout rate can be attributed to low scores in core academic areas, such as math and reading, and low attendance in school (McKee & Caldarella, 2016). Research studies show that dropout indicators can be identified and tracked as early as middle school (McKee & Caldarella, 2016). Identifying students who exhibit these behaviors in middle school and offering them academic intervention and support can help to decrease the dropout percentage of students entering ninth grade (Atwell et al., 2021).

Success in math can positively affect students' lives. Scoring high in math can result in students having better college choices and opportunities (McKee & Caldarella, 2016). Certain degree programs require that students have a strong math foundation, based on test scores, to

apply for admission (Atwell et al., 2021). Students need to have strong math proficiency to have a variety of options when choosing career paths (McKee & Caldarella, 2016). Some of these programs include Engineering and Accounting (Atwell et al., 2021). Many colleges require students without strong math foundational skills to enroll in and pass Math Remedial classes in college before they can progress within their chosen majors.

Math success is critical in determining outcomes for adult life (McKee & Caldarella, 2016). Math proficiency affects many essential elements of a person's life (McKee & Caldarella, 2016). For example, the skills of computation, solving, and budgeting are necessary for every adult to be able to pay bills, maintain a budget, shop for groceries, plan for expenses, etc. The inability to effectively execute these skills can negatively impact a person's quality of life (Atwell et al., 2021). A person struggling with these skills would have a difficult time sustaining an independent life. For adults to be able to function adequately daily with real-life situations, foundational math knowledge is needed (Atwell et al., 2021).

In a middle Georgia, fourth-grade classroom, a teacher created her own version of the math workshop model, modeled after the current reading workshop model in the school. The reading workshop used was the America's Choice model (Supovitz et al., 2002). The America's Choice School Design is a K–12 comprehensive school reform model designed by the National Center on Education and the Economy (Supovitz et al., 2002). The purpose of the design is to provide a standards-based curriculum that is rigorous and that also catches any learning deficits early, so the deficits can be remediated quickly. The goal of America's Choice School Design is to help all students reach a benchmarked standard of achievement in English language arts and mathematics by the time they graduate high school (Supovitz et al., 2002).

Students in the school were very successful year after year when using this model. Every year, students within the school scored 85% or higher on the Criterion-Referenced Competency Test. The teacher realized quickly that there was something special about the workshop model of instruction. She decided to test it out in math, since her students were struggling in this area. She modeled the same components of the America's Choice reading workshop model as she developed her own math workshop model. She taught the math workshop for one whole school year with fidelity. The results collected at the end were significant. She found that the same body of students, who had a pass rate of 41% on the math portion of the CRCT the previous year, had a pass rate of 73% at the end of their fourth-grade year. This meant that by using the math workshop model of instruction, students who entered fourth grade already below grade level, experienced a 32% gain in math achievement over the course of nine school months.

Problem Statement

This study aimed to investigate if the workshop model of instruction was effective in middle school math classrooms. This study was important in determining how students should be taught math in middle school. In doing so, it could help to build strong mathematical foundations within middle school students; therefore, increasing their chance of graduating, and inadvertently, decreasing dropout rates.

Purpose and Scope

The purpose of this study was to bring about a change in the teaching of math by testing an experimental instructional approach. Research shows that the workshop model of instruction is effective in reading classrooms. The design of this study investigated if the workshop model approach is also effective in middle grades math classrooms. The scope of this study included a

public middle school in the Southeastern United States. Another consideration, in regard to the scope, was the content areas of math that were addressed during data collection.

Research Questions

In order to fulfill the study's purpose, the following research questions guided the work in this study.

1. For students who participate in the math workshop model of instruction and students who participate in the lecture-style of instruction:
    a. How do student learning gains compare?
        i. To what degree, if any, do students in the math workshop classrooms perform better on the benchmark assessments than students in the lecture-style classrooms?
        ii. To what degree, if any, are the learning gains in the math workshop classrooms greater than the gains in the lecture-style classrooms?
    b. Is the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education)?
    c. How do student perceptions of teaching compare?
2. For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction:
    a. How do their pedagogical beliefs compare?
    b. How do their teaching practices and strategies (motivation, engagement, differentiation, assessment) compare?
    c. How do their self-perceptions about teaching (most effective to student learning, most challenging to implement) compare?

Research question 1 investigated whether the math workshop model of instruction influenced middle school students' performance on math benchmark exams and whether it was a more effective method than lecture-style, regarding achievement on the math benchmark exams. This research question also revealed if the learning gains in the math workshop classrooms were greater than the gains in the lecture-style classrooms. Furthermore, research question 1 aimed to discover if the effect of the instructional method (workshop vs. lecture) was influenced by classroom settings (special education, general education, gifted education). Finally, student perceptions of teaching were compared for both models of instruction.

Research question 2 compared the pedagogical beliefs of teachers who utilize the math workshop model of instruction and teachers who use the lecture model of instruction. The teaching strategies and practices of teachers from both models of instruction were compared. The teaching strategies and practices that were targeted for comparison were motivation, engagement, differentiation, and assessment. Finally, research question 2 compared the self-perceptions about teaching (most effective for student learning, most challenging to implement) for teachers from each model of instruction.

Theoretical Framework

The framework underlying this study consists of three components: motivation, differentiation, and engagement. The integration of these components enables students to experience math in engaging and comprehensive ways.

Motivation

When analyzing math instruction, researchers discuss several theories that work to enhance the achievement of students. For example, the theory of student motivation is an important factor to consider when analyzing how students learn. According to Park et al. (2016),

the motivational framework states that a teacher's instructional practices directly affect a student's motivation. For example, if a teacher focuses on performance instead of mastery, a student will be motivated to keep trying and not feel defeated if the taught skill is not mastered immediately (Park et al., 2016). The principles are manifested in the workshop, described later, and through these manifestations generate data used to answer the research questions.

Differentiation

Trinter, Brighton, and Moon (2013) discuss the framework of differentiation as an important factor in teaching mathematics. The five key elements that are the foundation of differentiated learning are high-quality curriculum with learning goals, ongoing assessment, respectful tasks, flexible grouping, and a learning environment that is focused on students' readiness and interests (Tomlinson & Moon, 2013). Morgan (2014) also concludes that differentiated instruction is required more now than ever with the American population expanding and with diversified populations on the rise. The above-mentioned principles, respectful tasks, and a learning environment focused on students' readiness and interests will be essential in answering the following research question: How does the math workshop model of instruction affect middle school students' perceptions of math? A high-quality curriculum with learning goals and ongoing assessment will provide a lens for whether and to what degree students' achievement on benchmark exams is affected by the math workshop model of instruction. The research questions focusing on teachers' perceptions may be influenced by how students perform on the ongoing assessments, as well as how students perceive the math workshop model.

Engagement

Another framework for implementing effective math instruction prevalent in literature is the concept of student engagement (Astin, 1985). For students to achieve academically, they must be actively engaged (Fredricks et al., 2004). Engagement increasingly declines as students' progress from elementary to middle school (Parsons et al., 2014). Because of this, educators need to understand engagement and how to facilitate it in middle school (Parsons et al., 2014). According to Reeve and Lee (2014), student engagement can lead to student motivation and higher levels of achievement. This is an important factor to consider when thinking about math instructional programs and their effectiveness.

The math workshop framework of instruction utilizes motivation, engagement, and differentiation through its instructional processes. What is the impact of these three frameworks working together within math instruction? In isolation, each of these frameworks has affected student achievement in mathematics. However, how does the combination of these frameworks affect middle school math instruction?

Math Workshop Model

The math workshop model is an inclusive model that allows many best practices to work at the same time (Heuser, 2002). Students are afforded the opportunity for group learning versus independent learning with the math workshop model of instruction. Through the math workshop model, students are able to have repeated experiences with math concepts and skills; teachers are provided time to work with students as individuals or small groups; and students are given the opportunity to take ownership of their learning (Heuser, 2002). Repetition of skills and concepts, differentiated instruction, formative assessment, guided practice, and independent practice are some of the best practices that are used during the math workshop model. These elements are

embedded in the theoretical framework of combining motivation, differentiation, and engagement to enhance student learning. Because the math workshop model encompasses these best practices strategies, which are differentiated for each student's needs, students are motivated and engaged when participating in this type of math instruction. Differentiated instruction was addressed above. Repetition and formative assessment are described below.

Repetition

Students are able to have repeated experiences with math concepts and skills within the math workshop model (Newton, 2015). Teachers introduce initial concepts, vocabulary, and skills in the form of a mini-lesson (Newton, 2015). Then, students work with the taught skills during a work period. Finally, students revisit the skill(s) again by rotating through stations involving the newly taught skill and previously taught skills for practice. Teachers will schedule which group of students participate in each station based on students' needs. Some students may participate in a review station, where they will practice a needed skill, while others may participate in a station where their learning is being extended. While station rotations are going on, students who need additional help meet with the teacher for a guided math session. During this session, students are retaught the skill that has been introduced.

Formative Assessment

Using formative assessment within the classroom is a best practice to use during all of the stages of the math workshop model. Formative assessments allow teachers to assess student learning during the instructional process (Moss & Brookhart, 2009). Teachers and students can assess student learning and can determine next steps in order to promote further learning (Cornelius, 2014). With the lecture model of instruction, formative assessments are not built into instruction naturally. The content is presented, and students either understand the content or they

do not. The math workshop model of instruction allows for formative assessments to be conducted during the lesson, and lesson adjustments can be made immediately to assist students with the learning process.

The math workshop model lends itself to many different opportunities for using formative assessment. Questioning students during guided math, observing students while they complete activities in their math stations, and providing students with "ticket out the door" questions are a few types of formative assessments that are used daily within the math workshop model (Moss & Brookhart, 2009). Providing formative assessments on an ongoing basis is a best practice that is helpful in providing the next steps for student learning. According to Moss and Brookhart (2009), formative assessment supports learning in two ways. Formative assessment supports learning by allowing teachers to adapt instruction based on evidence. Teachers can make changes and improvements that will benefit student learning immediately (Jacoby et al., 2014). The second way formative assessment benefits learning is by allowing students to use evidence from their current progress to make adjustments to their own learning (Jacoby et al., 2014). This allows students to self-assess and to take ownership of their own learning.

In the math workshop model of instruction, students are given a warm-up exercise to practice previously taught skills. After the warm-up, the teacher introduces the lesson for the day. The teacher models how to solve problems and gives the students problems to solve independently. Next, students transition into learning centers. Each center focuses on a skill or standard that students still need to master, as determined by previous assessment data. Each center has 4-5 students. The guided math center is one of the centers where students transition during class. In this center, the teacher reteaches content that the students have not yet mastered. They are given additional practice problems and the teacher checks for understanding. The

teacher documents the students' progress towards mastering needed standards in a guided math notebook. Each week the teacher gives an assessment at the end of the week to gauge students' progress toward mastering the standards that were practiced during the week.

Research Design

A mixed methods concurrent parallel design was used in this research (Creswell & Plano Clark, 2017). Both quantitative and qualitative data were collected. This aspect was crucial within this research project because of the time limits of the school year. The qualitative and quantitative data sets both play a role in answering the research questions presented in this study (Creswell & Plano Clark, 2017).

Participants

Participants of this study were recruited from a public middle school in middle Georgia. The school was selected as part of the study because of its geographical proximity to the researcher. Also, there are specific teachers at the school who have already been trained in how to implement the math workshop model of instruction. Workshop model teachers participated in a two-day training during the summer, prior to the beginning of the school year. One-hour professional development workshops were offered during the school year to refresh teachers on the training they received during the summer. These sessions occurred in August, September, October, and November.

Four classrooms using the workshop model and four classrooms using the traditional lecture model in each of sixth, seventh, and eighth grades, totaling 24 classrooms, were targeted for participant recruitment. Approximately 600 students, 200 per grade level, were included in the study.

Data Sources

Multiple sources of student and teacher data were used in this mixed methods study. Quantitative data included math benchmark assessments, pre- and post-unit assessment scores, as well as the student mathematics perception survey responses in the 4-point Likert scale. Qualitative data included open-ended questionnaire responses from the students and teacher interviews.

Data Collection

First, math benchmark assessment scores for the student participants were collected. This data was comprised of content that has been taught from August to December. Prior to starting the units of study on exploring real-life phenomena through one-step equations and equalities (sixth grade), making relevant connections with geometry (seventh grade), and real-life phenomena explored through systems of linear equations (eighth grade), a pre-unit assessment was given to all students in sixth, seventh, and eighth grades who received lecture-style and workshop models of math instruction and who were study participants. After the unit instruction, a post-unit assessment was given to all students included in the study. A student perception survey was created and administered to both the control and experimental groups. The survey included Likert scale items, as well as open-ended questions. Classroom observations and teacher interviews were also conducted in the study.

For the next phase of data collection, the survey results were analyzed. Student focus groups were developed from the survey data. The interview questions were derived from student survey responses and were used to answer in part the following qualitative research questions: How does the math workshop model of instruction affect middle school students' experiences in math? The focus group responses, classroom observations, and the survey results worked to answer the previously stated qualitative questions of the study.

In December, the benchmark assessment was given to the control and experimental groups. The results of the post-assessment answered the following quantitative question of the study: How do student learning gains compare with the workshop and lecture models of instruction? These results were recorded and analyzed. The interview questions for this phase of data collection focused on student perception of math instruction and learning.

Data Analysis

There were several stages of data analysis within this study. In January, unit pre-assessment scores were gathered and recorded on the Learning Gains spreadsheet (see Appendix A). After the unit pre-assessment was administered and the unit was taught for the duration of 5 weeks, a post-unit assessment was given. The post-unit assessment data was gathered and recorded on the Learning Gains spreadsheet (see Appendix A). Then, the pre- and post-unit data was analyzed, and the unit of change was calculated for each student from the pre- to post-assessment data. The data analysis shed light on whether there was a significant difference between the lecture-style or workshop model of math instruction and why that was the case.

Initially, *t*-tests were conducted to discover if there were significant differences between the math workshop model of instruction and the lecture model of instruction. This gave a preliminary answer to research question 1: How do student learning gains compare? Descriptive statistics were analyzed to discover the degree of difference that was evident, if any. A difference was evident, therefore, a multiple regression analysis was conducted to analyze subgroup data. The subgroup data consisted of classroom setting qualifiers (special education, general setting, and gifted education). The researcher analyzed if a particular method of instruction worked for a specific subgroup. After this analysis, student surveys were administered to gain

insight into student perceptions about math instruction and learning. The surveys aimed to answer research question 1c: How do student perceptions of teaching compare?

After collecting the pre- and post-assessment data, the student survey data, and the teacher interview data, a side-by-side comparison of the collected quantitative and qualitative data was conducted. These findings were displayed in a summary table. The summary table included a comments section where the quantitative data confirmed or disqualified the qualitative data or vice versa. Then, similarities and differences among the themes were identified. Through this process, the limitations of the study were identified.

Terms and Definitions

The following terms are defined to help the reader understand the context of each term in this study.

- **America's choice model:** A K–12 comprehensive school reform model designed by the National Center on Education and the Economy (Supovitz et al., 2002). The goal of this educational design is to help all students reach a benchmarked standard of achievement in English Language Arts and Mathematics by the time they graduate high school (Supovitz et al., 2002).
- **Benchmark exam:** Aligned to state or district standards for academic content and given three to five times during the year. These assessments are used to monitor students' learning and to make needed instructional adjustments to increase student achievement (Olson, 2005).
- **Differentiation:** Tailored instruction that is designed to meet individual needs of students (Morgan, 2014). The efforts of teachers to respond to the different needs of learners within the classroom (Trinter, Brighton, & Moon, 2013).

- **Economically disadvantaged:** Socio-economic status of students that acknowledges that they receive free or reduced lunch, based on parents' income (L. Nelson, personal communication, January 22, 2022).
- **Formative assessment:** Assessments that allow teachers to assess student learning during the instructional process (Moss & Brookhart, 2009). Formative assessments gauge student learning and can determine the next steps in order to promote further learning (Cornelius, 2014).
- **Math workshop model:** An inclusive, instructional model that allows many best practices to work at the same time (Heuser, 2002). Repetition of skills and concepts, differentiated instruction, formative assessment, guided practice and independent practice are some of the best practices that are used during this instructional model.

Chapter II

LITERATURE REVIEW

Math performance has been a topic of concern over the past decades (Desilver, 2017). Longitudinal student data has shown a weakness in the area of math foundational knowledge and skills at both state and national levels (Desilver, 2017). This literature review aims to delve into the math data that has been collected over the years and to discuss concerns related to that data. This review will also analyze current math instructional practices and how they are impacting student achievement. Overall student performance and specific subgroup data will be analyzed in this review, in order to show the relevance for analyzing current math instructional practices, the implications of current math practices and the need to investigate alternative practices that could prove to be beneficial.

The purpose of this review of literature is to present an overview of the literature that is available, related to the math workshop model and its effectiveness. This review presents background information that helps to explain the importance of strong instructional math practices in order to help students learn mathematical concepts and skills. The elements of the math workshop model and how they work together to help students learn math content are presented and explained in this review. The elements that influence this study are as follows: student motivation, differentiation, and student engagement. Each element will be explored as it relates to the math workshop model of instruction. When researching literature, peer-reviewed

journals were searched using the following terms: math workshop model, math stations, student engagement in math, student motivation with math tasks, and math differentiation.

Current State of Math in the United States

Math continues to be a topic of discussion and debate in the United States (Desilver, 2017). How do students learn math best? Does one type of math instruction work better than another? These are valid questions that continue to be asked and explored. Every 2 years, the National Assessment of Educational Progress (NAEP) is administered to fourth and eighth grade students across the nation. Every 4 years, an assessment is given to 12th grade students. The assessment measures mathematical knowledge and the ability to apply mathematical concepts to problem-solving situations. The assessment is designed to measure students' math knowledge and progress over time. The most recent NAEP assessment was given to fourth- and eighth grade students in 2022. Approximately 116,200 fourth graders and approximately 111,000 eighth graders were administered the latest assessment. The latest NAEP assessment that twelfth graders completed was in 2019 (Laird et al., 2007).

The data reported by the National Center for Education Statistics (2023) from the fourth grade NAEP showed that 36% of fourth-grade students scored proficient or higher on the assessment. The eighth grade NAEP data showed that 26% of students scored proficient or higher on the assessment. This data reflects a deficiency in math understanding as it relates to the nation's fourth and eighth grade student populations. The data from the 2019 administration of the 12th grade NAEP showed that 27% of students scored proficient or higher. Again, the data shows a reason for concern in the area of math knowledge as it relates to 12th grade students, as well (National Center for Education Statistics, 2023).

Georgia Math Data

As reported by the Georgia Department of Education (2023), the State of Georgia math data also shows a deficiency in the mathematical understanding of Georgia students. The Georgia Milestones Assessment System focuses on four core categories. These categories are operations and algebraic thinking, numbers and operations, measurement and data, and geometry. The assessment contains Level 1 Bloom's Taxonomy questions, which focus on remembering and recalling information. Approximately 25%–35% of questions involve recalling information. Level 2 Bloom's Taxonomy questions are also included, and these questions focus on understanding and utilizing specific math skills. Approximately 45%–55% of the test questions involve using specific math skills. Also included in the assessment are Level 3 Bloom's Taxonomy questions, which focus on applying math knowledge. Approximately 15%–25% of the test questions involve application of math skills (Georgia Department of Education, 2023).

According to the Georgia Department of Education (2023), the percentage of third-grade students in Georgia who scored proficient or higher on the Math Georgia Milestones Assessment in Spring 2022 was 43%, fourth-grade students scoring proficient or higher was 44%, fifth-grade students who scored proficient or higher was 37%. The elementary school data shows that there is a deficiency in mathematical foundations among elementary students in Georgia (Georgia Department of Education, 2023).

The middle school data for the State of Georgia also shows a deficiency in mathematical foundations. According to the Georgia Department of Education (2023), the percentage of sixth grade students in Georgia who scored proficient or higher on the Math Georgia Milestones Assessment in spring 2022 was 31%, 35% of Georgia's seventh graders scored proficient or higher, and 37% of Georgia's eighth graders scored proficient or higher. Georgia's high school

math data mirrors the concerns that the elementary and middle grades show with 28% of students scoring proficient or higher in coordinate algebra and 37% of students scoring proficient or higher in Algebra 1 (Georgia Department of Education, 2023).

The previous data points discussed are for all students taking the Georgia Milestones math state assessment. This encompasses students who fall in various categories: special education, gifted education, economically disadvantaged, African American, Caucasian, Hispanic, Indian, multiracial, etc. The math milestones assessment data associated with students who participate in the special education program across the State of Georgia is alarming. As reported by the Georgia Department of Education (2023), fourth grade students in the special education program scored at a 19% proficiency rate on the state math assessment and eighth graders who took the state math assessment scored at an 8% proficiency rate. In the high school setting, students who participated in the special education program scored at a 6% proficiency rate (Georgia Department of Education, 2023). The special education subgroup of students is considered a high-risk population of students. Many of these students are performing below grade level and are in need of strong math instructional practices to help them gain necessary foundation skills and to help them reach grade level proficiency. This data shows that this group of students is not getting what they need to be successful in math.

Both state and national assessment data show that students are not learning the math foundations that they need in order to be successful in math as they progress through school. States have realized the gaps in math learning, and some have initiated changes to the standards. The State of Georgia has revised the math standards twice over the last 10 years. New math standards were adopted by the Georgia Department of Education in 2015. The new standards were named the Georgia Standards of Excellence, and they mirrored the national Common Core

math standards. The most recent math standard changes were adopted by the state in August 2021 and will go into full implementation in August 2023 (Georgia Department of Education, 2023). These changes have been initiated in order to help identify the necessary foundational pieces that students need to be proficient in math. The standards have been revised to delve deeper into the learning of math concepts and the application of those math concepts, to ensure that students have a thorough and comprehensive understanding of math skills and concepts, and not only the knowledge of these, but also how to apply these skills and concepts in real-life situations. The revision of the math standards has been a process to change how math is being taught, but is it effective?

Traditional Math Instruction

According to Reuell (2019), traditionally, math has been taught predominantly in a lecture format. The teacher introduces a math skill, models how to solve a few problems, gives students a few problems to practice, checks over the work, clears up misconceptions, and moves on. This style of teaching can work for students who have a strong mathematical background and for students who learn quickly, but for others it is not as effective. For example, if a student is a hands-on learner, but isn't given the opportunity to practice with manipulatives, they may never fully understand the math concept being taught. Also, students who are in the remedial or special education programs need additional support within instruction in order to truly master content. A simple lecture will not be enough to help them learn the content. They need to experience hands-on learning opportunities that allow the use of visual aids, manipulatives, real-world connections, etc. (Reuell, 2019).

The lecture model of instruction does not take into consideration the various needs of learners. A lecture approach to instruction is designed to stay the same, no matter the population

of students (Westman, 2021). The only time it changes is if the standards or learning objectives themselves change. The lecture model does not take into account the learning needs of specific students. It is a one-size-fits-all approach and does not lend itself to differentiation (Westman, 2021). Research shows that differentiation is required for optimal learning results (Morgan, 2014). Each classroom has a variety of students present. Some are quick learners, some require more time, some students have special needs, some students are gifted. With all of these differences being prevalent in one classroom, it is unrealistic to believe that students with very different needs will all learn the same exact way (Westman, 2021). It is impossible to meet the needs of all students with a one-size-fits-all approach to learning. One size does not fit all. Students are individuals and they have different strengths and weaknesses. The process of differentiation allows for each student to receive the strategies, tools and resources that are necessary for them to master the content (Westman, 2021). According to Westman (2021), differentiation is a clear focus on students' academic and social-emotional needs. When teachers are focused on the needs of students, any action that is taken to meet those needs is differentiation (Westman, 2021). It is impossible to meet every student's needs without providing differentiated learning opportunities (Morgan, 2014).

According to Bajak (2014), teaching practices that turn students into active participants versus passive listeners are more effective and it boosts scores on exams by one-half a standard deviation. Research has also shown that when teachers shift their position to be more of a guide, students are able to develop the confidence to learn reasoning and to also prove how they came up with their solutions (Baytops-Paul, 2022). Being able to explain the solution pathway is a key expectation that is promoted by the National Council of Teachers of Mathematics (Baytops-Paul, 2022). Strategies that help a teacher release learning responsibility and shift from passive to

acting learning are dimming the teacher's light, standing back and facilitating discourse among students (Baytops-Paul, 2022).

Baytops-Paul (2022) poses that strategy of dimming the teacher's light, which refers to taking the focus off of the teacher and placing it on the students. Instead of the teacher telling the students everything they need to know and telling them what to think about the content, the teacher allows students to explore tasks that are centered around the math concept. Instead of lecturing on a math topic, the teacher assigns a task and allows students to experiment with it. The talking of the teacher is limited, and opportunities are created for the students to speak, think, debate, question, and justify. This allows students to make meaning of their own learning and to gain a deeper understanding of the math content (Baytops-Paul, 2022).

Baytops-Paul (2022) continues with the standing back strategy, which is also used to shift the focus of instruction from the teacher to the student. This strategy has physical and literal implications. Allowing students to offer solutions and justify those solutions without teacher intervention can foster effective learning outcomes. Allowing students to justify claims and reasoning for those claims gives them the opportunity to experience a deeper depth of knowledge within the learning task. The teacher stands back and positions herself out of the sightline of students when using this strategy. This fosters discourse among the students, and they are able to think critically and share their thoughts with others (Baytops-Paul, 2022).

Lastly, Baytops-Paull (2022) write about the strategy of facilitating discourse, which involves shifting the energy that was previously devoted to lecturing and funneling that energy into the facilitation of learning, specifically in the form of asking questions, providing encouraging words and giving clarifying statements, as needed. Teachers and students have to get comfortable with productive struggle in order for this strategy to work. Teachers have to give

students time to tackle the task and have productive struggle before swooping in to save the day. The teacher should facilitate and support but should allow the students to draw conclusions and develop solutions. The shift from teacher to facilitator can be challenging, but it has positive learning outcomes. Recognizing that student voice is necessary for true learning and understanding to develop is the basis for the facilitating discourse strategy (Baytops-Paul, 2022).

Math Workshop Model

Research shows that there are best practices that can help to foster learning opportunities that allow students to have control over their own learning, to justify their reasoning and to allow for the facilitation of discourse about the content (Morgan, 2014). These learning opportunities can be provided through a math workshop model of instruction. Within the workshop model of instruction, best practices are utilized together to create a learning environment that fosters critical thinking and that allows students opportunities to learn the content through meaningful ways that cater to their individual needs. The key elements that work together to make the math workshop model of instruction successful are motivation, differentiated instruction, and engagement.

Student Motivation

The motivation of students is an important element in regard to student learning (Deci & Ryan, 2008). Motivation refers to a student's drive or intrinsic will to learn (Steinmayr et al., 2019). Motivation has also been referred to as a student's willingness to learn the material that is presented to them (Williams & Williams, 2011). Motivation deeply affects a student's ability to learn content (Steinmayr et al., 2019). If students are interested and motivated to learn about a specific topic, they will be more inclined to focus, practice, and use trial and error to work through problems (Deci & Ryan, 2008). Researchers have been studying student motivation in

education for years. They have found that several different factors can inspire student motivation (Williams & Williams, 2011). For example, relevance for learning is enough to inspire many students to learn new material (Williams & Williams, 2011). When students understand the why behind the learning, they are often motivated to learn the content. Self-efficacy is another factor that helps motivate students to learn (Steinmayr et al., 2019). When students believe that they can learn and experience success, they are more inclined to achieve success (Deci & Ryan, 2008). Goal setting and reflection also help students succeed (Williams & Williams, 2011). When students take ownership of their own learning and are responsible for setting goals and tracking their progress, then they are more likely to learn and reach their maximum potential.

Relevance for Learning

How many times has a student asked, "Why do we have to learn this?" or "When will I ever have to use trigonometry in real life?" Relevance is a key factor in student motivation (Williams & Williams, 2011). Students desire to know the why behind the learning. Understanding why learning is necessary helps students to understand the need for learning the information. Connecting learning to real-life situations helps students to understand that the content is relevant to their lives, and it also emphasizes the importance of learning it (Williams & Williams, 2011). When learning math content, students need to understand why it is important to learn it. They need to be provided relevance for the content by learning about situations in which they need to rely on the math concepts they are learning. The math workshop model allows for relevance to be taught daily. Students are provided multiple opportunities to discuss the relevance of math during guided math instruction, station work, and small-group stations.

Self-Efficacy

Self-efficacy is a major element to consider when reviewing student motivation. Self-efficacy is a person's view that they are capable of succeeding in whatever task they set out to achieve (Mathewson, 2019). Believing that one can and will succeed is a major indicator of future success. When students believe that they can learn math, then those students will possess the necessary confidence to take risks in their learning. This experience will allow them opportunities to learn, make mistakes, clear up mistakes, and learn at a deeper level. Possessing the confidence to try, even at the risk of failure, is an indicator of flexibility and durability, which will allow students to learn and master math concepts. When students do not believe they can learn math, they lack confidence to try. Lacking the confidence to try directly affects one's motivation level (Steinmayr et al., 2019). When a student lacks confidence, they often also lack motivation. If a person is confident with a certain skill, they are more likely to experiment and take risks within that skill. Which, in turn, allows them to connect even more deeply with the content and allows them to have a deeper understanding of that content (Mathewson, 2019). However, when a person lacks confidence within a topic or skill, they are less likely to experiment with it, which causes their learning within that content to be stagnant. A skilled bicycle rider would be more likely to take risks and try stunts on their bicycle. However, an unskilled bicycle rider may lack the confidence to even ride the bicycle in front of others.

Self-efficacy is an important factor within motivation (Mathewson, 2019). Students need to experience success in order to gain the confidence to take risks in learning (Mathewson, 2019). The math workshop model allows students to participate in a safe environment where risks can be taken with teacher support and scaffolding. Within the workshop model, all students are working to improve. There are no experts. Everyone has an area that they are trying to get

better at. Students who are experts with equations may be novices in relation to measurement. Everyone has their individual path to travel.

Goal Setting and Reflection

Goal setting and reflection are important factors to consider in regard to student motivation (Stainmayr et al., 2019). When students set goals for themselves, they are taking ownership of their learning (Carrabba & Farmer, 2018). They are determining what goals are necessary for their success. When students are given the power to select their own goals, they are given a sense of purpose, which will help to motivate them to learn the content. Often, students do not see the purpose of why they are learning specific content in math. They learn it because the teacher is telling them it is important for them to know, or they are not learning it because they do not understand the importance. When students are given the opportunity to set goals for themselves, they become the force in charge of their learning. During reflection, students are able to think about why they did or did not do well on a specific assignment or task. They are able to deeply think about what they still need to learn or what else they need to do to master the content. This process enables students to take ownership of their own learning outcomes and to develop learning more deeply. By setting goals and reflecting, students are practicing with higher order thinking skills, such as analyzing and critiquing (Carrabba & Farmer, 2018).

Differentiation

The way teachers instruct students has come a long way over the past few decades. Education has shifted from a one-size-fits-all lecture-based model to a more hands-on, individualized model (Morgan, 2014). This paradigm shift occurred because of the vast number of differences that can be observed in a group of learners (Morgan, 2014). Some students learn better with visual supports, some learn better with auditory techniques, others are better with

grasping concepts by means of hands-on experiments and kinesthetic experiences (Trinter et al., 2013). Within a class, there can be different ranges of performance. Some students may be on grade level, others may be below grade level, and still others may be above. It is impossible in today's time to give every student what they need by simply teaching grade level material. Teachers have to be skilled in being able to identify students' strengths and weaknesses, and by being able to individualize the learning experiences, in order to give all students what they need to be successful. This is where differentiation of instruction comes into play. The definition of differentiation is to tailor instruction to meet the individual needs of students (Morgan, 2014). Differentiation takes the one-size-fits-all concept and shapes and alters instruction to fit the needs of each learner in the class. Differentiation can be defined as the efforts of teachers to respond to the different needs of learners within the classroom (Trinter et al., 2013). Whenever the teacher responds to an individual student or small group of students to vary the teaching strategies to create the best learning experience possible, then the teacher is differentiating instruction. Differentiation can occur in four major areas within the classroom: content, process, product, and learning environment.

Content

The information students need to learn and the way they access that information can be differentiated within the classroom (Reis & Renzulli, 2015). For example, in a middle school science class, the content could be the water cycle and students may be given the task to read about the water cycle and answer questions about it. However, the reading passages on the water cycle may be leveled differently. Each student would be reading a passage about the water cycle, but each student's passage would be on a different reading level. One passage may be on grade level, another may be below grade level, and another may be above grade level. All of the

students will be reading about the water cycle, but the way they access the information, or the specific leveled passage, they use to learn the information may be different. Another example of differentiated content is the teacher meeting with a small group to reteach a previously taught skill (Reis & Renzulli, 2015). Other students who have already mastered the skill will not need the small-group instruction, but students who do need the content to be retaught can benefit from this type of differentiation of content.

Process

According to Reis and Renzulli (2015), differentiation of process can be defined as tasks or activities in which the student engages to master the content. These can differ based on the learning modality in which the student learns best. For example, for a math task, some students who are kinesthetic learners may be provided manipulatives to help them learn the math content they are working on, while other students may not need that extra support. Tiered activities where different students are provided with different levels of support and resources, based on their individual needs, can also be an example of differentiation of process. When the process is differentiated, each student will receive instruction by the method that is most suited for their needs and learning styles (Reis & Renzulli, 2015).

Product

Reis and Renzulli (2015) also define product differentiation as the culminating activities that a student participates in to show that they have successfully mastered the content culminating activities can be rehearsing what was learned, applying what was learned to a real-life scenario, extending what was learned, etc. Students have different strengths and weaknesses. Some students may be more skilled with showing what they have learned by visual means, while other students may be more creatively inclined and may be better at creating a design of what

they learned. Differentiating the product allows students to have different choices of how they will represent what they have learned (Reis & Renzulli, 2015).

Learning Environment

The learning environment of a classroom is the way it looks and feels. Seating arrangements, how students access materials, and learning centers are examples of are part of the learning environment (Morgan, 2014). These elements can be differentiated within a classroom. The variations in the learning environment are based on the needs of the students within that classroom. For example, in an elementary reading classroom, students will be expected to spend time reading throughout the day. One learning environment variation that would be helpful in this classroom is a reading nook or a quiet area where students can access books and read quietly. Another variation to the learning environment could be a teacher developing routines for students to get help when the teacher is helping other students, and setting a culture where students understand that some learners need to get up and move when learning, while others are able to learn while sitting.

Differentiation in the Math Workshop Model

A major incentive of the math workshop model is that it allows for differentiation within the content, process, product and learning environment (Heuser, 2002). Differentiation has proven to be a very effective best practice. Research has shown that differentiated instruction leads to academic success among students (Morgan, 2014). The math workshop model allows for all of the elements of differentiation to work together in order to provide an optimal learning experience for every student (Heuser, 2002).

Content

There are several different ways to differentiate content within the math workshop model of instruction. One way is for the teacher to provide small-group instruction on a specific topic (Heuser, 2002). This strategy is effective for remediating students who have not mastered a skill by reteaching the skill within the small group, and it is also effective for extending the learning of students who have already mastered the content, by using the small-group instructional strategy to dig deeper into the concept. Guided math is a portion of the math workshop model that is dedicated for small-group instruction (Heuser, 2002). During the guided math segment of learning, small groups of students can participate in remediation or extension of concepts, based on the group's needs.

Process

Process refers to the activities students engage in to make meaning of the content they are learning (Morgan, 2014). During the math workshop model of instruction, students are given opportunities to work in different learning stations (Heuser, 2002). Some of the stations include activities that are reinforcing the lesson for the day, while other stations are reviewing previously taught material or offering remedial opportunities for students to master standards that were previously taught. The use of tiered activities is another strategy that is used to differentiate the process during the math workshop model. Activities can be tiered, based on the learner's current level (Heuser, 2002). Commonly, there are three tiers associated with this strategy: above grade level, on grade level, and below grade level. Each tiered activity is geared to give students the opportunity to practice the specific skill they need to master at that particular time during instruction. Offering manipulative and hands-on support is another way to differentiate the process (Reis & Renzulli, 2015). Specific students will need this hands-on support in order to

master the content. Task checklists and checkpoints are other supports that can be used to make sure the process is modified for students who need the extra support. These time management supports help to keep students engaged and on task during the learning process.

Product

Students will have the opportunity to show their learning in various ways while participating in the math workshop model of instruction (Heuser, 2002). Students having the choice to produce their product of choice is an example of differentiation of product (Reis & Renzulli, 2015). Some students may choose to draw a picture to explain their learning, while others may choose to create a song describing the steps used to solve a problem. The choice of working alone or in groups is another way that product is differentiated for students (Morgan, 2014). The use of rubrics also allows for product differentiation (Reis & Renzulli, 2015). Students are expected to work at their own pace and to complete tasks, based on rubric indicators for mastery.

Learning Environment

Within the math workshop model of instruction, the learning environment is differentiated by design (Reis & Renzulli, 2015). Routines are established. Students know the expectations for each station, and they know the procedures for accessing materials and for getting the teacher's attention if they need assistance. This enables students to take care of their own needs when the teacher is busy assisting other students. The workshop model allows for spaces in the classroom environment for students to work independently and in groups (Heuser, 2002). This differentiation method allows for the classroom to serve different purposes, based on the learning goals of the day. Some lessons will require independent study, while other days will call for collaboration among peers.

Student Engagement

As written by Reeve and Lee (2014), student engagement is essential to foster motivation for learning among students. There are several elements that work together to keep students engaged during the learning process (Astin, 1985). Learning relevance, interest and learning goals are some of the key strategies used to keep students engaged with learning (Reeve & Lee, 2014).

Learning Relevance

Students need to know why they are learning specific content if they are going to be engaged and remain engaged while they are learning. Providing relevance for learning helps students to understand the importance of learning the content (Mathewson, 2019). When students understand why they are learning something and how the learning will be applied in the future, they are more likely to learn it and retain it.

Interest

Learning has to be interesting in order for students to be motivated to learn. If the learning experience is boring and uneventful, students will be less focused (Carrabba & Farmer, 2018). Their ability to stay on task and to persevere through the learning tasks will diminish. If they are enjoying the learning process, students will be more likely to stay on task and to keep progressing until the learning targets are met.

Taking students' interests into account and connecting the learning to topics of their interest is another strategy that can be used to engage students in the learning process (Harvey et al., 2016). During the math workshop model, students can participate in stations where the math content is centered around sports, video games, etc. This will assist in motivating and engaging

students to learn. Students will be more engaged and focused when the content is presented in an interesting format that they enjoy (Liu & Chiang, 2019).

Learning Goals

Learning goals are effective in providing students content in small, manageable chunks that they can tackle at their own pace (Steinmayr et al., 2019). When students are given the opportunity to make their own goals, they will have ownership in the learning process (Carrabba & Farmer, 2018). They will be more apt to reach the goals they have set for themselves. When students break the learning up into smaller chunks and have goals attached, it allows them to exhibit self-efficacy in achieving their goals. They are able to self-monitor and adjust, as needed.

Middle School Math Instruction

Historically, middle school math has been taught much like high school math, through lecturing or direct instruction (Barkley & Major, 2018). The lecture model consists of skill introduction, modeling of the skill, practicing the skill while being guided by the teacher, and independently practicing the skill (Barkley & Major, 2018). According to Parker (2010), "If you want students to learn a fairly large body of knowledge and develop a framework for further investigation, lecturing accomplishes these goals better than most other pedagogical tools" (p. 9). The lecturing instructional strategy provides students with necessary information presented by the instructor (Meyer & Hunt, 2017). Students are able to learn and be given immediate examples, in order to clear up any misconceptions (Meyer & Hunt, 2017). Although many different pedagogical approaches have developed over the years in education, lecturing continues to be the preferred method of instruction for many teachers (Meguid & Collins, 2017). According to Meguid and Collins (2017), the lecturing instructional approach allows the instructor to present and synthesize information, engage students through storytelling, provide

context for the learning, model the content being taught and clarify any confusing principles or ideas. When implemented effectively, lecture model math classrooms can be very beneficial for students (Barkley & Major, 2018). In a lecture classroom, information can be shared from multiple sources, not just a textbook (Barkley & Major, 2018). Also, information can be presented that would be otherwise unavailable to students, such as sharing an experience or story to emphasize a point (Barkley & Major, 2018). This practice provides relevance for the learning. This is especially important in the math domain, where it can sometimes be difficult to connect skills and strategies to real-life applications (Meguid & Collins, 2017). The lecture model in math classrooms also provides an opportunity for the teacher to help students realize similarities and differences and to clarify confusing principles or concepts (Meyer & Hunt, 2017).

Lecture teaching in math classrooms efficiently delivers foundational concepts (Parker, 2010). It also allows for complex ideas to be clearly explained through visual aids (Meyer & Hunt, 2017). Using visual aids, such as graphs, diagrams, and examples can help students visualize abstract mathematical concepts (Rahman & Masuwai, 2014).

According to Barkley and Major (2018), a typical day of middle school math instruction in a lecture model classroom begins with the teacher introducing a math skill and then modeling several practice problems for the students. Next, there is practice time for students to practice the skill that was just taught, where the teacher also checks for students' understanding. Finally, the lesson involves the students practicing the skill independently (Barkley & Major, 2018). In lecture model classrooms, teachers are moving along with the pacing guide (Meyer & Hunt, 2017). Remediation is not built into the lesson. Any clarifying misconceptions or reteaching is done on the spot as the teacher checks for understanding (Meyer & Hunt, 2017).

Before the Common Core State Standards for Mathematics were implemented in July 2010, rote memorization was an integral part of the Georgia Performance Math Standards (Carmichael et al., 2010). The standards focused on teaching students math facts, formulas and procedures to solve problems (Carmichael et al., 2010). Drill and skill was the focus of these standards. Teachers would lecture about the math content and allow time for repeated practice, but the explanations behind the mathematical practice were seldom a focus (Rahman & Masuwai, 2014). Lecture teachers rely heavy on textbook-based instruction with an emphasis on drills and practice problems to achieve fluency (Meyer & Hunt, 2017).

There are several key aspects that are involved in the lecture model of instruction. Memorizing facts and following procedures are two aspects that are reflective of the lecture model of instruction (Gooblar, 2019). Teacher-centered instruction is also a key factor (Letrud & Hernes, 2018). Standardized practice is also an important piece within this model of instruction (Letrud & Hernes, 2018).

Memorizing Facts

With the lecture model of instruction, students are expected to memorize their multiplication tables (Hoque, 2018). They are also expected to memorize basic geometric formulas and other important mathematical concepts (Hoque, 2018). Much instructional time is spent on the rules and memorization of mathematical concepts, but not necessarily the why behind those mathematical concepts (Hoque, 2018).

Following Procedures

The lecture model approach in teaching focuses on the teacher presenting a set of procedures for each mathematical principle (Meyer & Hunt, 2017). A set of steps or algorithms are presented to assist students with solving problems. Teaching emphasis is placed on

memorizing the steps and algorithms in order to master the mathematical skill (Hoque, 2018). During this type of instruction, generally one or two problem-solving strategies are taught; alternative strategies and critical thinking tasks are not the primary focus (Meyer & Hunt, 2017).

Teacher-Centered Instruction

In classrooms where lecturing is the primary instructional strategy, instruction is delivered primarily through the teacher (Barkley & Major, 2018). The teacher does not act as a facilitator, but rather provides direct instruction to help the students understand the material that is being presented (Barkley & Major, 2018). After presenting the information, the teacher spends time modeling how to solve problems (Barkley & Major, 2018). The students are expected to replicate the steps that are taught by the teacher. Through repeated practice, students are expected to master the skill that has been taught (Barkley & Major, 2018). The teacher checks the students' practice problems for understanding and clears up any misconceptions during the practice portion of the lesson.

Standardized Practice

Barkley and Major (2018) maintain that standardized practice is another key component of the lecture model of instruction. This type of practice is a standard component of lecture classrooms. Students are expected to participate in repeated practice with solving problems until the taught skill is mastered. Often, the practice problems are completed from textbooks or worksheets to reinforce learned concepts (Barkley & Major, 2018).

Lecture Model Issues

Although there are many advantages to the lecture model of teaching, research also outlines some disadvantages (Cerbin, 2018). Among the advantages of the lecture model of instruction are structured content delivery, efficient use of time, expert insight, and clarification

of concepts (Cerbin, 2018). However, the disadvantages of lecture pedagogy include limited student engagement, the inability to differentiate for diverse learning styles, limited math discourse and difficulty with assessing students' understanding (DiCarlo et al., 2021).

Limited Student Engagement

One of the issues found with the lecture model of instruction is limited student engagement (Delialioglu, 2012). Lecture teaching is teacher-centered. The learning predominantly comes from the teacher who is delivering information to the students (Delialioglu, 2012). The lecture model can lead to passive teaching. When students are not actively engaged in the learning process, it can lead to them not retaining information correctly (Delialioglu, 2012). Some researchers argue that students learn math better in learning situations where they work collaboratively and explore the math content independently, with the teacher acting as the facilitator, not the sole source of information (Arghode et al., 2017).

Diverse Learning Styles

Another concern regarding the lecture model that is found in research is the inability for the lecturer to attend to the varying learning styles within the classroom (Arghode et al., 2017). Middle school students, as well as all students, have varied learning preferences and varied learning styles, methods for how they learn best. Lecture methods heavily rely on the auditory style of learning (Arghode et al., 2017). Some students may learn better through visual or kinesthetic modalities. Therefore, auditory learners could possibly have an advantage over different types of learners in lecture-style classrooms.

Limited Math Discourse

Math discourse refers to the ways that students communicate about mathematical ideas, processes, and concepts (Hattie et al., 2017). It encompasses the discussions that occur between

students and students and the teacher (Hattie et al., 2017). According to Hattie et al. (2017), "Meaningful discourse includes students comparing and contrasting ideas and methods, constructing viable arguments, critiquing each other's reasoning, and helping each other make sense of mathematics" (p. 146). Math discourse is centered around several key components. One component is collaboration (Gresham & Shannon, 2017). Students work together to solve problems, explain their thinking and deepen understanding (Gresham & Shannon, 2017). Another key component of math discourse is explanation and justification (Gresham & Shannon, 2017). Students are expected to explain their reasoning behind math concepts and to justify their thoughts. They also are expected to articulate what they are thinking. This practice helps to deepen their understanding of mathematical concepts (Gresham & Shannon, 2017). Through math discourse, students are able to practice mathematical language (Hattie et al., 2017). They are able to use specific vocabulary and symbols that are associated with the math content (Hattie et al., 2017). Immediate feedback is another key component that is delivered through math discourse (Gresham & Shannon, 2017). Students are actively engaged and discussing the math content amongst themselves and with the teacher (Gresham & Shannon, 2017). Math discourse is not embedded in the lecture model of instruction. Limited math discussion may exist between the teacher and the students, but the lecture model is not set up to foster a collaborative discourse environment (Sharp et al., 2019). Many researchers criticize the lack of this component within the lecture model of instruction (Gooblar, 2019).

Assessing Understanding

Another limitation that is evident in the lecture model of instruction is assessing students' understanding (Gooblar, 2019). The primary way that teachers assess understanding during lectures is through questioning (Parker, 2010). It can be difficult to assess every student's

understanding because some students may not feel comfortable asking or answering questions in front of the class. Quizzes, tests and graded assignments are common ways that lecture teachers assess students' understanding, but these assessment techniques are more formal, in nature (Parker, 2010). Not having informal assessments throughout the lesson to gauge understanding and to quickly clear up misconceptions could pose an issue for students participating in lecture classrooms (Gooblar, 2019). Lecture teachers do routinely check for understanding individually, but time does not always allow for every student's work to be checked, and it could be hard to check for common misconceptions when the checks for understanding are predominantly through observations.

Changes in Middle School Math Instruction

Many changes with instructional math practices came with the shift to Common Core math standards in July of 2010 (McDuffie et al., 2017). The Common Core math instructional standards shifted from predominantly memorization of skills, facts, algorithms and formulas and being able to manipulate numbers to solve math problems to a deeper dive of actually applying the skills, facts, algorithms and formulas that are learned (McDuffie et al., 2017). With the new standards, students were not only expected to be able to solve problems, they were required to apply learned skills within the context of word problems and real-life scenarios (McDuffie et al., 2017). They also were required to be able to identify mistakes in problems and to be able to correct those mistakes in order to correctly solve the problem (Davis et al., 2017). The Common Core math standards required students to use higher order thinking skills to achieve mastery, not just rote memorization (McDuffie et al., 2017). Because of the vast changes within the math standards, math teachers were tasked with changing their instructional approaches in order to meet the needs of all of their students (Davis et al., 2017). Teachers had to ensure that students

not only knew how to solve the math problems, but they had to make sure that students understood the why behind the math. Teachers had to instruct in a method that would teach students how to apply the learned math skills to real-life situations (Davis et al., 2017). According to Akkus (2016), the Common Core math standards aimed to create a consistent set of K–12 math learning objectives across participating states in the United States, focusing on deeper conceptual understanding and problem-solving skills, rather than rote memorization, emphasizing critical thinking and application of mathematical concepts to real-world situations.

With the standard changes, middle school math teachers had to change their method of instruction (Akkus, 2016). This is when hybrid lecture approaches began (Meguid & Collins, 2017). Lecture teachers started adding additional instructional approaches to their lessons to enhance student learning outcomes (Meguid & Collins, 2017). Since the new standards required students to apply their learning and connect to real-life situations, teachers had to plan lessons that allowed to apply content and critical thinking skills (McDuffie et al., 2017).

Some of the common pedagogical additions to the lecture method of instruction include collaborative discussion or math discourse, technology integration through game-based learning, project-based learning and informal assessment opportunities (DiCarlo et al., 2021). Adding additional pedagogical techniques to lectures is referred to as interactive lecturing (Delialioglu, 2012). Interactive lecturing is a teaching method where the teacher incorporates active student participation within a traditional lecture format (Delialioglu, 2012). According to White (2011):

> Interactive lectures are classes in which the instructor incorporates engagement triggers and breaks the lecture at least once per class to have students participate in an activity that lets them work directly with the material. The engagement triggers capture and

> maintain student attention and allow students to apply what they have learned or give them a context for upcoming lecture material. (p. 236)

Engagement triggers are learning tasks that spark student engagement (White, 2011). Some examples are think-pair-share activities, question of the day, quick write tasks, collaborative discussions, etc. White (2011) maintains that this type of instruction allows students to directly engage with the content through activities, such as questioning, collaborative discussions, and group work. Through this instructional model, interactive elements are sprinkled throughout the lecture, to break the whole-group instruction up and to encourage student engagement. With interactive lecturing, students are not just listening to the teacher passively, they are actively participating by answering questions, discussing ideas, and completing small tasks throughout the lecture. The lecture is segmented and planned engagement activities are included to foster student engagement and to motivate the students to learn the content. Additionally, interactive lecturing allows for frequent checks for students' understanding through planned informal assessments (White, 2011).

Interactive lecturing has advantages and benefits that traditional lecturing does not. For example, interactive lecturing fosters student engagement, while traditional lecturing is more passive in nature for the learner (Cerbin, 2018). Interactive lecturing also encourages student participation (Cerbin, 2018). This helps to create a more active learning environment. Through interactive lectures, students are able to deepen their understanding of math content and to retain the math content through collaborative discussions and group work (Gresham & Shannon, 2017). Critical discussions are evident within interactive lecture classrooms and there are opportunities for critical thinking tasks through group collaboration and math discourse opportunities (Gresham & Shannon, 2017).

Student engagement is a key factor associated with interactive lecturing (Cerbin, 2018). There are several strategies the teacher can use to foster engagement (Capraro et al., 2015). Questioning is one strategy that effectively engages students and makes the instructional experience interactive. When students are consistently asked questions throughout a lesson, the students are more likely to pay attention and participate. The teacher is also able to determine students' understanding of the lesson through questioning techniques. If the teacher asks a question and the students' responses show that there is a learning misconception, the teacher can adjust the lesson immediately to clear up the misconception and reteach the skill, if necessary. Students are more likely to retain information when they are actively engaged and participating in the lesson (Capraro et al., 2015).

Gresham and Shannon (2017) maintain that collaborative discussion and group work are also effective strategies for enhancing student engagement and participation. They pose that through collaborative discussions, students are able to participate in math discourse and can explain their thinking and reasoning. Additionally, students can learn from one another during math discourse, and prove and disprove math assumptions. These tasks require critical thinking and higher order thinking skills, and therefore, students are able to deepen their understanding of math content through collaborative discussions (Gresham & Shannon, 2017). In addition, when students are tasked with completing a math project together, they are given the opportunity to deepen their understanding by applying the concepts they have learned (Gresham & Shannon, 2017). When the group projects require students to think critically and apply math to real-world situations, the students are able to stretch their thinking and broaden their mathematical understanding. Applying what has been learned through creating a project is a higher order

learning task and it is beneficial for students to take part in tasks that encourage them to ask questions and to think critically to solve and create (Gresham & Shannon, 2017).

In conclusion, middle school math instruction has changed drastically over the last 20 years (McDuffie et al., 2017). Historically, middle school math teachers have taught predominantly using the lecture model of instruction by introducing the math skill, modeling the skill and allowing time for students to practice the skill (Barkley & Major, 2018). With the implementation of the Common Core State Standards for Mathematics in July 2010, math instructional standards evolved to include more analysis and application expectations (McDuffie et al., 2017). With the standards shift, math teachers had to modify their modes of instruction and evolve their lecture styles of teaching to include strategies to promote student engagement and to foster critical math thinking (McDuffie et al., 2017). These changes paved the way for the new and improved lecture-style, interactive lecturing (Cerbin, 2018).

Chapter III

METHODOLOGY

The purpose of this study was to bring about a change in the teaching of math by testing an experimental instructional approach. Research shows that the workshop model of instruction is effective in reading classrooms. The design of this study investigated whether the workshop model approach was also effective in middle grades math classrooms.

The following research questions were used to investigate if the math workshop model of instruction is effective for middle school students.

1. For students who participate in the math workshop model of instruction and students who participate in the lecture-style of instruction:
    a. How do student learning gains compare?
        i. To what degree, if any, do students in the math workshop classrooms perform better on the benchmark assessments than students in the lecture-style classrooms?
        ii. To what degree, if any, are the learning gains in the math workshop classrooms greater than the gains in the lecture-style classrooms?
    b. Is the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education)?
    c. How do student perceptions of teaching compare?
2. For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction:

a. How do their pedagogical beliefs compare?
b. How do their teaching practices and strategies (motivation, engagement, differentiation, assessment) compare?
c. How do their self-perceptions about teaching (most effective to student learning, most challenging to implement) compare?

Research Design

The design of this study was mixed methods concurrent parallel (Creswell & Plano Clark, 2017). Students were not able to be randomly selected due to specific services that were needed for groups of students and due to the nature of master scheduling in a large student population. The treatments were randomly assigned. For the school included in this study, school administrators scheduled students based on services needed, tracks of study, etc. The researcher did not have control over scheduling participants for the control and experimental groups. In this particular study, it would not have been ethical to randomly assign students, without considering the educational services they needed to be best served in the educational setting.

The mixed methods concurrent parallel approach in research involves collecting and analyzing both quantitative and qualitative data and then comparing and integrating the results (Creswell & Plano Clark, 2017). This approach allows researchers to gain a more comprehensive understanding of the research topic by examining it from multiple perspectives. In this approach, researchers collect both quantitative and qualitative data and then analyze each type of data separately (Creswell & Plano Clark, 2017). After the separate analyses, the results are compared and integrated to provide a more complete understanding of the research question or problem (Creswell & Plano Clark, 2017). This approach is particularly useful when the research question

is complex and requires a deeper understanding that cannot be achieved through a single method of data collection and analysis.

The deeper type of research questions posed in this study, such as, "How are middle school students' perceptions of math influenced by the math workshop model of instruction versus the lecture-style of math instruction?" and "What do teachers perceive as the most challenging aspects of the instructional approach?" could not be answered with quantitative data alone. The researcher had to incorporate qualitative data through student surveys and teacher interviews, in order to discover the strengths and weaknesses of each instructional approach and to glean if one approach was more effective than the other. Incorporating quantitative data collection helped to answer which instructional model best promotes student learning. Incorporating qualitative data enabled the researcher to discover why a particular method worked best or why it may not have been the best method.

Participants

Participants of this study were recruited from a public school in Georgia. Specific teachers at the school had already been trained in how to implement the math workshop model of Instruction. Workshop model teachers participated in a two-day training during the summer, prior to the beginning of the school year. One-hour professional development workshops were offered during the school year to refresh teachers on the training they received during the summer. These sessions occurred in August, September, October, and November. The researcher also had a prior relationship with the school, making it easier to build relationships with the participants.

According to school statistics, 62% of the students are White, 29% are African American, and 5% are Hispanic. Special education students make up 17% of the school's population

> and gifted and high achieving students make up 32% of the school's population. Students who are economically disadvantaged make up 49% of the school's population. Approximately 56% of math teachers (5 of 9) have been trained on the workshop model of mathematics instruction and agreed to teach with the method, and the remaining four teachers kept their traditional teaching method. (L. Nelson, personal communication, April 13, 2024).

Four classrooms using the workshop model and four classrooms using the traditional lecture model in each of sixth, seventh, and eighth grades, totaling 24 classrooms, were included for participant recruitment. A total of nine mathematics teachers and approximately 600 middle school students were associated with the 24 mathematics classes at the school. Among these, a total of 12 classes were taught with the workshop model and 12 classes were taught with the traditional lecture model, across the three grade levels. Details of the teacher participants and the classes they taught are reported in Appendix B.

Curriculum Used in Experiment

The units targeted in this study are summarized in Table 2. For sixth grade, the unit focused on exploring real-life phenomena through one-step equations and inequalities. The state academic standard aligned with this unit of study is 6.PAR.7- Write and solve one-step equations and inequalities as mathematical models to explain authentic, realistic situations. Mathematical practices for 6.MP.1-8 were also applied throughout the unit.

For seventh grade, the unit focused on making relevant connections with geometry. The state academic standard aligned with this unit of study is 7.GSR.5-Solve practical problems involving angle measurement, circles, area of circles, surface area of prisms and cylinders, and

volume of cylinders and prisms composed of cubes and right prisms. Mathematical practices for 7.MP.1-8 were also applied throughout the unit.

The eighth grade unit focused on real-life phenomena explored through systems of linear equations. The state academic standard aligned with this unit of study is 8.FGR.7-Justify and use various strategies to solve systems of linear equations to model and explain real-life phenomena. Mathematical practices for 8.MP.1-8 were also applied throughout the unit.

These three units of studies for sixth through eighth grades were selected because they each contain a real-world application strand. For the sixth grade unit, students were expected to explore real-life phenomena through one-step equations and inequalities. The seventh grade unit required students to make relevant, real-world connections with geometry. Finally, the eighth grade unit involved real-life phenomena, in which students explored through systems of linear equations. Exploring relevance and real-life connections requires application and oftentimes hands-on learning. These types of learning experiences are easily integrated within a workshop model of instruction. Students participated in various stations where different types of learning experiences occurred and the workshop model also provided small-group instruction with the teacher, which was beneficial for facilitating real-world connections to the math concepts being taught. Details of the units are reported in Appendix C.

In the sixth grade unit, students were expected to explore real-life phenomena through one-step equations and inequalities. The overarching state academic standard for the unit was 6.PAR.7 and it states that students will write and solve one-step equations and inequalities as mathematical models to explain authentic, realistic situations. In this unit, students explored one-step equations and inequalities. Students built upon their problem-solving stamina. Students

demonstrated their ability to solve equivalent expressions and possible solutions for inequalities with nonnegative numbers and solutions. The unit lasted 5 weeks.

The seventh-grade unit focused on making relevant connections with geometry. The state academic standard aligned with this unit of study is 7.GSR.5-Solve practical problems involving angle measurement, circles, area of circles, surface area of prisms and cylinders, and volume of cylinders and prisms composed of cubes and right prisms. Students wrote and solved equations using facts involving measures of angles. Students studied circles and used proportional reasoning to understand the relationship between the diameter and circumference, deriving formulas for circumference and area to solve problems. Students solved problems involving surface area and volume of right prisms and cylinders and explored two-dimensional cross sections of three-dimensional solids. The unit lasted 5 weeks.

The eighth grade unit focused on real-life phenomena explored through systems of linear equations. The state academic standard aligned with this unit of study is 8.FGR.7-Justify and use various strategies to solve systems of linear equations to model and explain real-life phenomena. In this unit, students extended their understanding of solving equations and functional and graphical reasoning to solving systems of equations, including those created by parallel and/or perpendicular lines. Solving systems included estimating solutions graphically, solving using substitution, and solving using elimination. The unit lasted 3 weeks for the general and co-teach classroom settings, but it lasted 3 weeks for the gifted/high achieving classroom settings, since those classes are accelerated classes.

Instrumentation

Benchmark Assessments

The math benchmark assessment for sixth, seventh, and eighth grades is a district-wide exam that is created by a team of sixth, seventh and eighth grade teachers, the middle school instructional coach, and a middle school administrator. The team works together to develop test items. The test items are pulled from a test bank within Illuminate Education software. Some of the items are from previous state standardized assessments, such as the Georgia Math Milestones Assessment, and other items are created by math teachers in the State of Georgia. All the items are vetted twice per year during the district's scheduled curriculum revisions workdays in January and May. Currently, there are no reliability measures in place for these exams. An assessment revision checklist is used to ensure validity. The assessment revision checklist is a tool that aids in making sure assessment items are aligned to the standards; each standard has a similar number of questions that are tied to the standard presented, etc. (see Appendix D).

The math benchmark assessments are administered three times during the school year, during the months of October, December, and March. Each math benchmark assessment contains 25 multiple-choice questions and is computer-based and housed within the Illuminate Education software platform. The questions are aligned to the standards that have been taught up until the point when the benchmark is administered. The benchmark assessments are cumulative; therefore, subsequent benchmark assessments include all the standards from the previous benchmark assessment, along with new information that has been taught up until that point (see Appendix E).

Unit Assessments (Pre and Post Unit)

Compared to the benchmark assessments, students in this school take unit assessments for each unit. The math unit pre and post assessments for sixth, seventh, and eighth grades are school-wide assessments that are created by sixth, seventh and eighth grade teachers. The grade level teams of math teachers work together to develop these pre and post unit assessments. Many of the test items are pulled from a test bank within Illuminate Education software. Some of the items are from previous state standardized assessments, such as the Georgia math milestones assessment, others are created by math teachers in the State of Georgia, and some items are created by the teachers at this school. All the items are vetted once per year during the district's scheduled curriculum revisions workday in January. Currently, there are no reliability measures in place for these assessments. An assessment revision checklist is used to ensure content and construct validity (see Appendix D). Teachers use this checklist when they are creating unit assessments to ensure that they are creating valid and reliable assessments.

The delivery of the pre and post assessments is scheduled on the school's calendar. All students took the pre and post assessments on the same day, except for eighth grade students who were enrolled in the gifted and accelerated class. These students are participating in an accelerated math program, so they took their pre and post assessments earlier than the other students. A common set of instructions was provided to all teachers on the day of the pre and post assessments. After the testing instructions were read aloud, the teachers shared the pre and post assessments electronically with students, through the Illuminate software. Students were given 60 minutes to complete the assessments. Each pre and post unit assessment contained between 20–25 multiple-choice questions and was computer-based and housed within the Illuminate Education software platform. The questions were aligned to the standards that were

taught within that specific unit. The unit assessments differed from the benchmark units because they were not cumulative. They only covered a portion of the yearly standards that were incorporated into specific units of study (see Appendix F).

To ensure content validity, teachers ensured that the questions included on the pre and post assessments were directly aligned to the standards that were taught in class. The questions for the assessments were selected from a test bank through the Illuminate software. The Illuminate software bank contains question samples that have been vetted by teacher groups all over the State of Georgia, to ensure alignment to the Georgia Standards of Excellence. Pacing guides were created and vetted by teachers to ensure that specific standards were being taught each week throughout the school year, based on the State of Georgia's pacing guide.

Construct validity was reached through the curriculum revision process. Grade level teachers throughout the district meet twice a year to revise curriculum and assessments. The meetings occur in January and May of each school year. During the curriculum revisions, an assessment revision checklist was used during the development of pre and post assessments. The assessment revision checklist includes items that are essential in order to ensure validity of the assessments. The assessment revision checklist ensures that the questions are aligned to the standard being taught, the number of questions included for a standard are directly correlated to the weight of that standard, all standards taught have questions represented on the assessment, etc.

Student Perception Survey (Post-Unit)

Students in the participating mathematics classrooms were surveyed electronically after the unit to capture their experience with each method of teaching. In total, the survey included seven demographics questions (gender, ethnicity, grade level, class, prior interest and experience

with learning mathematics, language), thirty six 4-point scaled items adopted from Ferguson (2010), and two open-ended questions about their perceptions about the teaching method used (see Appendix G).

Ferguson's (2010) survey is designed to capture students' perceptions of classroom teaching. The instrument includes thirty-six 4-point scaled items that students will relate their level of agreement on, as well as two open-ended questions about students' perceptions. Students respond to statements that are categorized under the following key constructs: care, control, clarify, challenge, captivate, confer and consolidate (Ferguson, 2010). Ferguson's (2010) survey has undergone multiple administrations and the survey items have been validated and refined to capture the essential elements of classroom-level teaching and learning. The survey uses Ferguson's delta coefficient and has no direct measure of reliability. The coefficient focuses on discrimination ability, not necessarily the consistency of measurement. Ferguson's delta is designed to assess how well and instrument can differentiate between individuals on a given construct, not how consistently it measures that construct over repeated administrations. Ferguson's (2010) survey constructs have been used in many research studies, including the Measures of Effective Teaching (MET) project. The initial and recent findings of the MET project demonstrate that student perceptions as measured by the survey can be one of multiple measures that reliably contribute to a balanced view of teacher performance and effectiveness (Ferguson, 2010). This instrument was a good measure to include in this study because it was useful in providing insight into the students' perspectives of both the lecture and workshop models of instruction, instead of just relying on assessment scores and teacher feedback, and it has proven to be effective in other research studies.

When administering the survey, teachers received instructions on how students should complete the survey. The instructions were read aloud to students. Next, the teacher shared the survey electronically with students. Students were given 50 minutes to complete the survey. All students completed the survey within the same week.

Teacher Interview

The purpose of the teacher interviews was to glean teacher perspectives about both the lecture and workshop models of instruction. The questions were aimed to provide insight into the teachers' pedagogical beliefs, teaching practices and strategies, and self-perception about teaching. The teacher interview presented questions, such as, "What do you think is the best way for your students to learn math?" and "Which aspect of your teaching do your students struggle with the most?" Ten questions were included in the teacher interview (see Appendix H). Teachers were invited by email to participate in the interview by the researcher. The researcher explained that the teachers' input was needed to share the teachers' perspectives on how their students learn best, in order to promote student learning. The interviews were conducted in person at the school. Each interview lasted approximately 30 minutes. The interviews were recorded and transcribed at a later date. The researcher had one teacher participant look over the interview questions to ensure that each question was clear and understood.

Data Collection

The following steps were taken to collect data for a comparison of the effects the math workshop model and the lecture model had on student learning.

Prior to the actual data collection, the researcher identified the research site and explored the setting. The researcher built a relationship with the instructional coach at the site, in order to receive support with collecting student data and with understanding the classroom settings and

the specific students and teachers involved in the study. The researcher obtained support from the administration, in order to conduct the study and collect data at the research site.

After the proposal defense and IRB approvals for both Valdosta State University and the school, the researcher contacted the school, specifically the instructional coach and the school administrators, to inform them of the commencement of the research data collection. See Appendix L. The researcher asked the instructional coach to share the anonymized student math benchmark assessment data for October, math benchmark assessment data for December, pre unit assessment in January, and post unit assessment in February (see Appendix E and Appendix F). The time lapse between October's Benchmark 1 Assessment and December's Benchmark 2 assessment was 8 weeks. The time lapse between December's Benchmark 1 assessment and the pre unit assessment was 3 weeks. The time lapse between the pre unit assessment and the post unit assessment was 5 weeks. The researcher also asked the instructional coach to distribute the student survey after the target units for pre test and post test comparison. Students were identified at the class level in the survey. The student surveys were distributed after the unit post-test in February, and they were completed over the course of 3 days. The majority of the surveys were collected on day 1, but days 2 and 3 were used for absent students to take the survey.

Before the beginning of the unit implementation, the researcher reached out to the teachers and informed them about the research and recruit participation in the post-unit interview. Participating teachers were individually scheduled for the in-person, semi-structured interviews at the school at their preferred time. The interviews were conducted in the teachers' classrooms. The teachers did not see the questions, prior to the interview session. The interviews were conducted during a 5-day time span. The interviews were audio-recorded and transcribed verbatim for analysis. The audio recordings were stored in a password-protected cloud space

provided by Valdosta State University. Access was granted to the researcher and the committee members.

Data Analysis

Student data analysis was conducted for RQ1. Quantitative data was collected via benchmark assessment data, pre-unit assessment data, and post-assessment data. Likert-scaled student survey items were analyzed quantitatively to discover student perception about both the lecture and workshop models of instruction. The two open-ended student survey questions were analyzed to provide further insight into student perception of the two learning conditions.

Teacher data analysis was conducted for RQ2. Teacher interview data was analyzed qualitatively through coding, categorization, and determining themes. This data provided insight into teacher perception of the two learning conditions.

Analyzing Student Data (RQ1)

To compare student learning gains between the treatment and control groups, student math benchmark assessment and unit pre-test and post-test scores were used. The October and December benchmark assessment data for the treatment and control groups were compared using separate independent group *t*-tests for each of the three grade levels. The grade level results showed whether or not student learning gains in one group are significantly higher than the gains in the other group.

Anonymized change scores were acquired from the district for individual students. Then, these change scores were compared between the two conditions using the independent *t*-tests at the three grade levels. These results showed whether the pre and post change scores for the target unit were significantly greater in the treatment versus control groups.

To examine the influence of classroom settings (special education, general education, gifted education) on the effect of the instructional conditions (workshop vs. lecture), a multiple regression analysis was performed using the change scores as the dependent variable. The results informed as to whether there was a significant interaction effect between the instructional conditions and the classroom settings. ANOVAs also were conducted to determine if there were significant interactions between gender and the instructional condition and ethnicity and the instructional condition.

Student survey data were analyzed. The survey responses were summarized using descriptive statistics. Means and standard deviations were calculated for the Likert-scaled items. The last two open-ended question responses were thematically coded.

Analyzing Teacher Data (RQ2)

To compare teacher perceptions of teaching between the two conditions, teacher interviews were used. The teacher interviews were audio-recorded and transcribed verbatim for analysis. The first step the researcher took in analyzing the interview data was to read the transcribed interview responses multiple times. The teacher interview instrument was designed to capture information relating to the theoretical constructs of interest presented in the study. These constructs include pedagogical beliefs, teaching practices and strategies, and self-perception about teaching.

The second step involved the researcher coding the interview data. For this study, theoretical constructs were already established before the interviews began. Deductive coding was utilized to assign labels to the raw interview data and to code the data into the following pre-established categories: pedagogical beliefs, teaching practices and strategies, and self-perception about teaching (Miles et al., 2014). The researcher monitored to see if an additional major

category emerged during the data analysis that could prove significant. If that had occurred, the researcher would have added that category to the pre-established categories for further analysis, which would have incorporated inductive coding to be utilized in this study as well, resulting in a hybrid coding approach (Saldaña & Omasta, 2018). However, no additional major categories emerged. The researcher began the coding process by initial coding. Using Microsoft Word's Comments tool, the researcher coded the data by assigning broad theme codes. Next, the researcher utilized In vivo coding, which involves using words from the data as codes (Saldaña, 2016). The participant's actual words were coded, instead of the researcher's interpretation of the words. This helped the researcher to avoid inferring meaning. After codes were assigned through the In vivo method, the researcher applied descriptive coding to the data set. This allowed the researcher to summarize extracts from the data and to apply words that encompassed the general meaning of that particular extract (Saldaña, 2016). After initial codes were assigned through in vivo and descriptive coding, line-by-line coding occurred. The researcher went through the interview data line by line and assigned any additional codes that were significant. The line-by-line coding process allowed the researcher to dig more deeply into the data and to apply even more descriptive coding to the data set (Saldaña & Omasta, 2018). As the researcher worked through the coding process, notes were taken to clarify the data.

Once codes were assigned, the researcher used thematic analysis to analyze the data set. Thematic analysis discovers patterns of meaning in a data set (Saldaña, 2016). This type of analysis allows the researcher to group the data according to similarities, or themes (Saldaña, 2016). The themes established allowed the researcher to make meaning of the data collected. Thematic analysis also aims to capture people's experiences (Saldaña, 2016). In this research, teacher perceptions were imperative to understand the two differing instructional models and to

gain insight on the impact that each model had on student learning. This research aimed to discover teacher experiences, which made thematic analysis a suitable choice for analyzing the data set.

As the researcher analyzed the codes that were applied to the data set, code categorization occurred. This process involved creating categories for the code set (Saldaña, 2016). In this research, theoretical constructs were already pre-established, and these served as the categories for the code set (pedagogical beliefs, teaching practices and strategies, and self-perception about teaching).

Next, the researcher completed the process of theme identification. The researcher identified the themes in the data set and clearly stated the themes in the data set (Saldaña, 2016). At this point in the theme identification process, all of the information gleaned from coding and categorization were grouped together to develop themes. The themes provided meaning for the data set and the researcher wrote a narrative summarizing the findings.

To promote credibility and trustworthiness, the researcher triangulated data from different data sources to repeat established identifiable patterns. Student survey data in the form of Likert-scaled items, student survey open-ended questions, teacher interview data and assessment score data from four different assessments were used in this research to gather information and establish patterns.

Threats to Validity

This study was conducted at one middle school, instead of multiple ones. The school consisted of sixth, seventh, and eighth grade. Because this study was conducted with one middle school, it could be difficult to generalize the findings to other middle school settings.

Internal Validity

Selection is one component that the researcher considered in regard to validity threats. Also, because of the nature of this study, true random sampling was not feasible. This is because only specific teachers were trained in the math workshop model that was used within the experimental group. Therefore, only students in classes taught by teachers who were trained in this model were selected as experimental group members.

Experimental mortality is another validity threat that was considered in this study. Even though it is not at a high rate, the middle school where the study was conducted does have several students who transfer out and into the school every year. The researcher had to monitor the control and experimental groups carefully to make sure that about the same number of participants made it through the entire study in both the experimental and control groups.

External Validity

The sample in this study aimed to represent the population of middle school students in rural areas of Georgia that received math instruction via the workshop model of instruction and the lecture model of instruction. The sample was valid in representing students who received math instruction via the lecture model because the lecture model of instruction can be found in states all over the country. However, it is harder for the sample to represent a population of students receiving math instruction via the workshop model because the workshop model of instruction is not widely used in middle schools. Furthermore, the workshop model of instruction varies from school to school, so the researcher cannot be certain that the workshop model used in other areas is comparable to the workshop model used in this research project. The conceptual framework that constructs the specific components of the math workshop model in this research focuses on student engagement, student motivation, and differentiation. For the results of this

study to truly be generalizable to similar schools, they would have to be generalized to schools where the math workshop model is similar in its make up.

There were several validity checks throughout the research project to maximize validity and reduce bias. For example, the pre- and post-assessments were district-wide benchmark assessments created by teachers. This increased the validity of the data that these tests revealed. Also, the researcher created an observation tool to assist with classroom observations. This provided the researcher with a systematic checklist to go by when observing. This eliminated the tendency of the researcher to be subjective or biased when conducting observations. The survey instrument was checked and approved by field experts. This helped to ensure its validity and to make sure that the instrument was set up to collect the actual data that was needed. Finally, focus group interviews were recorded, and notes were taken. This ensured the validity of the data collected through the interviews because the researcher was able to check and recheck from the audio file to the recorded notes. The research also helped to ensure validity by checking over the open-ended survey items, the focus group interviews, and by coding them and comparing them to the findings.

Limitations

A key limitation to the study is that the participants are from a single school. This could limit the generalizability of findings to wider populations. The findings may not necessarily apply to populations in different geographic locations.

There are no reliability metrics for the district's benchmark and unit assessments. This could cause an issue of the scores not being reliable. Reliability metrics ensure that the tests produce dependable, repeatable, and consistent results. Not having reliability metrics could mean the results reflect random error.

Another limitation of the study is that the student survey may not capture students' perceptions of teaching in depth, which could make it difficult to explain how the instructional experience affected the students' assessment scores.

Additionally, teachers and students self-reported experiences may not be accurately capturing classroom interactions. Including classroom observations could enhance understanding of how the two instructional methods impacted middle school students' math learning.

Chapter IV

RESULTS

The purpose of this study was to bring about change in the teaching of math by testing an experimental instructional approach. The study investigated the effects of the workshop model of instruction and the lecture model of instruction in middle school math classrooms to determine if there were any differences in learning outcomes.

In order to fulfill the study's purpose, the following research questions guided the work in this study.

1. For students who participate in the math workshop model of instruction and students who participate in the lecture-style of instruction,
    a. How do student learning gains compare?
        i. To what degree, if any, do students in the math workshop classrooms perform better on the benchmark assessments than students in the lecture-style classrooms?
        ii. To what degree, if any, are the learning gains in the math workshop classrooms greater than the gains in the lecture-style classrooms?
    b. Is the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education)?
    c. How do student perceptions of teaching compare?
2. For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction,

a. How do their pedagogical beliefs compare?
b. How do their teaching practices and strategies (motivation, engagement, differentiation, assessment) compare?
c. How do their self-perceptions about teaching (most effective to student learning, most challenging to implement) compare?

Demographics

The study consisted of 195 sixth grade participants, 51% were female and 49% were male. The ethnicity totals were 32% Black, 64% White, and 4% Hispanic. Students who are economically disadvantaged make up 48%. The services totals were 13% were special needs, 50% were regular education, and 37% were gifted/high achieving.

Out of 197 seventh grade participants, 50% were female and 50% were male. The ethnicity totals were 29% Black, 62% White, 5% Hispanic and 4% multiracial. Students who are economically disadvantaged make up 49%. The service totals were 13% were special needs, 51% were regular education, and 36% were gifted/high achieving.

There were 194 eighth grade participants, 51% were female and 49% were male. The ethnicity totals were 27% Black, 60% White, 5% Hispanic, 6% multiracial, and 2% Asian. Students who are economically disadvantaged make up 49%. The service totals were 17% special needs, 60% were regular education, and 23% were gifted/high achieving.

Overall Findings

The following passages present the findings associated with each research question. For each section, the study's research question, or sub-question, is presented followed by a brief description of the analysis work done to answer that question. Following the description, the

results of the analysis work are presented. At the end of each passage, an interpretation of the findings is provided (i.e., the research question is answered).

RQ1-a: For students who participate in the math workshop model of instruction and students who participate in the lecture-style of instruction, how do the student learning gains compare?

According to the independent samples *t*-test results of the benchmark assessment (Benchmark 1 and Benchmark 2) and the unit assessment (pre-test and post-test) data, students who participated in the math workshop model of instruction in general performed higher than those who participated in the lecture model of instruction. The patterns found were consistent in both benchmark and unit assessment data and across the seventh and eighth grade levels. However, the sixth grade level showed a different pattern. Details are discussed below with reference statistics.

RQ1-a-i: To what degree, if any, do students in the math workshop classrooms perform better on the benchmark assessments than students in the lecture-style classrooms?

For the current study, the intervention and control groups collected two sets of benchmark assessment scores — one in October (BM 1) and another in December (BM 2). As the assessments are designed to evaluate a student's cumulative knowledge and skills in relation to target academic standards at a specific timepoint in an academic year, the two benchmark assessment instruments were not comparable. As such, a total of six *t*-tests were performed, one for each benchmark assessment data and each grade level between groups. Below are the results by grade level, comparing the scores between-group differences at two timepoints in the academic year.

As shown in Table 1, math learning gains were generally higher in the workshop group compared to the lecture group. Such tendencies became more evident in the latter benchmark

assessment. In particular, the sixth grade students in the workshop classrooms performed significantly higher on their Benchmark 1 than their peers in the lecture classrooms (M_{diff} = 9.02, p = < .001, d = .68). The sixth grade students in the workshop classrooms also performed significantly higher on their Benchmark 2 than their peers in the lecture classrooms (M_{diff} = 17.93, p = < .001, d = 1.80). Between-group gain score differences were significant for both BM1 and BM2, but the size of the between-group differences grew almost twice in BM2, as verified by the increased effect size scores (d = .68 versus d = 1.80).

A slightly different pattern was found from seventh and eighth grade benchmark data. The seventh-grade students in the workshop classrooms did not perform significantly higher on their Benchmark 1 than their peers in the lecture classrooms (M_{diff} = 2.22, p = .19). However, the seventh grade students in the workshop classrooms did perform significantly higher on their Benchmark 2 than their peers in the lecture classrooms (M_{diff} = 11.52, p = < .001, d = 1.14). The same pattern was observed for eighth graders. According to the data, the eighth grade students in the workshop classrooms did not perform significantly higher on their Benchmark 1 than their peers in the lecture classrooms (M_{diff} = 3.12, p = .08), but their performance became significantly higher on their Benchmark 2 than their peers in the lecture classrooms (M_{diff} = 14.21, p = < .001, d = 1.35). The results are shown in Table 1.

RQ1-a-ii: To what degree, if any, are the learning gains in the math workshop classrooms greater than the gains in the lecture-style classrooms?

The unit pre and post test data were collected in January and February on exploring real-life phenomena through one-step equations and inequalities (sixth grade), making relevant connections with geometry (seventh grade), and real-life phenomena explored through systems of linear equations (eighth grade). Because the pre- and post-unit tests were comparable within

each grade level, change scores were used to compare the student learning gains between the workshop and the lecture classrooms. A total of three *t*-tests were performed, one for each grade level.

Table 1

T-Test Results of Benchmark Assessments Between Workshop and Lecture Groups by Grade

Grade	Test	Condition	*M*	*SD*	M_{diff}	*t*	*df*	*p*	*d*
6	BM 1*	Workshop	81.55	14.58	9.02	4.79	193	<.001	.68
		Lecture	72.52	11.47	-	-	-	-	-
	BM 2*	Workshop	88.88	8.90	17.93	12.57	193	<.001	1.80
		Lecture	70.95	10.93	-	-	-	-	-
7	BM 1	Workshop	78.36	12.40	2.22	1.30	195	.19	.186
		Lecture	76.13	11.55	-	-	-	-	-
	BM 2*	Workshop	86.40	9.47	11.52	8.00	195	<.001	1.14
		Lecture	74.88	10.66	-	-	-	-	-
8	BM 1	Workshop	76.93	14.76	3.12	1.73	192	.08	.249
		Lecture	73.80	10.03	-	-	-	-	-
	BM 2*	Workshop	86.60	9.99	14.21	9.43	192	<.001	1.35
		Lecture	72.38	10.94	-	-	-	-	-

Note. Significant results are marked with * ($p < .05$).

According to the data, student learning gains were larger in workshop groups for all three grade levels. Between-group differences were largest for seventh grade, followed by eighth grade, and then sixth grade, with the first two differences being statistically significant ($p = <$ .001). Table 2 shows the independent samples *t*-test results for all middle school students and by grade levels.

Table 2

T-Test Results of Unit Gain Scores Between Workshop and Lecture Groups by Grade

Grade	Condition	*M*	*SD*	M_{diff}	*t*	*df*	*p*	*d*
All	* Workshop	64.84	13.84	8.80	4.68	192	<.001	1.42
	* Lecture	56.04	12.33	-	-	-	-	-
6	Workshop	52.44	21.90	2.61	.96	193	.168	.13
	Lecture	49.83	15.13	-	-	-	-	-
7	* Workshop	58.18	16.21	8.76	3.66	195	<.001	1.25
	* Lecture	49.42	17.29	-	-	-	-	-
8	* Workshop	58.40	18.36	6.63	4.75	584	<.001	1.26
	* Lecture	51.77	15.32	-	-	-	-	-

Note. Significant results are marked with * ($p < .05$).

RQ1-b. Is the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education)?

To examine the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education), a multiple regression approach was used. Stepwise regression was the statistical technique used to calculate multiple regression. The results of the regression indicated that both the condition (lecture versus workshop) and the classroom setting (special education, gifted education, regular education) significantly affect the learning outcomes of students, based on the unit change scores, (R^2 = .156, F=53.91, p < .001). The multiple regression results also showed that the model of instruction (lecture versus workshop) and the classroom setting (special education, gifted education, regular education) both significantly impacted the learning outcomes via the unit change scores, (F=53.91, p = < .001). It was found that both instructional method (B = -.345, p < .001) and classroom setting (B = .190, p < .001) significantly predicted unit change scores. An ANOVA was conducted to determine if there was a significant interaction between gender and the instructional method. The result was not significant, (F = .059, p = .808). An additional

ANOVA was conducted to determine if there was a significant interaction between ethnicity and the instructional method. The result was not significant, (F = .113, p = .737).

RQ1-c. How do student perceptions of teaching compare?

Student perceptions of teaching in both conditions were captured through a modified version of Ferguson's (2010) survey, which examined the perceptions in terms of seven C's: care, control, clarity, challenge, captivate, confer, and consolidate.

Overall, data in this study suggests that students in the workshop classrooms had significantly more positive perceptions about how teachers were managing the classroom (i.e., control), compared to their peers in lecture classrooms, M_{diff} = .17, p = < .001, d=.29. All but one item under Control were statistically significantly different. No statistically significant differences were found in the other six areas, except for one item in Challenge. Appendix I reports the t-test results of the between-group comparison using independent samples t-tests.

As shown in Appendix I, Control was the only domain where most items suggest that student perceptions differed significantly between the instructional conditions. Responses from six out of seven items under Control were statistically significantly different, all favoring the workshop condition. In particular, students in the workshop classrooms reported more positively to perceiving that student behavior in the classroom was under control, M_{diff} = -.06, p = .40, more negatively to hating student behavior in class, M_{diff} = .19, p = .01, d =.22, attributing student behavior in class to the teacher getting angry, M_{diff} = .21, p = .00, d =.24, and thinking that student behavior in class is a problem, M_{diff} = .21, p = .00, d = .25. Furthermore, students in the workshop classrooms reported more positively on perceiving that their classmates behaved the way the teacher wanted them to, M_{diff} = -.18, p = .01, d = -.24, that students in the class treated the teacher with respect, M_{diff} = -.16, p = .01, d = -.21, and that their class stayed busy and did

not waste time, M_{diff} = -.19, p = .01, d = -.22. Student responses in all but the first item was statistically significant at the alpha level of .05, suggesting that student perceptions regarding teachers' classroom management (i.e., control) were different between the two instructional conditions. A summary of the comparison of teachers' pedagogical beliefs is shown in Figure 1.

RQ2- For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction, how do their pedagogical beliefs compare?

Teacher-Centered vs. Student-Centered

Nine math teachers were interviewed in the study. Five of the math teachers were workshop model teachers and four of the teachers were lecture teachers. See Appendix B. For anonymity purposes, pseudonyms were used to identify teacher responses.

The biggest difference in pedagogical beliefs that were evident from the workshop and lecture model instructional methods was their preference towards individual learning versus collaborative/social learning. The workshop model teachers emphasized the importance of student-centered teaching through collaborative/social learning via groups and by providing teacher-led small-group instruction, where math skills would be retaught to students who had not yet mastered them. For example, "I pull a small group to work with and my co-teacher pulls a small group to work with. We teach simultaneously, but we have less students, so we can better meet their needs" (John). They also focused on providing centers, e.g., "I include math centers and stations. That gives me an opportunity to really focus on specific standards. My stations look different for different groups. They are based on the needs of the students, where the content can be practiced with peers" (Misty). See Figure 1.

Figure 1

Comparison of Teachers' Pedagogical Beliefs

Lecture	Workshop
Practice • Continued practice • Extra practice • Lots of practice • Lots of practice increases math understanding • Making mistakes and reworking the problems to discover the mistakes • Memorization • Whole-group learning Formative Assessment • Checking for understanding • Monitoring students' progress • Providing plenty of examples • Use of a variety of strategies • Implementing (math) procedural fluency • Using a discovery or question-based approach when teaching • Use of warm-ups and mini reviews	Practice • Repeated practice • Lots of practice increases math understanding • Making mistakes and reworking the problems to discover the mistakes • Real-life experiences • Teacher-student relationships Formative Assessment • Informal assessment (quick checks) • Providing feedback to students Personalized Learning • Utilizing stations and centers • Flexibly grouping students • Differentiated instruction, based on students' needs Hands-On Learning • Students learn best through hands-on application • Use of manipulatives • Students need to see and experience content in more than one way • Use of visuals

On the other hand, lecture teachers emphasized teacher-centered learning through whole-group instruction. For example, “I have really seen a lot of results through extra practice and providing multiple examples for my students. I feel that they learn best by watching me present the information and then by having continued practice within class” (Alex). Their pedagogical beliefs centered around teaching the math content thoroughly through a lecture-style, whole-group delivery, e.g., “I really do think that it is my content knowledge and ability to align instruction to the curriculum pacing guide that helps me be a successful teacher,” (Andy); modeling the skill, e.g., “I like providing examples for the students. I feel like modeling how to work through the problems is going to help them so that they can visually see it,” (Alex); and allowing multiple practice opportunities in a whole-group setting, e.g., “Lots of practice is the best way for students to learn in my experience” (Shay). See Figure 1.

The workshop model teachers emphasized the importance student-centered teaching through collaborative/social learning via groups and by providing teacher-led small-group instruction, where math skills would be retaught to students who had not yet mastered them. For example, “I pull a small group to work with and my co-teacher pulls a small group to work with. We teach simultaneously, but we have less students, so we can better meet their needs” (John). They also focused on providing centers.

> I include math centers and stations. That gives me an opportunity to really focus on specific standards. My stations look different for different groups. They are based on the needs of the students, where the content can be practiced with peers. (Misty)

One-on-One Support vs. Flexible Grouping

Related to this, the workshop teachers' pedagogical beliefs centered around personalized learning, where the instruction is differentiated for all learners. For example, workshop teachers plan their small-group instruction, based on students' needs.

> My three key characteristics in the classroom would be differentiated instruction, so just applying or just giving them different levels of complexity, making sure that I'm accommodating my students and meeting them where they are. I would say that that would be my first one. Collaboration, like working in flexible groups, making sure that my groups are fluid and that a child is not living in a certain group, so doing a lot of mastery checks, so looking at my data and letting my data kind of drive my instruction. Doing those tickets out the doors, looking at how they're doing on formative assessments, whether it be observations or the questions that I'm asking in the classroom, and making sure that my students are not living in one particular group. When they've mastered that standard, I am moving them around and making sure that there's solid understanding there and that they're ready to move on. (Misty)

Lecture teachers differentiate by walking around the classroom and offering one-on-one support to students as they recognize mistakes.

> Through whole-group instruction, I try to provide one-on-one support. I walk around the room, and I check for understanding. I provide one-on-one help to make sure they understand the lesson. My differentiation is me approaching them with that one-on-one support and seeing if they need extra help from me. (Theo)

Practice Questions vs. Student Need-Based Materials

Workshop model teachers had the belief that not all students will master the skill through practice alone, but that they could through small-group instruction where the skill is taught again by the teacher in a smaller setting.

> Differentiation means that you are putting the students together who have shown that they are on the same instructional level in that area, and then giving them work they can complete at their current level of understanding. It's not just as simple as changing one worksheet for another, which is just a big mistake that I see happen with differentiation. If you're truly differentiating, you are taking that individual student's needs into account when you create what it is that you're going to give them to work on. (Jen)

The workshop model teachers also believed that it is important to offer multiple forms of practice with the content through center activities. They believed that instructional materials had to be student-centered and tailored to students' individual needs.

Lecture teachers strongly believed that students would master the content through practice-based instructional opportunities. They believed that if students kept practicing the content in a whole-group setting, they would eventually master the skill, e.g., "The students are given practice problems daily and I check on them if they indicate that they are struggling with a problem" (Alex).

Seeking Relevance for Motivation

Another difference noticed between the two instructional models was the workshop model teachers focus on hands-on learning and real-life connections. They spoke about the importance of allowing students to work with manipulatives and to practice with them when solving problems. The workshop model teachers also highlighted the importance of connecting

the content to real-life situations to provide students with relevance for learning, e.g., “I think anytime that I can make learning relevant, the students will give more effort. That is a motivation strategy, too. You connect the math to what is important to them” (John). The lecture teachers did not discuss hands-on learning and providing relevance as key factors contributing to their pedagogical beliefs.

RQ2-b. For teachers who implemented the math workshop model of instruction, and teachers who implemented the lecture-style of instruction, how do their teaching practices and strategies (motivation, engagement, differentiation, assessment) compare?

To explore how the teachers’ teaching practices and strategies compare across the dimensions of motivation/engagement, differentiation, and assessment, emergent themes from the teacher interview data were categorized into each dimension. Overall, teachers from the workshop and lecture instructional models had several similarities in their responses regarding student motivation/engagement (healthy class competition, sufficient time for problem solving, activating and summarizing), as well as differences (student collaboration, student self-efficacy).

A summary of themes identified from teacher interviews is shown in Appendix J, followed by descriptions of each theme in subsequent paragraphs.

Similarities in Motivating Students

Healthy Class Competition. Both sets of teachers emphasized the importance of utilizing healthy class competitions to motivate and engage students to be active in the learning environment, e.g., “I integrate competition. My students tend to be competitive. I set up class competitions with rewards because most students will work harder for incentives. Individual and group competitions help to motivate students” (Jen). Some of the competitions described were a pizza party for the class with the highest unit test average or additional technology free time for

the class that showed the most growth on the benchmark assessment. The teachers also agreed that verbal praise for encouragement and tangible rewards, such as candy or additional technology time, was beneficial to foster motivation and engagement among students, e.g., “I feel like my students are motivated just sometimes just by me praising them, they get super excited when I make a big deal out of the work that they do” (Misty).

Sufficient Time for Problem Solving. Other strategies that were common among both conditions were allowing plenty of practice time for students to solve problems and providing real-world connections to the learning content. Both sets of teachers addressed the need for practice to be guided, where the teacher is available to assist.

> I have seen positive results through practicing and providing multiple examples for students. They learn best by watching me present the information and then by having continued practice with it. I'm able to monitor if they're getting the problems correct or incorrect. (Alex)

Teachers agreed that providing real-world connections to learning was necessary to engage students in the learning and to motivate them to work hard to master the skill. Knowing they may need the skill in the future was a significant motivating factor that was mentioned.

Activating and Summarizing. The teachers across both sets of conditions believed that activating and summarizing strategies were effective measures for engaging and motivating students. Both groups of teachers reported that activating strategies help engage students and set the tone for the day's learning.

> I like to use videos as activators. I like to make sure that it includes some type of relevancy, so that they can connect the math standard that we're working on to something that's happening in the real world. We might have a short discussion about that video if

> it's required or to further their understanding. Then, we'll begin working on whatever topic or standard it is that we're scheduled to work on for that day. (John)

It was also stated that summarizing strategies keep students engaged by recapping the main points of the lesson. It was also shared that part of the summary of the day addresses what lesson will be taught next, and this also serves as a motivator as some students look forward to the next lesson.

Difference in Motivating Students

Student Collaboration. A major difference discovered between the two conditions was student collaboration. The workshop model teachers spoke about the need for student collaboration when practicing content and solving problems, e.g., “Collaboration with their peers is important. Working together with a partner offers deeper understanding for my students, so I try to make sure that I am providing that for my students” (Misty). The lecture teachers did not mention collaboration regarding motivation and engagement.

Role of Technology and Games. The workshop model teachers also focused on the use of technology during instruction. Using game-based software programs to practice content and using videos to aid with instruction was mentioned as engagement strategies to help students remain interested in the learning. Several game-based programs have class competitions embedded within them, and the workshop model teachers reported that as a major motivational factor for students.

> I use review platforms like gym kit and quizzes. They are informal as well, but they're usually a lot more telling than something that seems more formal because the students are highly motivated because it's a game and it's a competition. (Jen)

Modeling. Modeling strategies for solving problems was mentioned by one of the lecture teachers, but it was mentioned by several of the workshop model teachers as a defining element of keeping students engaged. The teachers reported that modeling helped students feel comfortable and secure with taking risks with problem-solving. According to Shay, "When students experience modeling by the teacher, they feel they have a lifeline and are not left to solve on their own, without help." It was reported that modeling throughout the lesson provided comfort for students and allowed them to make mistakes during practice time, but it also allowed for their misconceptions to quickly be corrected, before they became confused and frustrated. Knowing the teacher would soon be coming to the board to model how to solve the problem helped to motivate the students to continue trying.

Student Self-Efficacy. Another element mentioned by the workshop model teachers, but not the lecture teachers, was student self-efficacy. The workshop model teachers stated that students are more motivated to learn because they are tracking their own data and setting goals for themselves, e.g., "We set goals for the classroom and as individuals and students have a data notebook, where they keep up with their progress. We set goals and have conferences to determine if progress is being made" (Misty). This practice allows them to take ownership of their own learning and to have buy-in with the learning process. Holding themselves accountable for their own learning fosters motivation and engagement.

Differences in Differentiating Instruction

Whole-Group vs. Small-Group. The biggest difference regarding differentiation as a practice that was evident from the workshop and lecture instructional methods was whole-group learning versus centers and small-group learning. The workshop model teachers focused on small-group learning and student collaboration in centers for practice, e.g., "I include math

stations. One station is a guided math station, where I reteach content to the students who have not yet mastered it. The lesson changes based on the students' needs" (Misty). This same finding was evident when the workshop teachers' pedagogical belief responses were analyzed. The teachers' responses regarding differentiation were consistent with their responses of how they define their pedagogical beliefs regarding differentiation.

> I do flexible grouping at least three times a week. When I differentiate academic abilities, sometimes it may be based on students who are grouped with the same academic ability or it may be a high/low grouping or maybe a low/mid grouping, just so they experience different opportunities. I try my best to alter the different ways that I differentiate because I don't want them to feel like they're always in the same groups. I also think that it's important for the students to understand why they're in the groups that they're in. So, before I even begin groups, I always stand before all of them and explain why they're in the groups that they're in, I explain the activity they will be working on and then I let them get started. (Cole)

No similarities regarding differentiation were evident between the groups. However, the lecture teachers emphasized whole-group teaching and practice, e.g., "I believe the students learn best through memorization, visual representation, and through whole-group learning, specifically when I walk around and check for understanding" (Theo).

Using Student Data to Personalize. Personalized learning and using data to plan for instruction were two additional areas that workshop model teachers relied heavily on, but lecture teachers did not mention. Workshop model teachers discussed how it is imperative to give each student exactly what they need instructionally. They focused on the importance of tiered assignments, small-group instruction with students on the same instructional level to reteach

skills, varied level of questioning, flexibly grouping based on students' needs and changing the groups often to ensure they were fluid, and every student was able to receive teacher support with remediation. According to Misty, "I feel like the best way for my students to learn math is through flexibly grouping via centers and stations. Providing feedback to students has also been very beneficial." The lecture teachers also discussed differentiating in terms of walking around to students and providing one-on-one support and by revisiting unmastered content in the form of warm-up for future lessons, but group learning, small-group instruction based on needs, and reteaching were not mentioned as key strategies for learning. Theo stated, "I believe the students learn best through memorization, visual representation, and through whole-group learning, specifically when I walk around by checking for understanding."

Similarity in Assessing Students

How Data Is Collected. Teachers from the workshop and lecture models had similar perspectives on assessment and its role in the education setting. Teachers from both conditions described the need for informal, formative and summative assessments to ensure students were mastering the content. Both discussed using quick checks to check for understanding throughout the lesson. Andy stated:

> We do little quick checks in the warm-up. The day after I've taught the lesson, the warm-up will relate to it. So, I can very quickly see who got the questions right, little checks for comprehension. I use multiple assessments to check for students' understanding.

Difference in Assessing Students

How Data Is Used. The major difference between the two conditions was what is done with the assessment data, once it was collected. The workshop model teachers spoke in detail about consistently using informal and formative data to continuously plan for next steps with

instruction. They focused on using unmastered content in future lessons through warm-ups and they also explained how the data would be used to reteach the content via small-group learning. According to Misty:

> I will take student data and go back to see, okay, just because I've given this common unit assessment, I still have some kids that have failed it. So, what do I need to do next? I do need to continue to teach based on my curriculum map, but I've got to continue to go back because these students still have not met that standard. So, then I plan. How am I going to spiral this review throughout and make sure that we're still going back over those standards? So, that might be as a part of homework or that might be as a part of at the beginning of the lesson. I'm going to take 10 minutes for us just to go back and review some things. A great strategy for me that I've used a lot is on my assessments, I might add one or two questions from our previous assessment just to go back and keep revisiting that content, so my students don't lose what we've learned at the beginning of the year.

However, the lecture teachers focused on solely using the data to gauge students' understanding of the content, but not to necessarily use the data to plan for next steps for instruction. The lecture teachers did describe using the data to present unmastered material again through warm-ups in future lessons, but that was the extent of the data usage.

Additionally, they talked about how the assessment data would also be used to plan centers where the needed skills would be presented and practiced again in collaborative student groups. Angie stated:

> I do a quick check every week to see where students are before I go deeper into the content, so I can know how to remediate. We have a data notebook, so I put my scores

into the data notebook. That helps me break my students up into groups and to decide on what content to remediate.

Students assigned to the collaborative groups would be grouped according to needs, derived from the assessment data. The workshop model teachers also described how they would use summative assessment data to plan for remediation in future lessons and review segments, to continually provide students with additional opportunities to master required standards. Jen expressed:

> The data is everything. The data drives my instructional decisions. So, looking forward, the data shows me what do I still need to remediate? Can I move forward? Do I need to pause and relook at how I presented the information? Does it need to be presented in a different way, or does it show mastery of that area? Now, maybe I only need to remediate a small group within that larger section, and everyone else we're able to move on to the next standard.

RQ2-b. For teachers who implemented the math workshop model of instruction, and teachers who implemented the lecture-style of instruction, how do their self-perceptions about teaching (most effective to student learning, most challenging to implement) compare?

The most noticeable difference between the workshop and lecture model teacher groups in regard to teachers' self-perceptions of teaching was what type of teacher they see themselves as, whole-group instructor versus small-group instructor. Workshop model teachers strongly believe that small-group instruction and center instruction is the most effective method for teaching students. Lecture model teachers believe whole-group instruction is the most effective way to teach. Another difference discovered was the element of differentiation. Workshop model teachers felt that differentiation was a strength for them, while the lecture model teachers felt that

differentiation was a weakness for them. Theo shared, “Differentiating and managing the diversity of student academic needs is difficult. I have a hard time differentiating to support the individual needs.”

Another difference was how the two types of teachers saw themselves regarding data usage. Workshop model teachers reported that they rely heavily on data to analyze and plan for next steps and saw themselves more as data-driven. Misty stated, “I use formal and informal assessments to gauge students’ understanding and to make informed decisions for next steps with instruction.” The lecture model teachers reported relying heavily on their content knowledge and ability to pace out the standards to plan for instruction and saw themselves more as curriculum driven. Alex explained, “Sometimes we feel rushed. We have to follow the pacing guide and stay on track, so all the content can be covered, and students will be ready for the end of course tests.”

Both groups of teachers reported having difficulty with being able to give every student exactly what they need instructionally, due to students being on different learning levels. They also reported that keeping students engaged during learning was sometimes difficult. Workshop and lecture model teachers agreed that there is not enough instructional time in the day to complete all the learning tasks needed for students to master the content. Workshop and lecture model teachers perceived themselves as overwhelmed and unable to meet the needs of all their students. Jen shared:

> The most challenging part is that there are so many students who have so many differences in my classrooms. I have so many levels of learners. I have really high learners and I'm spending a lot of time trying to figure out how can I accelerate their learning, how can I move them to the next level and at the same time, I have struggling learners that I'm trying to not leave behind, and I’m trying to create something that's

going to bring them along and hopefully move them more to the middle so that they're not at the lowest point. So, doing all of that within one class period per day is challenging.

Refer to Appendix K to review the comparison of teachers' self-perceptions of teaching.

Summary of Findings for Research Question 1

The data suggests that the math workshop model of instruction is effective in teaching mathematics to middle school students. The overall performance of workshop students was significantly higher than lecture students across multiple assessments. Although the perceptions of students in both the workshop and lecture model students were similar among most of the survey domains investigated, workshop students did perceive their classrooms as being more controlled, or better managed, than the lecture students.

The benchmark data in this study suggests that the students who participated in the math workshop model of instruction performed better overall on benchmark assessments than the students who participated in the lecture-style of instruction. The data also suggests that workshop students experienced greater gains than the lecture students. In the two benchmark assessments compared between workshop and lecture groups, the workshop model of instruction seemed to be better than the lecture model of instruction for sixth grade students. There were some interesting patterns noticed in the sixth grade assessment result. The sixth grade students in the workshop classrooms performed significantly higher on Benchmark 1 than their peers in the lecture classrooms. The workshop students in sixth grade also performed significantly higher than the lecture students on Benchmark 2. One possible interpretation of the findings is that all the sixth grade students who attended elementary school in the same district received the workshop model of instruction daily in their elementary math classrooms. Students were familiar

with this type of instruction. Students who were used to the math workshop model of instruction received the type of instruction they were used to when they participated in sixth grade math. However, sixth grade students participating in the lecture classrooms experienced a different type of instruction than what they were used to. They would be learning a new method of instruction in order to gain math understanding, and this could have had an impact on how they scored on the assessment.

However, on the unit post-assessment, sixth grade workshop students did not score significantly higher than the lecture students. The reason for this could have to do with the content topic that was covered in the unit assessment. The sixth grade unit that was covered, exploring real-life phenomena through one-step equations and inequalities, is a difficult standard for students to grasp. It involves correlating real-life situations into one-step equations and inequalities. Explaining how to use equations and inequalities in real life can prove to be difficult for students to grasp. Sixth grade math introduces students to a new level of abstraction and critical thinking (Basri et al., 2019). Students must not only learn to understand the math concept, but they have to learn how to apply the abstract concepts to solve real-world problems.

Another reason why the workshop students could have possibly performed similarly to the lecture students on the unit post-assessment was the amount of time that was spent on the unit instruction. This specific unit lasted for 5 weeks. Students were instructed on the real-life phenomena through one-step equations and inequalities, and then they were assessed at the end of the 5 weeks. When students were assessed on the benchmark exams, they had received approximately 10.5 weeks of instruction. Students received double the amount of instruction on the concepts presented on the benchmark exams than they did on the concepts presented on the unit post-assessment. The workshop model of instruction involves small-group math remediation

over unmastered content with the teacher, and it involves station activities where unmastered content is able to be practiced over and over again. Having less time for this type of practice and reteaching could have been a contributing factor to why the workshop students did not perform significantly higher than the lecture students on the unit post-assessment, but did perform significantly higher than them on both benchmark exams. Also, the benchmark exams cover content from the beginning of the school year, not just one specific standard topic. This means that students could have had 15–20 weeks of practice on some of the standards that were covered on the Benchmark 2 exam. More practice and preparation on the standards would better prepare students to score higher on the exam.

Even though the sixth grade unit change scores between the workshop and lecture groups were not significant, the performance of the workshop students compared to the lecture students on the unit post-assessment was significant. The workshop students scored a mean difference of 15.74 points higher than lecture students. This data suggests that workshop students were better prepared instructionally than the lecture students overall.

The seventh grade students in the workshop classrooms did not score significantly higher than the lecture students on Benchmark 1. However, the seventh grade workshop students scored significantly higher than the lecture students on Benchmark 2 and the unit post-assessment. One possible explanation for why the workshop and lecture students scored similarly on the Benchmark 1 exam, but not on the Benchmark 2 and unit post-exam, could have been that many students would have been participating in a different type of math instruction than the previous year when they started in seventh grade. Several students who had previously participated in the lecture model in sixth grade, could have been assigned to a workshop class for seventh grade and vice versa. It would take time for students participating in a new model of instruction to get

familiar and comfortable with the new method of teaching and learning. Also, the first 5 weeks of school focus on the routines and procedures of the classroom and review from the previous school year. Therefore, the students would have only had approximately 5 weeks to learn new content in each of the models of instruction. The possible effects of small-group instruction with the teacher and remedial learning stations that are correlated with the math workshop model may not have been able to take effect and be visible in a short period of time. However, as time progressed, the workshop model proved to be more effective in relation to the scores obtained on the Benchmark 2 exam and the unit post-assessment.

Even though the Benchmark 1 exam scores between the two groups were not significant, the change scores from the Benchmark 1 exam to the Benchmark 2 exam did prove to be significant. Workshop students scored significantly higher than the lecture students. The workshop students scored a mean difference of 9.30 higher than lecture students. The unit pre and post changes scores proved to be significant, as well. Workshop students scored a mean difference of 8.76 higher than lecture students.

Students in the eighth grade followed the same patterns as the seventh grade students. Workshop students did not score significantly higher than lecture students on the Benchmark 1 exam, but they did score significantly higher on the Benchmark 2 exam and the unit post-assessment. The possible reasoning could be the same as was discussed for the seventh grade students. Several students who had previously participated in the workshop model in seventh grade, could have been assigned to a lecture class for eighth grade and vice versa. It would take time for students participating in a new model of instruction to get familiar and comfortable with the new method of teaching and learning. Also, the first 5 weeks of school focus on the routines and procedures of the classroom and review from the previous school year. Therefore, the

students would have only had approximately 5 weeks to learn new content in each of the models of instruction. The possible effects of small-group instruction with the teacher and remedial learning stations that are correlated with the math workshop model may not have been able to take effect and be visible in a short period of time. However, the workshop model proved to be more effective in relation to the scores obtained on the Benchmark 2 exam and the unit post-assessment as time progressed, just as the same was reflected with the seventh-grade students.

Even though the Benchmark 1 exam scores between the two groups were not significant, the change scores from the Benchmark 1 exam to the Benchmark 2 exam did prove to be significant. Workshop students scored significantly higher than the lecture students. The workshop students scored a mean difference of 9.75 higher than lecture students. The unit pre- and post-assessment score changes proved to be significant, as well. Workshop students scored a mean difference of 6.64 higher than lecture students.

Overall, the Benchmark 1 to Benchmark 2 change scores between workshop and lecture students were significant when calculated for all sixth, seventh, and eighth grade students. Workshop students scored significantly higher than lecture students. The workshop students scored a mean difference of 11.09 higher than lecture students. The unit pre- and post-assessment change scores between workshop and lecture students showed a similar trend when calculated for sixth, seventh, and eighth grades and were also significant. Workshop model students scored significantly higher than lecture students. The workshop students scored a mean difference of 8.80 higher than lecture students. Even though there were some outliers present in the analysis of the data for each grade level, there is sufficient data to support that the workshop model was more effective than the lecture model in sixth, seventh, and eighth grades.

Data gleaned from the multiple regression analysis showed that not only did the classroom condition (workshop versus lecture) matter in regard to student performance, but the classroom setting also mattered in determining student outcomes. The results of the multiple regression indicated that both the condition (lecture versus workshop) and the classroom setting (special education, gifted education, regular education) significantly affect the learning outcomes of students, based on the unit change scores, (R^2 = .156, F=53.91, p<.001).

Summary of Findings for Research Question 2

Overall, data in this study suggests that students in the workshop classrooms had significantly more positive perceptions about how teachers were managing the classroom (i.e., control), compared to their peers in lecture classrooms, M_{diff} = .17, p = <.001. The workshop classrooms involve small-group instruction where students are retaught skills that they have not yet mastered by the teacher. The teacher pulls a small number of students to a table and instructs them on skills and standards that they have not mastered. This process could have a positive impact on how students perceive the management of the workshop classroom. If they feel that the teacher is keeping students engaged and attending to their learning needs, students could feel that the teacher is managing the learning environment well. This is evident on the survey item; our class stays busy and does not waste time. Workshop classrooms had significantly more positive perceptions about the class staying busy and not wasting time, compared to their peers in lecture classrooms, M_{diff} = -.19, p = .01. The process of meeting with small groups of students to address their needs and planning center activities based on students' needs could also affect students' perceptions about classmates respecting the teacher. Workshop classrooms had significantly more positive perceptions about classmates treating the teacher with respect, compared to their peers in lecture classrooms, M_{diff} = -.16, p = .01.

Students also participate in station work that is centered around skills that they need extra practice with. The workshop model focuses on meeting students where they are academically. It provides personalized learning instruction to assist students with mastering math content. When students feel that their learning needs are being met and their learning is relevant, this could positively affect the students' perceptions of control in the classroom as evidenced in the data.

For the Care, Clarify, Challenge, Captivate, Confer and Consolidate domains, student responses were not statistically significant between the two groups. Students in both groups responded similarly to the survey questions presented in these domains. The interpretation of the results of the survey questions found in the six domains previously discussed remains unclear. A key limitation is the lack of clarity around why students from both groups would view six out of the seven domains similarly, even though the two classroom conditions are very different. Further research is needed in this area to dig deeper to explain why the responses were not significantly different between the two conditions.

It is evident that students who participated in the math workshop model of instruction felt that their teachers had better control of the class than the lecture students. Workshop students viewed behavior in their classrooms more positively than lecture students. The view of the teacher being respected was more positively portrayed through the workshop students' responses versus the lecture students. Finally, workshop students felt that their class stayed busy and did not waste time at a higher rate than the lecture students.

For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction, their pedagogical beliefs differed significantly in delivery of instruction. Teacher-centered instruction versus student-centered instruction were the two emerging instructional types that surfaced during the study. Workshop teachers relied on

student-centered, personalized learning to meet the needs of students. Lecture teachers focused on teacher-centered, whole-group instruction to meet the needs of students.

Overall, teachers from the workshop and lecture instructional models had several similarities in their responses regarding teaching practices and strategies for student motivation/engagement. Both groups relied on healthy class competition, sufficient time for problem solving, and activating and summarizing to promote student motivation and engagement. The groups had significant differences regarding student collaboration and student self-efficacy. Workshop teachers utilized student collaboration daily in station activities and small-group lessons, while lecture teachers took a more whole-group learning approach. Workshop teachers facilitated goal setting and student data tracking, while lecture teachers did not refer to self-efficacy as a teaching practice that they use in class. Differentiation was another teaching strategy where the teacher groups differed significantly. Workshop teachers relied heavily on differentiation to meet the needs of learners, through remediating skills in small groups, providing practice through station activities and providing learning tasks through group collaboration, while lecture teachers relied on whole-group instruction, aligned with the curriculum pacing guide, and provided differentiated instruction via one-on-one assistance, as needed. One major differentiation strategy difference noted was that workshop teachers would consistently reteach unmastered content until it was mastered. On the other hand, lecture teachers would continue to move with the pacing guide if mastery was not achieved, but they would provide additional practice problems for students to work on as they moved on.

The most significant difference between the workshop and lecture model teachers regarding teachers' self-perceptions of teaching was the type of teacher they saw themselves as, whole-group instructor versus small-group instructor. Workshop model teachers strongly believe

that small-group instruction and peer collaboration through center instruction was the most effective method for teaching students. Lecture model teachers believed whole-group instruction was the most effective way to teach. The two types of teachers also differed with differentiation. Workshop teachers felt that differentiation was a strength for them, while the lecture teachers felt that it was difficult for them to implement. Workshop teachers utilized differentiation heavily to meet the needs of all students, through planning collaborating stations and small-group instruction. Lecture teachers differentiated instruction for students individually, by walking around and providing one-on-one assistance, as needed.

Chapter V

OVERVIEW OF STUDY

The purpose of this study was to test an experimental instructional approach in middle grades mathematics classrooms to determine its effectiveness. The design of this study compared the workshop model and lecture instructional approaches to determine if one approach was more effective than the other in middle grades math classrooms. Research shows that the workshop model of instruction is effective in elementary reading classrooms. The design of this study investigated if the workshop model approach is also effective in middle grades math classrooms.

This study was important in determining how students should be taught math in middle school. This particular research could help determine the most effective approach to build strong mathematical foundations within middle school students. Therefore, increasing their chances of mathematical understanding and content mastery.

According to the U.S. Department of Education (2023), 15% of students who enter ninth grade will never graduate high school. Low scores in math and reading can lead to high drop rates (McKee & Caldarella, 2016). Research shows that dropout indicators can be identified and tracked as early as middle school (McKee & Caldarella, 2016). Since these indicators in middle schoolers can contribute to possible dropout rates in the future, it is imperative that middle school educators are using the best instructional approaches to help middle school students experience math success. In doing so, graduation rates will increase, and dropout rates will decrease.

The math workshop model is an inclusive model that allows many best practices to work at the same time (Heuser, 2002). The framework underlying this study consists of three components: motivation, differentiation, and engagement. Repetition, differentiated instruction, formative assessment, guided practice, and independent practice are some of the best practices that are used during the math workshop model. These elements are embedded in the theoretical framework of integrating motivation, differentiation and engagement, in order to enhance student learning. The math workshop model incorporates these best practices strategies, along with differentiating based on students' needs, to increase student motivation and engagement.

Participants of this study were recruited from a public middle school in middle Georgia. Four classrooms using the workshop model and four classrooms using the traditional lecture model in each of sixth, seventh, and eighth grades, totaling 24 classrooms, were targeted for participant recruitment. There were 586 students included in the study. A total of nine mathematics teachers were associated with the 24 mathematics classes at the school. Among these, a total of 12 classes were taught with the workshop model and 12 classes were taught with the traditional lecture model, across the three grade levels. The class settings involved in the study were Co-teach (consisting of special education and remedial education students), regular setting (no specialized services) and gifted/high achieving (gifted students and students who maintain an A average or above for class average and score proficient or distinguished on the previous year's Georgia Milestones Math Assessment).

Out of the participants, 72% of the students are White, 23% are African American, and 2.8% are Hispanic. Special education students make up 17% of the school's population and gifted students make up 17% of the school's population. Students who are economically disadvantaged make up 49% of the school's population. Approximately 56% of math teachers

(five of nine) have been trained on the workshop model of mathematics instruction and agreed to teach with the method, and the remaining four teachers kept their traditional teaching method.

The purpose of this study was to bring about a change in the teaching of math by testing an experimental instructional approach. Research shows that the workshop model of instruction is effective in reading classrooms. The design of this study investigated whether the workshop model approach was also effective in middle grades math classrooms.

Research Questions

In order to fulfill the study's purpose, the following research questions guided the work in this study.

1. For students who participate in the math workshop model of instruction and students who participate in the lecture-style of instruction:
    a. How do student learning gains compare?
        i. To what degree, if any, do students in the math workshop classrooms perform better on the benchmark assessments than students in the lecture-style classrooms?
        ii. To what degree, if any, are the learning gains in the math workshop classrooms greater than the gains in the lecture-style classrooms?
    b. Is the effect of the instructional method (workshop vs. lecture) influenced by classroom settings (special education, general education, gifted education)?
    c. How do student perceptions of teaching compare?
2. For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction:
    a. How do their pedagogical beliefs compare?

b. How do their teaching practices and strategies (motivation, engagement, differentiation, assessment) compare?

c. How do their self-perceptions about teaching (most effective to student learning, most challenging to implement) compare?

Literature Review

This study analyzed the math data that has been collected over the years, and to discuss concerns related to that data. It also analyzed current math instructional practices and how they are impacting student achievement. The purpose of this study's literature review was to analyze current math instructional practices, the implications of current math practices, and the need to investigate alternative practices that could prove to be beneficial.

According to Desilver (2017), math performance has been a topic of concern in the United States over the past decades. Historically, student data has shown a weakness in the area of math foundational knowledge and skills at both state and national levels (Desilver, 2017). Every 2 years, the National Assessment of Educational Progress (NAEP) is administered to fourth- and eighth grade students nationwide and measures mathematical knowledge and the ability to apply mathematical concepts to problem-solving situations (National Center for Education Statistics, 2023). The data from the fourth-grade NAEP showed that 36% of fourth-grade students scored proficient or higher on the assessment, and eighth grade NAEP data showed that 26% of students scored proficient or higher on the assessment (National Center for Education Statistics, 2023). The data shows a deficiency in math understanding as it relates to the nation's fourth and eighth grade student populations.

The Georgia Department of Education (2023) math data also shows a deficiency in the mathematical understanding of Georgia students. The Georgia Milestones Assessment System

focuses on four core categories: operations and algebraic thinking, numbers and operations, measurement and data, and geometry. The percentage of third-grade students in Georgia who scored proficient or higher on the Georgia Milestones math assessment in Spring 2022 was 43%, 44% of fourth-grade students scored proficient or higher on the assessment, and fifth graders who scored proficient or higher on the assessment was 37%. The elementary school data shows Georgia Milestones math data shows that there is a deficiency in mathematical foundations among elementary students in Georgia (Georgia Department of Education, 2023).

As explained by Reuell (2019), traditionally, middle school math has been taught predominantly in a lecture format. The teacher introduces a math skill, models the skill, allows students to practice the skill with similar problems, checks over the problems, clears up misconceptions, and moves on to the next skill. This teaching style can work for students with a strong mathematical background and for students who learn quickly, but for others it is not as effective. For example, if a student is a hands-on learner, but is only shown how to solve a problem through steps on the board, that student may not be able to learn that skill. They may need the opportunity to practice with manipulatives before fully understanding the math concept being taught. Also, students who have learning needs, such as remedial or special education students, need additional support within instruction to truly master content. A lecture, without the use of manipulatives and visual aids, will not be enough to help them learn the content. They need extra layers of support beyond the whole-group lesson in order to experience success (Reuell, 2019).

Another issue with the lecture model of instruction is that as national and state math standards have changed over the course of the last 20 years, what students are being expected to do in math instruction has also changed. Previous standards focused more on rote memorization

and skill and drill. However, as math standards have changed, students are required to do more than just regurgitate formulas and rules. They are required to apply math concepts to real-world scenarios and they are expected to critically think and dig deeper to solve more complex math problems. In order to properly complete these types of tasks, students have to participate in more than whole-group instruction and practice with problems. They have to have conversations with peers, they have to apply complex mathematical ideas, they have to prove and disprove mathematical reasoning, etc. These types of learning experiences cannot be accomplished through whole-group lecture instruction only. Differentiated learning tasks that require discussion, real-world connections and problem solving must be integrated into math instruction in order for students to be able to master these skills.

The Lecture model of instruction utilized in this study consists of a teacher-centered environment. Instruction begins with a warm-up. The warm-up is a review segment where skills that have been taught before are revisited for practice. Then, the teacher provides instruction for the students in a whole group setting, based on the curriculum pacing guide. The teacher models how to solve problems and gives students time to practice solving problems independently. For the remainder of the instructional time, students spend time working out practice problems that are centered around the skill they just learned.

The math workshop model of instruction turns students into active participants during the instructional process, instead of just passive listeners (Bajak, 2014). Research shows that when teachers shift their position to be more of a guide, students are able to develop the confidence to learn reasoning and to also prove how they came up with their solutions (Baytops-Paul, 2022). Math Workshop Model teachers consistently position themselves as facilitators in their classrooms (Reuell, 2019).

The key elements that work together to make the math workshop model of instruction successful are motivation, differentiated instruction, and engagement. Within the workshop model of instruction, best practices are utilized together to create a learning environment that fosters critical thinking and that allows students opportunities to learn the content through meaningful ways that cater to their individual needs (Baytops-Paul, 2022). Within the math workshop model of instruction, students are able to experience group learning versus independent learning. Through the math workshop model, students are able to have repeated experiences with math concepts and skills; teachers are provided time to work with students as individuals or in small groups; and students are given the opportunity to take ownership of their own learning, by tracking their own academic data and setting goals for themselves (Heuser, 2002).

The workshop model of instruction implemented in this study starts off like the Lecture model. Students are given a warm-up exercise to practice previously taught skills. After the warm-up, the teacher introduces the lesson for the day. The teacher models how to solve problems and gives the students problems to solve independently. Next, students transition into learning centers. Each center focuses on a skill or standard that students still need to master, as determined by previous assessment data. Each center has 4-5 students. The guided math center is one of the centers where students transition during class. In this center, the teacher reteaches content that the students have not yet mastered. They are given additional practice problems and the teacher checks for understanding. The teacher documents the students' progress towards mastering needed standards in a guided math notebook. Each week the teacher gives an assessment at the end of the week to gauge students' progress toward mastering the standards that were practiced during the week.

Another center included in the math workshop model is a technology center. In this center, students experience personalized learning through gaming software. When students first logon to the program, they take a diagnostic assessment. The software generates an independent learning path for each student based on the diagnostic assessment data. Each time the student logs on to the software, they are assigned learning tasks based on their individual learning needs, as determined by the diagnostic assessment.

Student collaboration centers are another example of centers that are included in the math workshop model. The collaboration centers are set up to allow a group of 4-5 students to practice together on math content that they have not yet mastered. An additional student collaboration is set up for students who have already mastered the previous and current math standards. This center allows 4-5 student to work together and be enriched on current content or the next content that will be covered on the curriculum pacing guide.

Research Methods

For this study, a mixed methods concurrent parallel design was used, in order to gather multiple forms of data to answer the research questions posed in the study. Quantitative data was used through benchmark and unit assessments. Qualitative data was used through surveys and interviews to answer more in-depth questions, such as, "How are middle school students' perceptions of math influenced by the math workshop model of instruction versus the lecture-style of math instruction?" and "What do teachers perceive as the most challenging aspects of the instructional approach?"

Participants of this study were recruited from a public school in Georgia. Certain teachers at the school had already been trained in how to implement the math workshop model of instruction. Workshop model teachers participated in a two-day training during the summer,

prior to the beginning of the school year. One-hour professional development workshops were offered during the school year to refresh teachers on the training they received during the summer. These sessions occurred in August, September, October, and November.

Three separate math units were targeted for sixth, seventh, and eighth grades. The specific units targeted each contained a real-world application strand. These units were selected purposely in order to have commonality amongst them, since the scores were being compared across grade levels. For sixth grade, the unit focused on exploring real-life phenomena through one-step equations and inequalities. For seventh grade, the unit focused on making relevant connections with geometry. The eighth grade unit focused on real-life phenomena explored through systems of linear equations.

Data Collection

Several instruments were used during this research study. For the quantitative data, benchmark and unit assessments were used. The math benchmark assessment for sixth, seventh, and eighth grades is a district-wide exam that is created by a team of teachers, the instructional coach, and an administrator for grades 6–8. The math benchmark assessments are administered three times during the school year, during the months of October, December, and March. For this study, the benchmark results for October and December were used. Each math benchmark assessment contains 25 multiple-choice questions and is computer-based and housed within the Illuminate Education software platform. The benchmark assessments are cumulative and are aligned to the standards that have been taught up until the point when the benchmark is given. Unit pre- and post-assessments were also given throughout the study. The math unit pre- and post-assessments for sixth, seventh, and eighth grades are school-wide assessments that are created by 6th–8th teachers. Many of the test items are pulled from a test bank within Illuminate

Education software. Other test items are created by the teachers and are vetted once per year during the school district's scheduled curriculum revisions workday. The pre unit assessment was given at the beginning of January and the post unit assessment was given at the end of February. All students took the pre- and post-assessments on the same day, except for eighth grade students who were enrolled in the gifted and accelerated class. Students participating in gifted and accelerated math classes took their pre- and post-assessments three weeks earlier than the other students. Each pre- and post-unit assessment contained between 20–25 multiple-choice questions and was computer-based and housed within the Illuminate Education software platform. The questions were aligned to the standards that were taught within that specific unit. The unit assessments differed from the benchmark units because they were not cumulative. The student perception survey was another quantitative piece of the study that was given to participating students after the post-unit assessment. Students in the participating mathematics classrooms were surveyed electronically after the post-unit assessment to capture their experience with both the workshop model and lecture model instructional methods. Ferguson's (2010) survey is designed to capture students' perceptions of classroom teaching and it was used in this study. In total, the survey included seven demographics questions (gender, ethnicity, grade level, class, prior interest and experience with learning mathematics, language), thirty six 4-point scaled items adopted from Ferguson (2010), and two open-ended questions about their perceptions about the teaching method used. The open-ended questions were included in the qualitative analysis of the study. Students responded to statements that were categorized under the following key constructs: care, control, clarify, challenge, captivate, confer and consolidate (Ferguson, 2010). Students were given 50 minutes to complete the survey. All students completed the survey at the end of February within the same week. The survey responses were

summarized using descriptive statistics. Means and standard deviations were calculated for the Likert-scaled items.

Teacher interviews were used to obtain qualitative data that could explain the why behind the quantitative data findings. Each teacher interview lasted approximately thirty minutes. The interview contained 10 questions. The questions were segmented by the following constructs: Teacher pedagogical beliefs, teaching practices and strategies and self-perceptions of teaching. In vivo coding and pattern coding was used for analyses. The purpose of the teacher interviews was to obtain teacher perspectives about both the lecture and workshop models of instruction. The questions were aimed to provide insight into the teachers' pedagogical beliefs, teaching practices and strategies, and self-perception about teaching. Ten questions were included in the teacher interview. Math teachers were asked questions, such as, "What do you think is the best way for your students to learn math?" The interviews were conducted in person at the school. Each interview lasted approximately 30 minutes. The interviews were recorded and transcribed at a later date.

Data Analysis

Quantitative data was collected through benchmark assessment data, pre-unit assessment data, and post-assessment data. Likert-scaled student survey items were analyzed quantitatively to discover student perception about both the lecture and workshop models of instruction. This data analysis was conducted for RQ1. The effects of the instructional methods were measured by utilizing independent samples t tests for benchmark assessment scores. The individual student pre unit assessment scores were subtracted from the post unit assessment scores to determine the unit change scores. The unit change scores were analyzed through independent samples t tests.

To analyze the differential effects by classroom setting, stepwise regression analysis was used. The regression measured the effects of special education and remedial education, regular education and gifted/accelerated education. The differential effects by gender and ethnicity were measured using ANOVAs.

Students' perceptions were analyzed through survey Likert-scale data. The survey data was aggregated by the constructs of care, control, clarity, challenge, captivate, confer, and consolidate. Independent samples t tests were used for the analysis. The two open-ended survey questions were also analyzed to provide clarity for students' responses to Likert-scale questions.

Teacher data analysis was conducted for RQ2. Teacher interview data was analyzed qualitatively through coding, categorization, and determining themes from the key constructs of teacher pedagogical beliefs, teaching practices and strategies and self-perceptions of teaching. In vivo coding and pattern coding was also used for analysis. Multiple readings of the transcripts were used during analysis. This data provided insight into teacher perception of the two learning conditions. The two open-ended student survey questions were analyzed to provide further insight into student perception of the two learning conditions.

Findings

The data suggests that the math workshop model of instruction is effective in teaching mathematics to middle school students. The overall performance of workshop students was significantly higher than lecture students across benchmark, pre- and post-unit assessments. Students' perceptions in both the workshop and lecture models of instruction were similar for most of the survey domains investigated. However, the workshop students did perceive their classrooms as being better managed than the lecture students.

The benchmark data in this study suggests that the students who participated in the math workshop model of instruction performed better overall on benchmark assessments than the students who participated in the lecture-style of instruction. Workshop students also experienced greater gains than the lecture students. Sixth grade workshop students scored significantly higher than their lecture peers on both of the benchmark assessments. However, the workshop students did not score significantly higher than their lecture peers on the post-unit assessment in sixth grade. The seventh grade students in the workshop classrooms did not score significantly higher than the lecture students on Benchmark 1. However, the seventh grade workshop students did score significantly higher than the lecture students on Benchmark 2 and on the unit post-assessment. Students in the eighth grade followed the same patterns as the seventh grade students. Workshop students did not score significantly higher than lecture students on the Benchmark 1 exam, but they did score significantly higher on the Benchmark 2 exam and the unit post-assessment. Overall, the Benchmark 1 to Benchmark 2 change scores between workshop and lecture students were significant when calculated for all sixth, seventh, and eighth grade students. Workshop students scored significantly higher than lecture students. Data gleaned from the multiple regression analysis showed that the classroom condition and setting mattered in determining student outcomes. The results of the multiple regression indicated that both the condition (lecture versus workshop) and the classroom setting (special education, gifted education, regular education) significantly affect the learning outcomes of students, based on the unit change scores, (R^2= .156, F=53.91, p<.001).

The data in this study suggests that students in the workshop classrooms had significantly more positive perceptions about how teachers were managing the classroom (i.e., control), compared to their peers in lecture classrooms. Workshop classrooms had significantly more

positive perceptions about the class staying busy and not wasting time, compared to their peers in lecture classrooms, M_{diff} = -.19, p = .01. Additionally, workshop classrooms had significantly more positive perceptions about classmates treating the teacher with respect, compared to their peers in lecture classrooms, M_{diff} = -.16, p = .01. Another area where workshop classrooms had more positive perceptions than lecture classrooms was in the area where their teachers accepted nothing less than their full effort, M_{diff} = -.10, p = .08. In the Care, Clarify, Challenge, Captivate, Confer and Consolidate domains, student responses were not statistically significant between the two groups. Students in both groups responded similarly. The explanation of the similarity of responses of the two groups in regard to the survey questions found in the six domains remains unclear.

For teachers who implemented the math workshop model of instruction and teachers who implemented the lecture-style of instruction, their pedagogical beliefs differed significantly in delivery of instruction. Workshop teachers were more student-centered, while lecture teachers were more teacher-centered. Overall, teachers from the workshop and lecture instructional models had several similarities in their responses regarding teaching practices and strategies for student motivation/engagement. Both groups relied heavily on healthy class competition, sufficient time for problem solving, and activating and summarizing to promote student motivation and engagement. The two groups differed significantly in the areas of student collaboration and student self-efficacy. Workshop teachers utilized student collaboration consistently, while lecture teachers relied on direct, whole-group instruction. Workshop teachers required students to track their own data and to set learning goals for themselves, while lecture teachers did not mention self-efficacy as a strategy they use to motivate and engage students.

Differentiation was another key area where the two groups differed. Workshop teachers relied heavily on the differentiation of content, small-group instruction and center activities, while lecture teachers focused on whole-group instruction and staying on track with the curriculum pacing guide. The most significant difference between the workshop and lecture model teachers regarding teachers' self-perceptions of teaching was the type of teacher they saw themselves as, whole-group instructor versus small-group instructor. Workshop teachers saw themselves as learning facilitators and small-group instructors, while lecture teachers saw themselves as whole-group instructors.

Conclusions

This study aimed to investigate experiences and outcomes of the workshop model of instruction compared to the traditional lecture model in middle school math classrooms by exploring student test scores, student perception survey data, and teacher interviews between the two conditions. This study aimed to identify more effective ways of teaching math to middle school students. The workshop model of instruction has been used in reading and math elementary classrooms (Sharp et al., 2019). The workshop model has proven to be effective in the elementary setting. In a previous pilot study, the America's Choice Reading Workshop Model of Instruction was used to teach reading in an elementary school setting (Supovitz et al., 2002). Positive learning outcomes were evident in that setting (Sharp et al., 2019). Implementing the workshop model of instruction into middle school classrooms proved to have similar positive learning outcomes.

The research findings suggest that middle school math students who participate in the workshop model of instruction perform significantly higher than students who participate in the

lecture model of instruction. As the school year progressed, workshop students continued to perform higher than lecture students on benchmark assessments.

Although there was not much difference in the student survey data, there was a significant difference in the two groups' perceptions of a well-managed classroom. The data suggests that the workshop students perceived their class as being well-behaved and their teacher being respected significantly more than the lecture students. This research is beneficial because it suggests that if teachers implement the workshop model in their math classrooms, students could make higher learning gains than in lecture-style classrooms. This research could help math teachers to implement an instructional model that could improve their math instruction and increase the academic achievement of their students.

This study revealed a significant correlation between the classroom condition (lecture model and workshop model) and middle school students' math performance. The results of the study indicate that middle school students who participate in the math workshop model of instruction experience better learning outcomes than middle school students who participate in the lecture model of instruction. The finding that students participating in the math workshop model of instruction experience greater learning outcomes implies that educators should consider implementing the math workshop model of instruction in their math classrooms.

Research shows that differentiation and engagement are key components in helping students master content and reach their full potential (Tomlinson & Moon, 2013). Motivation is another key factor that contributes to students' success (Park et al., 2016). The math workshop model of instruction integrates these three best practices. Students receive individualized instruction, based on their current needs. Because students are getting exactly what they need at their current level of ability, they are engaged in the learning process (Parsons et al., 2014). The

workshop model of instruction motivates students through guided instruction, station work with peers, and game-based learning (Heuser, 2002). Because students are meeting with their teacher to get remediation weekly, they are able to clear up misconceptions and feel success. This process motivates them to do their best and keep taking learning risks to achieve content mastery (Steinmayr et al., 2019).

The survey data in the study showed a strong correlation of workshop model students perceiving their classrooms as well-managed. The workshop students' perceptions of a well-managed classroom environment were significantly higher than the lecture students. This implies that when students participate in the workshop model, where differentiation occurs daily, students are getting exactly what they need and there are opportunities to meet with the teacher for guided instruction, students feel like the classroom environment is managed well.

In conclusion, the assessment data in this study is mostly in favor of the workshop model of instruction. Different assessment data patterns were found for sixth grade students and this could be an area to investigate in future research. For sixth grade, there was a statistically significant difference between the workshop and lecture groups on the first benchmark assessment. This was not the case for the seventh and eighth grades. Unit gain scores showed a statistically significant difference between the workshop and lecture groups for seventh and eighth grade, but not sixth grade.

There was a significant effect of the classroom setting on the effects of the instructional methods on math learning. However, student gender and ethnicity were not a significant factor. This could be an area for future research.

Student perceptions of teaching did not differ much, except for how they viewed the control of the classroom. Workshop students felt their classrooms were more controlled than

lecture students. Teacher perceptions illustrated how the two methods differed, despite sharing similarities. Both sets of teachers valued differentiation, due to students' diverse learning needs. However, they had different views of how to effectively differentiate in the classroom. Lecture teachers believed one-on-one support was the most effective way to differentiate, while workshop teachers felt small-group math instruction and math centers based on assessment data were the best ways to differentiate. They both agreed that lack of time and keeping middle school students engaged were challenges.

The workshop model of instruction relies heavily on individualized instruction (Morgan, 2014). Every student is getting exactly what they need to help master skills. Learning is scaffolded to meet the students' needs (Morgan, 2014). Students are able to meet with the teacher to remediate skills they are struggling with, and they are able to work with their peers to practice needed skills. The instruction in the workshop classroom is tailored to the learners' needs (Trinter et al., 2013). The instruction in the lecture classroom is tailored more to the pacing guide and the grade level demands, but not necessarily the individual needs of the students (Reuell, 2019).

Educators have observed many middle school students scoring below the proficiency level in math. The 2023–2024 Georgia Milestones math assessment results showed that 41.6% of sixth graders, 39.8% of seventh graders, and 44.7% of eighth graders scored at the proficiency level or above (Georgia Department of Education, 2024). This study suggests that implementing the math workshop model of instruction in middle school math classrooms could improve middle school students' learning outcomes and performance. Therefore, having the potential to increase statewide math scores for sixth, seventh, and eighth grades. It also suggests that implementing

the math workshop model of instruction could improve the students' perceptions of the management of the classroom environment.

Recommendations for Practitioners

1. Middle school math teachers should be informed about the benefits of the math workshop model instructional approach. The workshop model of instruction has proven to be effective in elementary reading classrooms. Through the pilot study mentioned in this research and the research study itself, the math workshop model of instruction has proven to also be effective in middle school math classrooms. The benefits of the math workshop model of instruction include increased student engagement and motivation through the means of individualizing instruction to meet the needs of all students.
2. Middle school math teachers should be trained in the math workshop model of instruction. If math teachers have limited experience with small-group instruction and personalized learning through center activities, it will be imperative that they receive training on how to implement the math workshop model of instruction. Middle school teachers are not as familiar with the workshop model approach as elementary teachers, so it will be important for them to receive thorough training.
3. Middle school math teachers should incorporate more differentiated learning opportunities in their instruction. Small-group instruction and center activities, based on students' needs, should be incorporated daily into math instruction.
4. Middle school math teachers should consistently collect and analyze student data to plan small-group lessons for remediation and to plan math center activities for practicing the math content.

5. Middle school math teachers should observe math teachers who are currently utilizing the math workshop model of instruction. Observing the workshop model approach in action will help teachers to understand the model and how it can be implemented to increase student math outcomes.

Recommendations for Future Research

1. To further explore the effects of the workshop and lecture models of instruction in middle school settings, future research could compare the two instructional conditions in other middle school settings (replication).
2. Future research could be conducted to examine effects of the workshop model in other subject areas.
3. Future research could be conducted to take a more in-depth look into the differential effects of the workshop model of instruction, specifically by classroom setting, such as special education, remedial education and gifted and accelerated education. Also, a more in-depth look into the differential effects of the workshop model of instruction could be conducted for specific sub-groups, such as economically disadvantaged, race and gender.
4. For this specific setting, future research could investigate why the sixth grade workshop model students performed significantly better than the lecture students on both benchmark assessment, but not the unit post-assessment. Findings could possibly lead to improved instructional practices moving forward.
5. For this specific setting, future research could investigate why the workshop and lecture students responded similarly to the constructs outlined in the student perceptions survey, even though the performance outcomes were significantly

different. Findings could possibly lead to improved instructional practices moving forward.

6. Future research could investigate if the workshop model of instruction is effective for other subject areas in the middle school setting. Findings could lead to improved instructional practices and improved student outcomes.

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Appendix A:

Learning Gains Spreadsheet

Appendix A. Learning Gains Spreadsheet

Student Identifier	Classroom Setting	Classroom Condition	Teacher's Initials	Benchmark 1 Data	Benchmark 2 Data	Change Rate (BM1 to BM2)	Unit Pretest Data	Unit Post Data	Change Rate (Pre to Post)
Student 0	SPED and Remedial	Lecture	CC						

Appendix B:

Teacher Participants and Their Classes

Appendix B. Teacher Participants and Their Classes

Grade	Condition	Teacher	Class Type	Students
6	Lecture	Shay	Co-Teach	8 Special Education and 17 Remedial Education Students
6	Lecture	Shay	Co-Teach	10 Special Education and 14 Remedial Education Students
6	Lecture	Shay	Regular Setting	25 Students/No Specialized Services
6	Lecture	Shay	Gifted & High Achieving	10 Gifted Students and 15 High Achievers
6	Workshop	John	Gifted & High Achieving	11 Gifted Students and 13 High Achievers
6	Workshop	Jen	Co-Teach	8 Special Education and 17 Remedial Education Students
6	Workshop	Jen	Regular Setting	27 Students/No Specialized Services
6	Workshop	John	Gifted & High Achieving	9 Gifted Students and 15 High Achievers
7	Lecture	Andy	Gifted & High Achieving	10 Gifted Students and 16 High Achievers
7	Lecture	Andy	Co-Teach	8 Special Education and 18 Remedial Education Students
7	Lecture	Alex	Gifted & High Achieving	9 Gifted Students and 15 High Achievers
7	Lecture	Alex	Regular Setting	25 Students/No Specialized Services
7	Workshop	Misty	Co-Teach	8 Special Education and 18 Remedial Education Students
7	Workshop	Misty	Co-Teach	9 Special Education and 16 Remedial Education Students
7	Workshop	Misty	Gifted & High Achieving	7 Gifted Students and 17 High Achievers
7	Workshop	Misty	Regular Setting	26 Students/No Specialized Services
8	Lecture	Theo	Regular Setting	25 Students/No Specialized Services
8	Lecture	Theo	Co-Teach	8 Special Education and 16 Remedial Education Students
8	Lecture	Theo	Gifted & High Achieving	9 Gifted Students and 16 High Achievers
8	Lecture	Theo	Co-Teach	6 Special Education and 17 Remedial Education Students
8	Workshop	Angie	Regular Setting	24 Students/No Specialized Services
8	Workshop	Angie	Co-Teach	8 Special Education and 15 Remedial Education Students
8	Workshop	Cole	Co-Teach	7 Special Education and 17 Remedial Education Students
8	Workshop	Cole	Gifted & High Achieving	10 Gifted Students and 15 High Achievers

Appendix C:

Summary of the Middle School Mathematics Units Targeted in This Study

Appendix C. Summary of the Middle School Mathematics Units Targeted in This Study

	Grade 6	Grade 7	Grade 8
Topic	Exploring real-life phenomena through one-step equations and inequalities.	Making relevant connections with geometry.	Real-life phenomena explored through systems of linear equations.
Academic Standards	6.PAR.7 Write and solve one-step equations and inequalities as mathematical models to explain authentic, realistic situations.	7.GSR.5 Solve practical problems involving angle measurement, circles, area of circles, surface area of prisms and cylinders, and volume of cylinders and prisms composed of cubes and right prisms.	8.FGR.7 Justify and use various strategies to solve systems of linear equations to model and explain real-life phenomena.
Mathematical Practices 6.MP. 1–8, 7.MP. 1–8, 8.MP. 1–8 MP.1 Make sense of problems and persevere in solving them. MP.2 Reason abstractly and quantitatively. MP.3 Construct viable arguments and critique the reasoning of others. MP.4 Model with mathematics. MP.5 Use appropriate tools strategically. MP.6 Attend to precision. MP.7 Look for and make use of structure. MP.8 Look for and express regularity in repeated reasoning.			

Note. MP: Mathematical Practices, PAR: Patterning & Algebraic Reasoning, GSR: Geometric & Spatial Reasoning, FGR: Functional & Graphical Reasoning

Appendix D:

Assessment Revision Checklist

Appendix D. Assessment Revision Checklist

Grade	Subject	Assessment Name	Evaluators

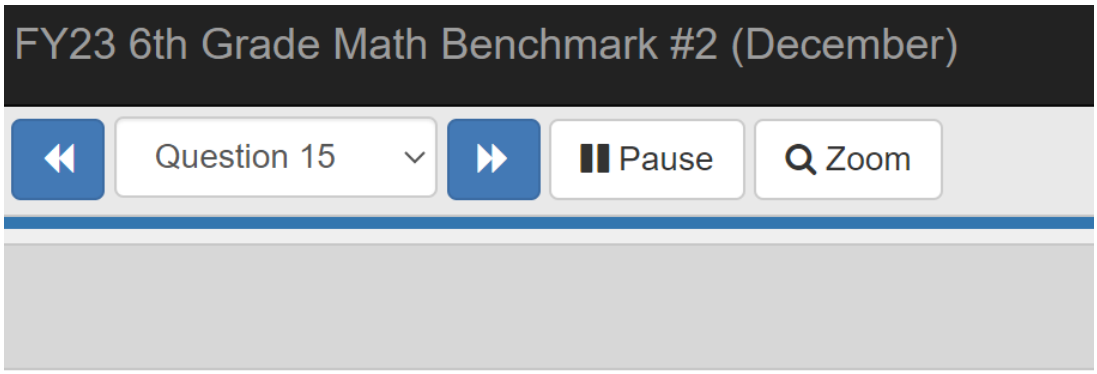
Assessment Revision Checklist

- Questions are aligned to grade-level standards Yes No
- Standards are in the instructional calendar Yes No
- Balanced % of questions per standard Yes No
- DOK level and standard are beside each question Yes No
- The assessment is balanced in terms of DOK levels (This will be determined by the standard.) Yes No
- The assessment includes brief constructed item(s) Yes No
- Rubrics are included for BCR items Yes No
- Reading passages are at the appropriate Lexile level Yes No

Appendix E:

Benchmark Assessment (Sample)

Appendix E. Benchmark Assessment (Sample)



Question 15

What improper fraction is equivalent to $7\frac{5}{8}$?

A $\frac{75}{8}$

B $\frac{56}{8}$

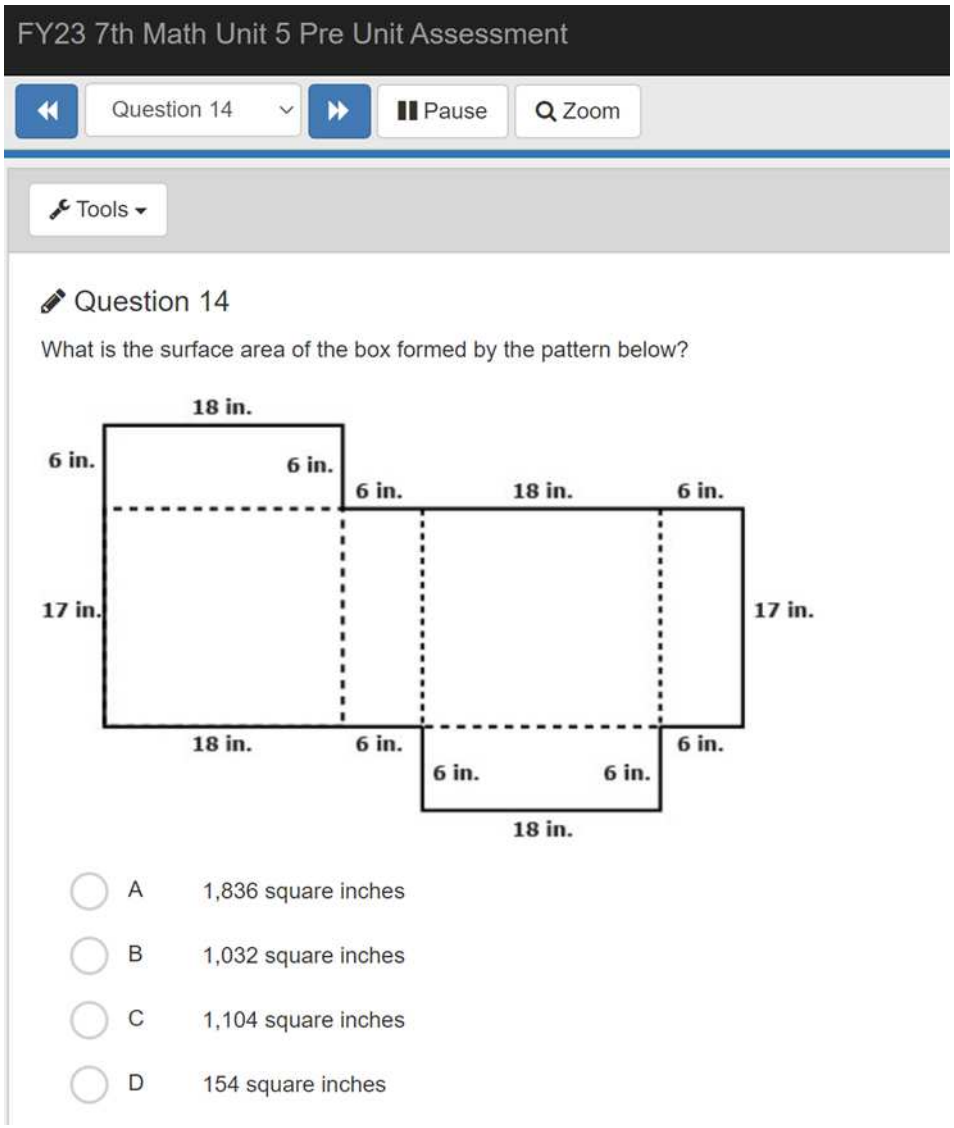
C $\frac{61}{8}$

D $\frac{78}{5}$

Appendix F:

Pre and Post Unit Assessment (Sample)

Appendix F. Pre and Post Unit Assessment (Sample)



Appendix G:

Student Perception Survey

Appendix G. Student Perception Survey

Direction: This survey will be developed with Qualtrics and be distributed electronically.

Demographics:

1. What is your gender?
    a. Female
    b. Male
    c. Prefer not to identify
2. What is your ethnicity?
    a. White/Caucasian
    b. Black/African American
    c. Hispanic
    d. Asian/Pacific Islander
    e. Multiple ethnicity
    f. Other, please specify:
3. What grade are you in?
    a. Sixth grade
    b. Seventh grade
    c. Eighth grade
4. Which class are you in?
    a. Co-teach and remedial
    b. Gifted and accelerated
    c. Regular setting

5. Do you enjoy learning math? (4-point Likert)
6. I usually do well on math tests. (4-point Likert)
7. How comfortable are you with learning math? (4-point Likert)

Student Perceptions of Teaching (Ferguson, 2010), 4-point Likert:

1. My teacher in this class makes me feel that s/he really cares about me.
2. My teacher seems to know if something is bothering me.
3. My teacher really tries to understand how students feel about things.
4. Student behavior in this class is under control.
5. I hate the way that students behave in this class.
6. Student behavior in this class makes the teacher angry.
7. Student behavior in this class is a problem.
8. My classmates behave the way my teacher wants them to.
9. Students in this class treat the teacher with respect.
10. Our class stays busy and does not waste time.
11. If you don't understand something, my teacher explains it another way.
12. My teacher knows when the class understands and when we do not.
13. When s/he is teaching us, my teacher thinks we understand even when we don't.
14. My teacher has several good ways to explain each topic that we cover in this class.
15. My teacher explains difficult things clearly.
16. My teacher asks questions to be sure we are following along when s/he is teaching.
17. My teacher asks students to explain more about the answers they give.
18. In this class, my teacher accepts nothing less than our full effort.
19. My teacher doesn't let people give up when the work gets hard.

20. My teacher wants us to use our thinking skills, not just memorize things.

21. My teacher wants me to explain my answers — why I think what I think.

22. In this class, we learn a lot almost every day.

23. In this class, we learn to correct our mistakes.

24. This class does not keep my attention — I get bored.

25. My teacher makes learning enjoyable.

26. My teacher makes lessons interesting.

27. I like the ways we learn in this class.

28. My teacher wants us to share our thoughts.

29. Students get to decide how activities are done in this class.

30. My teacher gives us time to explain our ideas.

31. Students speak up and share their ideas about classwork.

32. My teacher respects my ideas and suggestions.

33. My teacher takes the time to summarize what we learn each day.

34. My teacher checks to make sure we understand what s/he is teaching us.

35. We get helpful comments to let us know what we did wrong on assignments.

36. The comments that I get on my work in this class help me understand how to improve.

Open-ended:

1. What do you most like about the way your math class was taught?
2. What do you least like about the way your math class was taught?

Appendix H:

Teacher Interview Protocol

Appendix H. Teacher Interview Protocol

The interviews will take place at the middle school involved in the study. The middle school contains sixth, seventh, and eighth grade students. The interviews will take place in the media room, located in the school's library.

"Good afternoon. Thank you for participating in the study and the interview. The purpose of the interview is to gain insight through the teacher's point of view, as it relates to classroom instruction in mathematics. There will be 10 questions presented to you. I will ask the questions, and you will respond. I am recording the interview session for the purpose of being able to go back and include all of the information shared. This interview will last approximately 30 minutes?"

1. How long have you taught math?
2. What do you think is the best way for your students to learn math?
3. Walk me through a typical day in your math classroom.
4. (For workshop model teachers only.) You are selected for this study as you are identified as implementing the math workshop model in your classrooms. What are the three key characteristics of the workshop model you are implementing?

   (For lecture model teachers only.) What are the three key characteristics of your teaching in the math classroom?

   a. Can you provide an example of XXX (repeat for each characteristic)?
5. Do students in your math classroom work with peers?

   a. If so, how?
6. If you regularly group students, how do you form student groups?
7. What are your strategies for differentiation in your math classrooms?

    a. Can you share an example?

8. Do you use student data to make decisions for instruction?
    a. If so, how?
9. Which aspect of your teaching do your students like the most?
    a. Why?
10. Which aspect of your teaching do your students struggle the most?
    a. Why?

"Thank you so much for your time. Your responses are imperative to the study."

Appendix I:

Comparison of Student Perceptions Between Workshop vs. Lecture Classrooms (*t*-Test Results)

Appendix I. Comparison of Student Perceptions Between Workshop vs. Lecture Classrooms (*t*-Test Results)

Construct/Item	Condition	*M*	*SD*	M_{diff}	*t*	*df*	*p*	*d*
Care	W	2.95	.73	.04	.66	572	.26	.06
	L	2.91	.76	-	-	-	-	-
My teacher in this class makes me feel that s/he really cares about me.	W	3.19	.82	-.05	-.78	570	.43	-.06
	L	3.13	.84	-	-	-	-	-
My teacher seems to know if something is bothering me.	W	2.68	.88	-.05	-.72	572	.47	-.06
	L	2.63	.88	-	-	-	-	-
My teacher really tries to understand how students feel about things.	W	3.0	.81	-.03	-.38	571	.70	-.03
	L	2.97	.88	-	-	-	-	-
*Control	W	2.75	.59	.17	3.45	561	<.001	.29
	L	2.58	.60	-	-	-	-	-
Student behavior in this class is under control.	W	2.81	.85	-.06	-.85	572	.40	-.07
	L	2.75	.82	-	-	-	-	-
* I hate the way that students behave in this class.	W	2.09	.87	.19	2.59	572	.01	.22
	L	2.29	.91	-	-	-	-	-
* Student behavior in this class makes the teacher angry.	W	2.57	.89	.21	2.86	569	.00	.24
	L	2.78	.87	-	-	-	-	-
* Student behavior in this class is a problem.	W	2.38	.89	.21	2.93	570	.00	.25
	L	2.60	.85	-	-	-	-	-
* My classmates behave the way my teacher wants them to.	W	2.65	.76	-.18	-2.82	570	.01	-.24
	L	2.47	.80	-	-	-	-	-
* Students in this class treat the teacher with respect.	W	3.02	.76	-.16	-2.49	570	.01	-.21
	L	2.86	.80	-	-	-	-	-
* Our class stays busy and does not waste time.	W	2.84	.83	-.19	-2.64	571	.01	-.22
	L	2.65	.91	-	-	-	-	-
Clarify	W	2.98	.64	.06	1.12	560	.13	.10
	L	2.92	.66	-	-	-	-	-
If you do not understand something, my teacher explains it another way.	W	3.11	.79	-.09	-1.33	571	.19	-.11
	L	3.02	.79	-	-	-	-	-
My teacher knows when the class understands and when we do not.	W	3.06	.82	-.06	-.82	566	.41	-.07
	L	3.00	.87	-	-	-	-	-

When s/he is teaching us, my teacher thinks we understand even when we don't.	W	2.38	.90	.06	.84	566	.40	.07
	L	2.44	.88	-	-	-	-	-
My teacher has several good ways to explain each topic that we cover in this class.	W	3.09	.83	-.05	-.70	570	.48	-.06
	L	3.04	.83	-	-	-	-	-
My teacher explains difficult things clearly.	W	2.99	.85	-.05	-.72	569	.47	-.06
	L	2.94	.83	-	-	-	-	-
Challenge	W	3.21	.52	-.003	-.06	557	.48	-.01
	L	3.21	.49	-	-	-	-	-
My teacher asks questions to be sure we are following along when s/he is teaching.	W	3.30	.73	.01	.10	567	.92	.01
	L	3.31	.68	-	-	-	-	-
My teacher asks students to explain more about the answers they give.	W	3.25	.69	.08	1.40	571	.16	.12
	L	3.33	.66	-	-	-	-	-
In this class, my teacher expects nothing less than our full effort.	W	3.24	.68	-.10	-1.78	567	.08	-.15
	L	3.13	.71	-	-	-	-	-
My teacher doesn't let people give up when the work gets hard.	W	3.17	.76	.05	.74	568	.46	.06
	L	3.22	.74	-	-	-	-	-
My teacher wants us to use our thinking skills, not just memorize things.	W	3.23	.76	.01	.16	570	.88	.01
	L	3.24	.70	-	-	-	-	-
My teacher wants me to explain my answers—why I think what I think.	W	3.13	.71	.08	1.39	570	.17	.12
	L	3.21	.65	-	-	-	-	-
In this class, we learn a lot almost every day.	W	3.16	.74	-.10	-1.54	570	.12	-.13
	L	3.06	.80	-	-	-	-	-
In this class, we learn to correct our mistakes.	W	3.21	.71	-.10	-1.75	569	.08	-.15
	L	3.11	.70	-	-	-	-	-
Captivate	W	2.63	.78	.06	.89	567	.19	.07
	L	2.58	.79	-	-	-	-	-
This class does not keep my attention—I get bored.	W	2.59	.10	.09	1.11	571	.27	.09
	L	2.68	1.00	-	-	-	-	-
My teacher makes learning enjoyable.	W	2.72	.90	-.06	-.76	571	.45	-.06
	L	2.67	.85	-	-	-	-	-
My teacher makes lessons interesting.	W	2.68	.85	-.01	-.16	570	.87	-.01
	L	2.67	.92	-	-	-	-	-
I like the ways we learn in class.	W	2.62	.93	-.03	-.44	569	.66	-.04
	L	2.58	.95	-	-	-	-	-
Confer	W	2.73	.58	-.03	-.53	562	.30	-.05
	L	2.76	.60	-	-	-	-	-

My teacher wants us to share our thoughts.	W	3.01	.72	.02	.26	569	.79	.02
	L	3.03	.76	-	-	-	-	-
Students get to decide how activities are done in class.	W	3.01	.72	.02	.26	569	.79	.02
	L	3.03	.76	-	-	-	-	-
My teacher gives us time to explain our ideas.	W	2.91	.75	.02	.39	568	.70	.03
	L	2.94	.76	-	-	-	-	-
Students speak up and share their ideas about classwork.	W	2.68	.83	.12	1.68	572	.09	.14
	L	2.80	.84	-	-	-	-	-
My teacher respects my ideas and suggestions.	W	3.01	.74	-.05	-.78	567	.44	-.07
	L	2.97	.75	-	-	-	-	-
Consolidate	W	2.93	.63	-.002	-.04	562	.49	-.003
	L	2.94	.69	-	-	-	-	-
My teacher takes the time to summarize what we learn each day.	W	2.87	.77	.00	.04	566	.97	.00
	L	2.88	.83	-	-	-	-	-
My teacher checks to make sure we understand what s/he is teaching us.	W	3.14	.76	-.02	-.32	567	.75	-.03
	L	3.12	.72	-	-	-	-	-
We get helpful comments to let us know what we did wrong on assignments.	W	2.84	.80	.03	.45	568	.65	.04
	L	2.88	.85	-	-	-	-	-
The comments that I get on my work in this class help me understand how to improve.	W	2.85	.78	.00	.03	565	.98	.00
	L	2.85	.86	-	-	-	-	-

Note. W and L under Condition stand for Workshop and Lecture. Significant results are marked with * ($p < .5$).

Appendix J:

Comparison of Teachers' Teaching Practices and Strategies

Appendix J. Comparison of Teachers' Teaching Practices and Strategies

	Lecture	Workshop
Motivation/ Engagement	Rewards/Incentives • Providing praise and incentives • Providing a reward system • Motivating students by providing extra credit for extra practice • Healthy competition among classes (prizes earned) Real-World Connections • Connecting the learning to the real world • Relating the lesson to real life Practice • Modeling • Providing guided practice Activating Strategies • Use of an activator prior to the lesson • Accessing prior knowledge before teaching • Beginning with warm-ups daily • Building relationships with students • Asking questions • Whole-group discussions • Utilizing game-based software and assessments • Summarizing the lesson	Rewards/Incentives • Healthy class competition • Provide candy and rewards to motivate • Offering praise to motivate • Facilitate competitions to motivate students • Provide candy and rewards to motivate • Offering praise to motivate • Facilitate competitions to motivate students • Implementing individual and group competitions • Providing incentive-based rewards • Use of a data wall to display class scores on assessments and class incentives for reaching class goals Collaboration • Collaborative group work (centers) • Collaborative group discussion • Allowing students to work in groups and with partners • Facilitate short discussions Practice • Providing guided review • Guided practice (step-by-step) Activating Strategies • Begin with an activating strategy • Engaging students in the lesson with an activating strategy • Providing warm-up activities • Providing warm-ups • Activating strategies

		Use of Technology • Use of technology (games, view board, graphing software) • Playing videos to engage students Modeling Strategies/Solving • Modeling skills • Modeling how to solve • Providing examples • Displaying exemplars of completed activities • Quickly clearing up students' misconceptions Real-life Connections • Providing relevancy • Motivating through relevancy • Providing relevancy for the lesson • Real-world connections to learning Self-efficacy • Students track their own data with the use of data notebooks • Soliciting feedback from students • Student self-efficacy through setting goals • Providing checklists to keep students on track Summarizing the Lesson • Summarizing the lesson • Summarizing • Providing a summary of the lesson • Using summarizing strategies to wrap up the day's lesson • Reviewing learning objectives/standards

		• Building relationships with students and being honest about math performance • Hands-on learning and activities
Differentiation	Whole-Group Learning • Whole-group instruction • Whole-group math review • One-on-one support within whole-group instruction (teacher walks around and assists individual students.) • Clearing up misconceptions in the whole-group setting (everyone gets the information) • Providing feedback to students during the lesson Peer Partnering • Peer pairing for practice (strong/weak learners paired) • Differentiating by the presentation of the content, who they get to work with (partners) Presentation of Content • Data-driven (warm-up and review activities are chosen based on students' performance data on assessments) • Students have opportunities to choose which activity they will complete to practice the content	Small-Group Instruction • Station teaching • Parallel teaching • Flexible grouping students who need remediation with the teacher • Small-group instruction with the teacher (reteaching of skills not mastered) • Providing small-group opportunities with the teacher • Providing remediation daily in small-group setting • Facilitating small-group, teacher-led instruction Personalized Learning • Leveled activities • Questioning (using varied levels of depth of knowledge) • Different levels of complexity for activities • Tailoring instruction to students' specific learning styles • Using flexible groups for differentiation (based on data collected and analyzed) • Tiered assignments, based on students' ability levels • Tiered lessons • Reteach content before moving on • Targeted instruction, based on student data

	• Spiral review (working previously taught skills into the warm-up portion of the lesson)	• Reviewing previously taught standards through warm-ups, centers, and small-group instruction (based on student data) Using Data to Form Groups/Lessons • Breaking students into different groups (based on learning levels or based on what the data shows the needs are) • Flexibly grouping • Fluid groupings • Using data to plan for next steps (lessons) • Using data to plan for next steps (lessons) • Using observation data to guide instruction and to form groups Instructional Learning Centers • Providing a differentiated work session for students to experience the content that was just taught • Station teaching with several stations going on simultaneously • Station activities implemented daily • Use of peer partners and groups Guided Practice • Providing guided practice opportunities • Providing guided practice time on skills that were just taught • Providing independent practice time for specific skills for specific students (teacher is available for support) • Gradually releasing responsibility with problem solving

		Use of Learning Aids • Use of manipulatives • Use of graphic organizers • Differentiating through content, process, and product • Teacher providing support throughout the lesson • Spiral reviews during warm-ups
Assessment	• Checking for understanding • The use of quick checks • Utilization of formative and summative assessments throughout lessons • Utilizing formative and summative assessments • Monitoring students' progress • The use of multiple assessments to gauge if students understood the lesson/unit	• Informal assessments • Formative assessments • Use of informal assessments to gain information to plan for next steps with instruction • Using formative assessments to guide instruction • Use of quick, formative assessments at the end of the work session (such as a ticket out of the door) • Weekly formative assessments to plan small-group instruction and center activities • Item analysis and corrections after assessments are conducted • Checking for mastery • Using observations to quickly clear up misconceptions • The use of a data notebook to track students' progress and next steps • Using questioning strategies to gauge students' understanding • Use of end of unit tests • Use of game software as assessment data • Summative assessments (unit tests) • Summative assessments to gauge students' understanding and to plan for review and remediation, if needed

Appendix K:

Comparison of Teachers' Self-Perception of Teaching

Appendix K. Comparison of Teachers' Self-Perception of Teaching

Lecture	Workshop
• Whole-group instruction • Engagement • Discussions	• Connecting the content to real-world scenarios • Motivation for students to take risks and try to solve problems • Differentiating through small-group learning/centers
Practice • Provides lots of practice • Allowing students to redo problems they have missed to figure out the correct answer	Data Usage • Data disaggregation • Data utilization • Using data to alter instruction
Strengths • Strong content knowledge • Strong ability to pace instruction (planning for teaching standards) • Strong understanding of procedural fluency • Skilled with building relationships with students • Skilled with asking questions • Strong with teaching note-taking strategies	Strengths • Strong with differentiating • Strong with engaging students • Strong classroom management and structure • Strong with providing feedback • Strong with building relationships with students • Strong with providing relevancy to the content
Weaknesses • Struggle with meeting all the students' needs because they are on so many different levels • Struggle with allowing students the proper wait-time to have productive struggle	Weaknesses • Not enough time to do everything that needs to be done • Students who struggle with the content are hard to motivate • Strong with building relationships • Strong with determining learning styles of my students

• Struggles with planning when students are not ready to move on with the pacing guide • Difficulty differentiating	• Struggle with being able to provide all of my students with exactly what they need when they are on so many different learning levels • Data collection is difficult (collecting and knowing what to do with it) • Difficult to meet every student's need • Difficult to keep gifted students engaged • Difficulty with targeting every student's exact need(s)

Appendix L:

IRB Certificate

Institutional Review Board (IRB)
for the Protection of Human Research Participants

PROTOCOL EXEMPTION REPORT

Protocol Number: 04483-2023

Responsible Researcher: Christina Chapman

Supervising Faculty: Dr. Jiyoon Jung & Dr. Steven Downey

Co-Investigator: n/a

Project Title: *Mixed Methods Study of the Math Workshop Model of Instruction in Middle School.*

INSTITUTIONAL REVIEW BOARD DETERMINATION:

This research protocol is **exempt** from Institutional Review Board (IRB) oversight under 45 CFR 46.101(b) of the federal regulations, **category 2**. If the nature of the research changes such that exemption criteria no longer apply, please consult with the IRB Administrator (irb@valdosta.edu) before continuing your research study.

ADDITIONAL COMMENTS:

- *Exempt protocol guidelines **permit** the recording of interview sessions provided recordings are made to create an accurate transcript. Exempt guidelines **prohibit** the collection, storage, and/or sharing of recordings. Upon creation of the transcript, the recorded interview session must be deleted from each recording and storage devices used.*
- *In keeping with established consent guidelines, interview recordings must include the researcher reading aloud the consent statement, confirming participant understanding, and establishing their willingness to take part in the interview. Participants must be provided with a copy of the research statement.*
- *To ensure confidentiality of participants, pseudonym lists must be kept in a separate secure file from corresponding name lists, email addresses, etc.*
- *Upon completion of the research study all data (e.g. data, pseudonym list, email lists, transcript, etc.) must be securely maintained (e.g. locked file cabinet, password protected computer, etc.) and accessible only by the researcher for a minimum of 3 years. At the end of the required time, collected data must be permanently destroyed.*

☒ ***Please submit any documents you revise to the IRB Administrator at tmwright@valdosta.edu to ensure an updated record of your exemption.***

Elizabeth W. Olphie *01.17.2024*

Elizabeth W. Olphie, IRB Administrator Date

Thank you for submitting an IRB application.

Please direct questions to irb@valdosta.edu or 229-259-5045.