The Impact of the Flipped Classroom Model on Elementary Students’ Achievement and Motivation for Learning Geometry

Kimberly M. Smalls

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THE IMPACT OF THE FLIPPED CLASSROOM MODEL ON ELEMENTARY STUDENTS’ ACHIEVEMENT AND MOTIVATION FOR LEARNING GEOMETRY

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DEDICATION

This work is dedicated to my loving husband Robert and the sweetest daughter in the world, Karleigh. Your love and support kept me afloat on days when I was drifting. You encouraged me when I wanted to give up and supported me in so many ways. I am forever grateful to my loves. Thank you.

To my parents, Willie and Juanita, thanks for always believing in me, pouring into me, and praying for me. Your love and support mean the world to me.
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Finally, I want to express my gratitude to all of the participants in this study. From the students to the parents who granted permission, my partner teacher for allowing me to work with her students, and my administrative team for your support. I appreciate you all.
ABSTRACT

National and state data show students in poverty perform lower on math standardized assessments than their peers who are not students in poverty. The purpose of this action research was to evaluate the implementation of the flipped classroom model on the achievement and motivation towards mathematics for fourth-grade students at an elementary school in the Southeast United States. Traditional teaching methods such as teacher-led modeling, the use of manipulatives, and small-group math instruction present barriers which have not led to overall academic improvement for these students. This study focused on three overarching questions: (1) Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model? (2) What is fourth-grade students’ motivation toward math after attending a flipped classroom model? (3) What are fourth-grade students’ perceptions of the flipped classroom model?

This study used a triangulation mixed methods design with 17 fourth-grade students learning a geometry unit. The students participated in the flipped classroom model for eight weeks. Qualitative and quantitative data were collected using a geometry pretest and posttest, a motivation questionnaire, a perception questionnaire, and focused group interviews. Qualitative data in this study were analyzed using inductive and thematic analysis. Quantitative data were analyzed using paired samples t-tests and descriptive statistics.
Quantitative findings from the study show there was a significant difference between the pretest and posttest scores on the geometry test after using the flipped classroom model. Qualitative data analyses led to the development of four themes: Using the flipped classroom model positively affected the four components of the ARCS model of motivation; The students used strategies that supported independent learning, engagement, and concept development; Students identified perceived benefits of using the flipped classroom model; and Students did not prefer the flipped classroom model of learning math.

Keywords: flipped classroom model, math, motivation, perception, elementary school
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CHAPTER 1

INTRODUCTION

National Context

Student achievement in fourth-grade mathematics increased by only one point in 2019 from 2017, according to the National Assessment of Education Progress (NAEP, 2019). The NAEP (2019) reported higher average scores for many subgroups, including Hispanic students, male students, and students eligible for the National School Lunch Program (NSLP) from the previous assessment in 2017. However, students eligible for NSLP scored on average lower than those who were not eligible, scoring 229 and 253 respectively. This means students receiving NSLP score on average below the proficient score of 249, while students not eligible for NSLP score slightly above the cut score (NAEP, 2019).

Math assessment data from the Programme for International Student Assessment (Schleicher, 2018) indicates student achievement for American students is below average when compared to countries around the world. The United States scored at a Level 2 with a mean score of 478. The average score for test takers was 489. Many countries far outperformed the United States such as Canada (512), Netherlands (519), and Korea (526) at Level 3 with China (591) and Singapore (569) at Level 4 (Schleicher, 2018). Since 2003, there has been no significant improvement or decline in mathematics (Organisation for Economic Co-operation and Development, 2018).
In many countries, socio-economically disadvantaged students were outperformed by their peers who were not classified as disadvantaged. Sixteen percent of the variation in math scores was attributed to socioeconomic status (OECD, 2018).

National solutions to these achievement gaps in mathematics tend to include an increase in the funding per student in the United States. Title I provides additional funding to schools with a high percentage of students from low-income families. These funds are intended to support these students by enhancing instructional services and activities (James, 2016). This has not been the most effective strategy concerning the issue of the achievement gap in mathematics, as countries such as Canada, Ireland, and New Zealand outperformed students in the United States according to PISA 2018 data while spending between 10 - 30% less per student (Schleicher, 2018).

These statistics show students in poverty need additional resources and strategies to improve in mathematics. Research indicates teachers, followed by principals are the most important school-based factors that affect the achievement of students (Public Impact, 2018). Conducting student-centered activities which include fostering students' active learning and solving their individual learning deficiencies are key to improving their learning outcomes (Lai & Hwang, 2016). The national focus on educational policies such as 21st Century Skills not only includes student-centered strategies but also includes the use of technology as a means of enhancing student learning as well as preparing students for the workforce (Kostaris et al., 2017).

The flipped classroom model is a student-centered approach which has been studied to improve learning experiences and competencies (Kostaris et al., 2017). The flipped classroom model has been used throughout the world with some success as
explained in literature reviews on the subject (Akçayir & Akçayir, 2018; Lo & Hew, 2017a). Lo and Hew (2017a) reviewed 15 studies completed in The United States and Taiwan with time spans of two weeks to one year. Overall, the flipped classroom model promoted active learning and students performed significantly better than students in traditional classrooms. Both reviews however found the flipped classroom model has mainly been studied at the high school and college levels. While finding there were more advantages to using the flipped classroom model than challenges, the researchers recommend more research be conducted at the K-12 level (Akçayir & Akçayir, 2018).

Local Context

This study took place at an elementary school in the Southeast United States in a Title I school. The elementary school currently has a student population with 71.9% of Pupils in Poverty (PIP). The school enrolls about 725 students from pre-K through 5th grade. This study focused on students in a fourth-grade math class. There were about 120 fourth graders at the school in six different classes. The students had daily access to Chromebooks, which were assigned to them for use in the classroom during instructional time. The students took their Chromebooks home with them each day. This changed about midway through this research, when students were then required to leave the Chromebooks at school as students transitioned back full-time to the classroom after the Covid-19 pandemic. The class also included a Clear Touch Board used by the teacher as an interactive tool to present instructional content. There were 22 (6 females, 16 males) students in the class. The students were an average of 10 years old. All of the students were in the fourth grade and no students had been retained in the past. Two students had an Individualized Educational Plan (IEP) and two students had a 504. Based on the
disability, students can have a 504 or an IEP plan which allows them to receive support in the general education classroom by providing them with accommodations to help them be academically successful. The 504 is for any disability while an IEP is for specific learning-related disabilities.

This group of students had received instruction using the Engage NY curriculum in the past. This curriculum was specifically chosen by the principal four years ago in an effort to address the mathematical deficits the students were facing. The students continued to show growth on district benchmark assessments as well as on end-of-the-year state testing. Another strategy implemented by the principal as a part of the district's strategic plan was ongoing professional development. Teachers receive professional development in math once per month. Teachers were given time during the school day to develop strategies and team plan for upcoming units. Teachers also spent time analyzing student data after benchmark assessments, taking note of student strengths and weaknesses in an effort to remediate students in their areas of weakness. These sessions included time with district specialists as well as with consultants from outside of the district. These efforts were proven to be successful as student scores continued to increase.

In comparing student achievement scores over the past few years, there have been steady improvements in mathematics test scores for the school. Fourth-grade scores in 2017 indicated 33.3% of students met or exceeded expectations on the end-of-the-year state testing. In 2018, that percentage improved to 46.5%, and in 2019 the percentage improved again to 48% of fourth-grade students meeting or exceeding state expectations (SC State Department of Education, 2020). The original goal as stated in the school's
strategic plan was a 10% increase over a five-year period. The fourth-grade students and teachers at this elementary school exceeded this goal by growing 14.7% over a three year period. While this is excellent growth for the school, there were still 52% of fourth-grade students who were not meeting state standards in mathematics. While 48% of the fourth-grade students at this elementary school met or exceeded expectations in 2019, the district average for the same year was 53.4% of fourth-grade students, with one school in the same district scoring as high as 77.6% of their fourth-grade students meeting or exceeding expectations (State Department of Education, 2020).

District Benchmark data has also shown steady improvement in math over a three year period. Students were entering fourth-grade with a better understanding of the base ten number system. Students also had a better grasp of strategies which could be used to help them think through and work through the problems according to observational data reported by fourth-grade teachers during professional development. Reviews of the data during professional development showed the fourth-grade students at this elementary school were often at or slightly above the district average for each strand.

**Statement of the Problem**

Student achievement in the elementary classroom is of major concern to all stakeholders from teachers, administrators, and state government officials to parents and the local community. This elementary school was listed as having 71.9% of Pupils in Poverty (PIP) for the 2019 school year (South Carolina Department of Education, 2020). Of those students, 61% of PIP were not able to meet expectations in fourth-grade math during the 2019 school year. For non-PIP students in the same year, only 28.8% were not able to meet the expectation.
The use of the flipped classroom model encourages the use of student-centered learning such as active learning, peer-assisted learning, and collaborative learning, giving students the opportunity to practice higher-order thinking skills and allowing students to move from passive listeners to active learners (Akcayir et al., 2018). The flipped classroom model is an instructional approach which uses video-based learning before the start of class and interactive groups within the class (Lo & Hew, 2017a). The flipped classroom model has been effective in significantly increasing student achievement in quasi-experimental designs for mathematics in which the control group was instructed using the traditional model and the experimental group was instructed using the flipped model (Kostaris, et al., 2017; Kumar, et al., 2016).

**Purpose Statement**

The purpose of this action research was to examine the impact of the flipped classroom model on fourth-grade students’ achievement in a geometry unit, and on their motivation towards mathematics, and their perceptions of the flipped model at an elementary school in the Southeast United States.

**Research Questions**

**RQ1:** Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ2:** What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ3:** What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?
Researcher Subjectivities and Positionality

I am an African American female, born in the mid-70s, reared, and educated in the south. I had a Christian, middle-class upbringing, in a home with both of my parents and two siblings. Throughout my career as an educator, I have been afforded the opportunity to work in Title I schools. While I am adept at building relationships with my students, I realize my background is often different from what they are experiencing, as many of my students are from single-parent homes and have a lower socioeconomic status than I experienced. I understand my ideas and expectations of them may seem simple and realistic to me, but may seem unachievable for them due to a lack of resources or parental support. I understand resources that were always available for me, such as consistent food, shelter, and clothing may not always be available for them. This difference can cause a deficiency in academic success that seemed so natural to me.

I have been in education for 24 years. I have served in many positions from teaching to administrator and instructional coach. When I began teaching in 1999, it was not uncommon for educators to go days without checking their recently established e-mail. Computers were large in size and the only one in the classroom belonged to the teacher. The technology consisted of digital games, a large television mounted in the corner of the room, an overhead projector, and the brand-new, very large laser disc which had to be checked out from the media center.

As we fast forward to 2023, there are over 20 devices in each classroom. The students are one-to-one with Chromebooks and there is a digital presentation board in each classroom. I have access to a laptop computer, a document camera, and wireless printing. Because of this rapid advance in technology, I feel teaching students to
effectively use technology will help them to succeed in school while equipping them with some of the 21st-century skills they will need in the future. I believe properly teaching students to use technology in the classroom will improve their future success.

As a current instructional coach and interventionist, I also feel it is my responsibility to share effective pedagogical practices with the teachers that were effective when I worked with their students during intervention. This promotes student learning for the students we serve, thus increasing the number of students I can impact throughout the school. I use current research to address the issues that teachers are currently facing in the classroom with their students. In this study, I had the opportunity to address a specific need in our school by conducting real-world research.

Real-world, practice-oriented actions such as the strategies and data collection methods which were used in this study aligned with the pragmatic worldview paradigm as described by Cresswell (2014). Pragmatism focuses on applications, what works, and solutions to problems. Mackenzie and Knipe (2006) also described this paradigm as real-world and practice-oriented. This study focused on the use of the flipped classroom model which is an application that could serve as a solution to the issue of low achievement in math.

My positionality as an insider or a researcher who studied her own practice was important to acknowledge (Herr & Anderson, 2005). Although I was considered an insider, doing research at my own school with my students in my building, did not necessarily gain me automatic trust. Some things that affected positionality was how well I knew my students and how well they knew me at the time of the study. A study done at the end of the school year as opposed to being done at the beginning of the year could
make a difference in the relationship between the students and myself. My age and position affected my positionality as students may have seen me as an authority figure and may not have been as open or honest with me when collecting qualitative data in the interview process. To prevent these issues, I worked to build strong teacher-student relationships before the start of the study. The students were reassured often that their participation in the study was voluntary and they would not be penalized for their performance or responses to this study.

Through critical reflexivity, I determined my values and biases affected my work as an educational technology researcher (Herr & Anderson, 2005, Chapter 3). The setting for my research was my classroom and I am passionate about the use of technology as a tool to increase student achievement. In the classroom, energy is contagious. Students may have seen my enthusiasm for the research, therefore they felt excited based on my feelings or actions. My bias is that I feel the use of technology in the classroom is an essential tool for student growth and success. Therefore, I may have worked harder and dedicated more time when preparing and delivering instruction using the flipped classroom model. Readers of my work must understand this bias as they seek to build their own truth from my results. However, I worked to combat bias by acknowledging my presence in the study and self-reflecting throughout the process (Herr & Anderson, 2005).

**Definition of Terms**

**Flipped Classroom:** The flipped classroom model was generally defined as "that which is traditionally done in class is now done at home or in another setting, and that which is traditionally done as homework is now completed in class" (Bergman & Sams, 2012, p.
Students were assigned video lessons which were viewed in their homeroom class during intervention before the lesson being taught in-person on the following day. The in-person classroom time was used more for active learning and problem-solving activities (Lo & Hew, 2017a). During the class, the teacher took on the role of an advisor and a supporter which resulted in effective learning (Sezer, 2017).

**Motivation:** The ARCS model of motivation breaks motivation into the four distinct categories of attention, relevance, confidence, and satisfaction (Simsek & Keller, 2014). The first three elements of the model being achieved, resulted in learners being motivated to learn. The final element of satisfaction supported a continued desire to learn (Loorbach et al., 2015). In this study, motivation was defined as the student’s willingness to achieve the math goals in the flipped classroom and the process of acting upon that desire.

**Digital Lessons:** In this study, digital lessons refer to the math lessons the students completed before attending the in-person instruction. Each lesson included adaptive fluency, lesson-aligned fluency, guided practice, and independent practice. The lessons were designed to take 30 minutes to complete.

**Zearn:** Zearn.org is a non-profit curriculum publisher and tech company. Zearn is an online learning platform where the digital lessons are presented to the students. This standards-based math program combines digital and paper-based instruction and practice. The program is designed by teachers and provides interactive visuals, checks for understanding, and precise feedback. The students progressed to the next lesson only after demonstrating an understanding of the current concept.
CHAPTER 2
LITERATURE REVIEW

Purpose Statement

The purpose of this action research was to examine the impact of the flipped classroom model on fourth-grade students’ achievement in a geometry unit, and on their motivation towards mathematics, and their perceptions of the flipped model at an elementary school in the Southeast United States.

Research Questions

RQ1: Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?

RQ2: What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?

RQ3: What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?

Literature Review Method

This literature review was conducted using a series of searches using several databases. The databases used were provided by The University of South Carolina through the library systems. The main databases I used were Education Source, Google Scholar, ERIC, ProQuest, and JSTOR. In the beginning, my searches were mainly focused on technology integration. I narrowed my focus from technology integration to the flipped classroom model. I found there were many articles on the flipped classroom model done at the high school and college levels. I then refined my search to include the flipped classroom model along with the term elementary. I later added the search term
math in the search to further align with my study. Some of the articles I searched also used the term “inverted classroom model” to refer to the flipped model which led me to search that term to find additional articles. For the topic of motivation, I again used the previously mentioned databases. Motivation is a broad topic; therefore, I had to add the terms elementary, math, and the flipped classroom model with the term motivation to find articles relevant to my research topic. This search led to information about the ARCS model of motivation, The Instructional Materials Motivation Survey (IMMS), and Reduced Instructional Materials Motivation Survey (RIMMS). These terms also became search terms to locate more information about these tools. Finally, I mined the references from articles I read.

Some of these references were searched by author’s name such as John Keller since his name and work were referenced in many of the articles I read. I also searched specific titles of works that were listed in the reference section of other articles which seemed to be related to my research.

This literature review focuses on three major areas, they are elementary mathematics instruction, the flipped classroom model, and attitudes toward mathematics. The first area of elementary math instruction focuses on strategies used for teaching math before the use of the flipped classroom model. The second section discusses the flipped classroom model, how it is used, as well as the benefits and challenges of the model. Finally, the third area of discussion is motivation in the flipped classroom.

**Elementary Mathematics Instruction**

Many types of teaching strategies and methods have been used to improve student math performance throughout the years before the use of the flipped classroom model.
Three of these methods stand out, as I have used them myself in the traditional math classroom. These strategies are teacher-led modeling, the use of manipulatives, and small-group instruction.

**Teacher-Led Modeling**

Data from one study by Schweig et al. (2020) showed typical math instruction in third and fifth grade included a considerable amount of time spent on skill and lesson review of previously taught material. One-third of the teachers in the study reported considerable time reviewing, with more than 92% of participants reporting they spend at least some time reviewing previously taught skills. Those teachers reporting a considerable amount on review time did not report high engagement in any other activities. This study also showed 57.14% of the teachers spent some time verbally explaining steps or procedures and 8.68% spent considerable time verbally explaining steps and procedures. Teachers also did not report using hands-on tools with their students during the review. Only 3% of teachers reported using hands-on materials.

In a study by Mongilo (2016), preservice teachers watched videos of teachers modeling the teaching of lessons. The purpose of the videos was to provide a vicarious experience which would lead to improved self-efficacy for the teachers. The students also took part in field experiences where they observed teachers teaching. The qualitative data showed there was an increase in teacher self-efficacy.

**Manipulatives**

There is a widespread belief by educators that the use of manipulatives increases student engagement and achievement (Bottia et al., 2014). In one study, the hands-on component of the intervention positively influenced the self-efficacy of preservice
teachers for teaching math (Mongillo, 2016). A combination of technology and hands-on materials helps to improve the comprehension skills, spatial intelligence, and mental rotation ability of the students (Kukey, et al., 2019). Other researchers report the use of manipulatives is not an effective tool for young students, especially minority children (Bottia et al., 2014; Davis & Farran, 2018). In fact, Bottia et al.’s (2014) study showed the use of manipulatives did not positively affect the achievement of any ethnic group, and it also hurt student achievement for black students. Davis and Farran (2018) added teachers should choose manipulatives with the least amount of distracting features as students can be easily distracted by features such as color. This distraction can cause students to miss the intended focus of the manipulatives.

**Small Group Instruction**

Interactive group activities as described by Bottia et al. (2014) in their study included students working together in small groups or in pairs. They used this time to work out math problems, with the expectation that students would solve and explain the problems as well as tutor each other. This study found students in kindergarten had higher achievement levels when they had more exposure to interactive group activities. Small group instruction has also been used as a part of the flipped classroom model. Lo and Hew (2017a) reviewed 15 empirical studies and found 11 of the studies used small groups as an in-class activity. In-class time can be used for small-group instruction. Lo and Hew (2017a) suggest most of the in-class time be used for small-group instruction. Some of these group learning activities include solving advanced problems, group discussion, and collaborative tasks. They also suggest teachers use small groups to review the lesson at the end of class.
The Flipped Classroom Model

There are several components of the flipped classroom model to be considered. They are definitions of the flipped classroom model, benefits of the flipped classroom model, challenges and barriers of the model, flipped model resources, and flipped classroom model research methods.

The flipped classroom model is an alternative teaching strategy, currently being explored by many practitioners to improve student motivation and engage students in the learning process (Kumar et al., 2016). The flipped classroom is also referred to as the inverted classroom, where learning is transformed by providing digital content for homework and using the classroom time to engage students in discussion and other activities (Brown, 2012; Lo & Hew, 2017b; Song et al., 2017). The flipped classroom model is generally defined as “that which is traditionally done in class is now done at home, and that which is traditionally done as homework is now completed in class” (Bergmann & Sams, 2012, p.13). Students were assigned video lessons which were viewed at home or at a designated time during school before the lesson was taught in class on the following day. The classroom time was used more for active learning and problem-solving activities (Lo & Hew, 2017b). During the class, the teacher took on the role of an advisor and a supporter which resulted in effective learning (Sezer, 2017). In this study, the flipped classroom model was defined as students viewing assigned videos during RTI (Response to Intervention) time in their homeroom class prior to attending an in-person meeting with the researcher. The in-person time included active learning and problem-solving.
Benefits

Research has shown there are many benefits to implementing the flipped classroom model. Ruffini (2014) reported there were seven benefits that came as a result of flipped learning: 1) an increase in student-centered and independent learning; 2) more face-to-face time with peers, and teachers guiding and intervening when needed to correct errors in the moment; 3) adjustable learning pace offers accommodations for both faster and slower concept development; 4) more opportunities for cooperative, collaborative, and group inquiry-based learning; 5) extended lesson availability for absent students; 6) increased parental participation; 7) opportunities for multi-modality instruction.

Of the 71 studies reviewed by Akcayir and Akcayir (2018), more than 52% reported using the flipped classroom model improved student learning performance as measured by GPAs, standardized test scores, and course grades. They also reported 23% of the studies shared flexibility as a positive outcome of the flipped classroom. Some of these flexible options reported in these studies included learning anytime and anywhere, learning at an individualized pace, and the ability to pause and rewind videos as needed. Other benefits of blended learning for students include personalized learning and allowing instruction to be focused on the needs and preferences of the student (Fazal & Bryant, 2019). Studies have shown flipped instruction can improve learning achievement, increase teacher and student interaction, create student-centered learning, improve peer-to-peer interaction, lead to more time for teachers and students to engage in individual and small group learning, project-based learning, problem-solving, and more in-depth discussion (Hwang & Lai, 2017). Aidinopoulou & Sampson (2017) reported in
their study that students in the traditional classroom and students in the flipped classroom had similar learning outcomes when it came to content memorization, however, there was a clear and positive impact on the student’s historical thinking skills.

Faculty benefits include teachers having more time for guiding and intervening during face-to-face instruction (D’addato & Miller, 2016). Teachers interviewed in a study by Hultén and Larsson (2018) shared that using the flipped model improved their interactions with students and allowed them to work toward common goals with the students. This improved interaction leads to teachers knowing their students better because of the increased amount of time spent with individual students while using the flipped classroom model (Bergman & Sams, 2012). Teachers also felt in-class discussion time was improved as students were given the information they needed beforehand to prepare for the discussion (Hultén & Larsson, 2018). Discussion was also improved because students were more active in class. The teachers in this study shared their hope that the flipped classroom model would cause an educational shift that could remove them from the front of the classroom delivering lectures to a more active student-driven classroom (Hultén & Larsson, 2018), while Bergman and Sams (2012) report this was an actual result of the flipped classroom model implementation.

Another benefit of using the flipped classroom model for teachers is they do not have to create all of their own material. Teachers can use free content such as Khan Academy or commercially available resources provided by the school or district (Johnson & Renner, 2012). A study done by Zengin (2017), used Khan Academy as a part of the intervention in the flipped classroom model and reported significantly higher posttest scores when compared to pretest scores on the same academic assessment. Teachers can
also reuse instructional materials they have created by storing them in a Learning Management System (LMS). Storing and sharing material with students using an LMS also allows the teacher to be more flexible in deciding how to spend classroom time (Brown, 2012).

Operational benefits include the use of technology which is adaptive; therefore, content can be adjusted in real-time and the program can give immediate feedback (Fazal & Bryant, 2019). An LMS or a class website can be set up to share content with students in one localized place (Johnson & Renner, 2012). An LMS allows teachers and students to ask and answer questions, take quizzes, and receive feedback, as well as post and view additional materials for the class (Aidinopoulou & Sampson, 2017). An LMS can also be useful in monitoring student learning and interactions with material (Lo & Hew, 2017a). Some LMS software allows teachers to collect session data that can track student interactions (Vercellotti, 2018).

**Barriers and Challenges**

While the flipped classroom model has shown benefits for students, there have also been some barriers and challenges related to this model. These challenges can be categorized into three groups. They are (1) student-related challenges, (2) faculty-related challenges, and (3) operational challenges. Despite these challenges, there are specific strategies that can be implemented to address them.

**Student-related challenges.** In a review of multiple studies on the flipped classroom model, some students were not receptive to the structure of the flipped classroom and had negative feelings toward the amount of prep time required at home (Lo & Hew, 2017a). Another challenge is students may not be self-motivated and may
come to class unprepared (Aidinopoulou & Sampson, 2017). Akcayir and Akcayir (2018) reviewed eight studies where students perceived the flipped classroom model as time-consuming, seven studies reported a workload increase for students and six studies reported students do not prefer the flipped classroom model. Students in a K-12 environment may face challenges such as limited time to use technology at home for out-of-class activities and technical difficulties due to a lack of experience with technology (Akcayir & Akcayir, 2018).

Teachers have also reported students will not watch the videos outside of class (de Araujo et al., 2017). A study by Yang and Chen (2020) reported that of the three videos students were required to watch for class, between 17 – 19%, did not watch the videos for the lesson. One teacher stated that a student who did not complete traditional homework assignments also did not complete the flipped classroom at-home assignments (de Araujo et al., 2017). Akcayir and Akcayir (2018) reported students’ lack of preparation was detailed in 13% of the studies they reviewed. Kelly and Denson (2017) also stated students who did not watch the videos were more likely to get behind and stay behind.

**Addressing student challenges.** Strategies for addressing student challenges include open teacher-student communication, demonstrating how to learn with the flipped model for students, using the Cognitive Theory of Multimedia Learning, retaining the workload during the flip, and providing a communication platform outside the class (Lo & Hew, 2017a).

Communicating with students about the model is important at the beginning of the process when transitioning to the flipped classroom. Teachers must fully explain the goals, routines, and expectations of the model to students to help them understand a
process that may be new to many students. Teacher modeling is an integral part of introducing the flipped classroom model to students and they must provide explicit instruction detailing the steps and the expected outcomes of the process (Moran & Young, 2015). Furthermore, students need to have opportunities to ask questions with teachers giving ample time to answer questions and address student concerns (Lo & Hew, 2017a).

**Faculty-related challenges.** There are many noted educator challenges when implementing and using the flipped classroom model. Ertmer et al. (2012) further categorize educator challenges into two groups. They are first-order barriers, which are external issues beyond the control of the teacher, and second-order barriers or internal barriers which can be controlled by the educator as they are based on teacher beliefs. First-order barriers include resource issues such as access, time, and professional development. Access to technology may include a lack of resources such as internet access or limited school technology resources (D’addato & Miller, 2016). Many studies have referenced the additional time it takes for teachers to plan and prepare for the use of technology in the flipped classroom (Akayir & Akayir, 2018; deAraujo et al., 2020; Lo & Hew, 2017a). Effective technology integration requires both time and resources (Kelly, 2015; Aidinopoulos & Sampson, 2017). Teachers reported needing extended time to create their own videos, search for existing videos and other resources, and edit the resources they locate to meet the needs of their students (Otten et al., 2020). These authors also suggested educators must understand multimedia design in order to create effective and high-quality videos. The six principles of multimedia design require teachers to consider ideas such as explaining graphics with audio, using pertinent
graphics, and audio and using a conversational tone. These principles and others have been linked with student learning outcomes when using videos (Otten et al., 2020).

Therefore, if a teacher not only creates or finds videos but then assesses them for these qualities, this could require even more time to meet the needs of students in the flipped classroom. deAraujo et al. (2020) note that much of teacher planning time is spent on making and gathering materials for students to use at home in preparation for class. While the time spent on these tasks is significant, it is also important for teachers to spend time on in-class activities when students are physically present with them in the room. These researchers found the same attention was not necessarily given to the in-class tasks.

Other faculty-related challenges included high costs and providing teacher training (Lo & Hew, 2017a). Teachers not only need to understand the flipped classroom model, but they will also need technological competence to develop and implement this model (Aidinopoulou & Sampson, 2017). The training to achieve competency, as well as user-friendly software for creating videos, and premade teacher resources, can be costly for a school or district.

Second-order barriers include internal barriers which can pose the greatest challenge to successfully implementing the flipped classroom model (Kelly, 2015). These barriers include the teacher’s beliefs, vision, and experience. In order to successfully implement the use of technology and the flipped classroom, teachers must believe in the usefulness and effectiveness of the technology. Teachers need a strong vision with the foresight to plan ahead and develop best practices. Finally, teachers need
experience with technology in order to provide a positive experience for their students (Kelly, 2015).

**Addressing faculty challenges.** Strategies for addressing faculty-related challenges include teacher professional development and preparing flipped resources progressively (Lo & Hew, 2017a). Teachers must play an integral part in the decision-making and implementation process when introducing new technology and teaching strategies such as the flipped classroom model (Kelly, 2015). In order for teachers to feel empowered to make these decisions, they must be trained in creating high-quality, engaging instruction (Brewer & Movahedazarhouligh, 2018). Educational leaders such as school administrators and instructional coaches must also promote the vision and provide clear communication during the implementation process (Kelly, 2015). Teacher leaders play an important role in sharing instructional strategies, integration practices, and success stories as a means to encourage their colleagues to implement new technology resources and strategies into their practice during this shift in thinking and change in the way technology resources are used (Brewer & Movahedazarhouligh, 2018; Kelly, 2015).

**Operational challenges.** Operational challenges include limited internet access, monitoring students online and technical problems may cause students to need technical support from the school (D’addato & Miller, 2016; Lo & Hew, 2017a). In the 71 studies reviewed by Akcayir and Akacyir (2018), they found that nine studies reported video quality issues, six studies reported inequality of access to technology issues, and five studies reported student technology competency issues as operational challenges.

**Addressing operational challenges.** The first step to technology integration must include goal setting and a needs assessment (Kelly, 2015). Providing teachers and
students with the appropriate tools for success is important in setting the tone for new learning strategies and practices. Strategies for addressing operational challenges include supporting students who have limited technology resources, using an LMS with gamification to monitor and motivate students, and providing institutional support for the flipped classroom (Lo & Hew, 2017a). Continuous review of technology is important to stay abreast of current and future technological needs (Kelly, 2015)

**Flipped Model Resources**

Providing appropriate resources is an important part of the success of the flipped classroom model. Videos, e-books, and multimedia games are some of the resources commonly used in the flipped classroom.

**Videos.** Videos are beneficial to students as they can stop and start the videos as needed or even go back and rewatch the videos (Bergmann & Sams, 2012; Kelly & Denson, 2017; Moran & Young, 2015). Quality, multimedia design, and interactivity are important characteristics to consider when deciding on the videos to be used in the flipped classroom model. (Kelly & Denson, 2017; Otten et al., 2020). There are two types of videos teachers can consider using in the flipped classroom, lecture videos and set-up videos (Otten et al., 2020). A study by Ryan and Reid (2016) recommends selecting videos which are compatible with the attention span of the students to ensure effective engagement. The expectation is students will not only watch but interact with the videos to aid in processing the learning and effective viewing (Bergman & Sams, 2012; Moran & Young, 2015). Strategies and scaffolds for learning need to be put in place to help students with this process. Note-taking, as well as requiring students to turn in their notes is one way to hold students accountable. (Bergman & Sams, 2012; Schmidt
One study by Wei et al. (2020), found implementing notetaking along with the flipped classroom model led to significantly better learning performance than students in the traditional math classroom. Students in the study stated participating in the notetaking “helped them think deeply and interact with the video” (Wei et al., 2020, p. 1476). There are also online resources to help with this accountability process. Students can use platforms such as EduCannon, which is a web-based product that allows students to take notes and ask questions while also monitoring their video watching progress (Moran & Young, 2015). Another tool teachers can use as an accountability tool for video watching is EdPuzzle, which allows teachers to use prerecorded videos or their own videos and make them interactive by adding questions and narration. Finally, Zearn is a digital learning platform which includes videos and games for the students to complete. This platform tracks student performance and the amount of time spent on the tasks.

**E-books.** E-books also referred to as e-text and digital books, are texts in digital formats (Berkeley et al., 2015). “E-books consist of various kinds of multimedia to engage students in learning with quality and well-organized content” (Hwang & Lai, 2017 p. 185). These books can offer many features to enhance student learning. Some of these features include definitions of terms, translation into other languages, note-taking guides, and embedded questions or tutorials. These books can also offer multiple modalities which allow students to use text-to-speech features, animation, and sound (Berkeley et al., 2015). E-books can also offer quiz features such as matching, drag and drop, fill-in-the-blank, and multiple-choice, with the system keeping track of the amount
of time spent reading as well as students’ scores on these assessments (Lai & Hwang, 2016).

One of the benefits of using an e-book is that students can often interact and annotate on the pages of an e-book. In a study by Hwang and Lai (2017), the researchers compared the use of the e-book (experimental group) to the use of videos (control group) in the flipped classroom model. The e-books used in this study allowed the students to make annotations which were recorded for students to refer to later. The teachers were able to see and monitor the progress of the students before class (Hwang & Lai, 2017). They noted the use of e-books gave students some autonomy in when and where they used the digital resource and they afforded students an opportunity to interact with learning materials in a way they could not with traditional print books. A study done by Kaman and Ertem (2018) showed digital texts have brought about improvements in reading fluency and reduced reading mistakes, but there was no improvement in student reading attitudes.

Multimedia and Games. Some games are considered educational or serious and are assumed to have positive effects on motivation and achievement (Say & Bag, 2017). There are mixed findings on the effectiveness of video games on mathematics achievement. This could be due to the lack of instructional-based theories in the creation of these games and teachers choosing games based on them being marketed as educational (Es-Sajjade & Paas, 2020). There are three main motivational reasons people play video games: achievement, socialization, and immersion (Barreto et al., 2017). Achievement in video games can be experienced by advancing, competing, and gaining an understanding of the game. Socialization is accomplished by engaging with others or
being a part of a team. Immersion can be accomplished by playing roles and customizing avatars (Barreto et al., 2017). One study by Es-Sajjade and Paas (2020) found students who played the educational game used in the study, MATHERIAL, achieved better math results than those who did not. However, there was no significant difference in math motivation from playing the video games (Ronimus et al., 2019). A study done by Rourke et al. (2017) showed statistically significant improvements in the mental math skills of students using handheld gaming devices to learn basic facts. The qualitative data in the form of student interviews showed students enjoyed using the handheld games, improved speed, and accuracy, and they were more motivated to learn. Barreto et al. (2017) reported some of the students in the study were not always motivated to play the video games, with some voicing their displeasure with one of the games in particular, Bits and Bolts. The students were not engaged with the game and did not enjoy the math tasks involved in the game. However, some students continued to play the game to earn coins to purchase items for their avatars in the game. The researchers found the students were engaged in many aspects of the study, but found limited academic knowledge was gained by playing these games.

This research on the flipped classroom model resources shows the importance of choosing the right materials and activities will keep students focused and engaged during the learning process. Once a tool is chosen, it is important to evaluate the potential effectiveness of the tool by reviewing the qualities of each tool as reported in the studies.

**Flipped Model Research Methods**

There have been several studies done using the flipped classroom model at the high school and college levels, but not as many studies have been conducted with
younger students (Barreto et al., 2017). In a literature review of 71 studies conducted by Akcayir and Akcayir (2018), they found 80% of the reviewed studies were conducted at the higher education level, while only 16% of the studies focused on learners at the K-12 level. Teachers and adults made up the remaining 4% of the groups studied.

Data collection methods to assess the outcomes of the flipped classroom model include classroom observations, teacher reflections, and surveys from both parents and students (D’addato & Miller, 2016). These researchers used action research to investigate the flipped classroom model with fourth grade students. They utilized teacher-created Likert scale items to collect student opinions of the flipped classroom model, administering these surveys before the study, midway through the study, and at the end of the study. Parents completed surveys as well. Anecdotal records of teacher observations were also kept to record student engagement and interactions while implementing the flipped model. Observation was also a data collection tool in Anthony and Dame's (2019) study. These researchers observed teachers and their teaching practices in the blended learning classroom. Urfa and Durak (2017) also observed teachers using the flipped model in an effort to collect data on how the teacher applied the model, students’ attitudes, and their behaviors when implementing the model.

Academic data has been collected through the use of GPAs, standardized test scores, and course grades (Akcayir & Akcayir, 2018). McNally et al. (2017) collected GPA and current class grade data in their study. Undergraduate and postgraduate study participants were divided into two groups: flip endorsers and flip resistors. They found there was no difference in the current grade or previous GPAs of the students in those groups. Aidinopoulou and Sampson (2017) also found there was no difference in the
summative standardized test performance of elementary history students in a traditional classroom setting as opposed to a flipped classroom setting.

IMMS has been used as a pretest and posttest to measure motivational needs before instruction or effectiveness after instruction (Loorbach et al., 2015). Karabatak and Polat used a true experimental design, with one experimental group (the flipped classroom model) and two control groups (distance education and the traditional classroom) of undergraduate students. Quantitative data was collected over an eight-week period. ARCS motivation strategies were incorporated as a part of the teaching process. The researchers used the Academic Achievement Test to measure achievement and the Course Interest Survey to measure interest in this study. Huang et al. (2004) also used a pretest and posttest design with undergraduate students. This study collected both quantitative and qualitative data using the IMMS as the tool to collect quantitative motivational data and open-ended questions to collect qualitative data.

**Motivation in the Flipped Classroom**

The second section of this literature review focuses on motivation in the flipped classroom with a focus on the ARCS motivational model and how motivation has been researched. Motivation is considered an important component of the learning process (Simsek & Keller, 2014). The Gale Encyclopedia of Psychology defines motivation as “the process that initiates, directs, and maintains a goal-directed behavior” (Longe, 2016, p. 152). Motivation has historically been defined as having two levels, will and volition. Will is a combination of desire and belief in the ability to achieve, while volition is the process of acting on that desire (Keller, 2008). The ARCS model of motivation breaks motivation into the four distinct categories of attention, relevance, confidence, and
satisfaction (Simsek & Keller, 2014). The achievement of the first three elements of the model results in learners being motivated to learn. The final element of satisfaction supports a continued desire to learn (Loorbach et al., 2015). In this study, motivation was defined as the student’s willingness to achieve the math goals in the flipped classroom and the process of acting upon that desire.

**ARCS Motivational Model.** John Keller developed the ARCS model, which is an acronym representing the words Attention, Relevance, Confidence, and Satisfaction (Simsek & Keller, 2014). The key components of the ARCS model are (1) Attention: Students’ curiosities must be captured and sustained; (2) Relevance: Students must feel the instruction relates to their personal values or will be instrumental in accomplishing desired outcomes; (3) Confidence: Students must feel they will be able to succeed based on their ability and not on luck; (4) Satisfaction: Students must feel the outcomes of the learning experiences are in line with their personal incentives and includes a mix of intrinsic and extrinsic rewards or outcome (Simsek, 2014; Keller, 2016).

The ARCS model of motivation was originally used in the traditional learning environment, but it has now been studied around the world in online environments (Huang et al., 2004; Loorbach et al., 2015). Keller (2008) credited Gagne’s Conditions of Learning, as well as Merrill’s Component Display Theory, as foundational theories of the ARCS model (Keller, 2008). However, these theories focused more on what teachers traditionally learn in college methods courses. Ideas such as the attention-getter at the beginning of a lesson and reinforcements to help manage behavior during the lesson can be attributed to Gagne and Merrill. The ARCS model improved upon these theories by providing a more comprehensive look into motivation (Simsek, 2014). The ARCS model
is also based on Tomlin’s and Lewin’s expectancy-value theory. This theory states that if people find value in the presented knowledge, then they will be motivated to learn (Malik, 2014).

ARCS is a 10-step model for addressing the motivational needs of students (Keller, 2016). These steps are a basic problem-solving and design process. “The ten steps are: (1) Obtain course information; (2) Obtain audience information; (3) Analyze audience; (4) Analyze other course elements; (5) List objectives and assessments; (6) List potential tactics; (7) Select & design tactics; (8) Integrate with instruction; (9) Select and develop materials; (10) Evaluate and revise” (Keller, 2016, p.5).

Three of these steps are very important to the process. They are (3) audience analysis, (6) list potential tactics, and (7) select & design tactics (Keller, 2016). Some researchers have used this simplified approach which has also been proven to be effective in motivational design (Keller, 1999). Steps (1) obtain course information and (2) obtain audience information, while extremely important in the process, may not need to be explicitly researched and developed in a setting the educator is a member of or is familiar with (Keller, 2016). Prior to Keller’s work on motivation, much of the work in the field of education had been on learning and instruction. Keller says in an interview, “My work helped provide a pathway for instructional designers to more systematically investigate the motivational components of learning design and performance” (Simsek, 2014). This was important in planning my research since I am an insider in my school, and I had prior knowledge of the course and audience information. The other steps in the process were important for the proper planning and implementation of the ARCS model.
Motivation has been researched in several ways. The Instructional Materials Motivation Survey (IMMS) is one tool which has been used in researching motivation. The Instructional Materials Motivation Survey is a 36-item instrument used to measure reactions to instructional materials (Loorbach et al., 2015; Kostaris et al., 2017). The IMMS was validated using the results of several studies which used this tool along with the ARCS model of motivation (Loorbach et al., 2015). In a study by Huang et al. (2004), a modified version of the IMMS was used as a pre-and post-assessment tool with students taking the first assessment prior to classes as a homework assignment and the final assessment taking place after instruction during the last class of the study. Both assessments were administered online. The quantitative data collected in this study was used to show the frequency of student responses to items. In another study done by Kostaris et al. (2017), the IMMS was used to determine if the use of the flipped classroom model would lead to higher motivation. This study included a control group and an experimental group and found the experimental group of students using the flipped classroom model reported significantly higher levels of attention, relevance, confidence, and satisfaction than their peers in the control group.

Another tool that has been used is the Reduced Instructional Materials Motivation Survey (RIMMS). The RIMMS is a shortened version of the IMMS with only a twelve-item scale and four subscales (Loorbach et al., 2015). A validation study of this tool found it aligns with the ARCS model, better than the original IMMS Survey (Loorbach et al., 2015). Statistical preferences for this tool were determined in a study with seniors between the ages of 60 and 70. They were tasked with using motivational instructions in a self-directed setting to learn to use a cell phone. The RIMMS is preferred since it is
shorter and does not include any reverse items. Reverse items are no longer needed in the shortened version since response bias is less likely with fewer questions. The RIMMS is also preferred as it has the same number of items in each category of ARCS, with three items in each. The IMMS has twelve items under attention, nine items each in the relevance and confidence category and six items under the category of satisfaction.

**Chapter Summary**

In summary, the flipped classroom model or inverted classroom is a teaching and learning model which can transform learning by combining digital learning at home with increased problem-solving and teacher-student interaction in the classroom (Brown, 2012; Song et al., 2017). There are many benefits to implementing this model. The benefits include student-centered learning and more face-to-face time with peers. The flipped model also offers an adjustable learning pace and extended access to missed lessons for absent students (Ruffini, 2014). With the benefits also come challenges to the flipped classroom model. Some students have negative feelings about the flipped classroom due to the increased amount of preparation expected outside the classroom (Lo & Hew, 2017a; Aidinopoulou & Sampson, 2017). There are also the operational challenges of limited internet access for students and monitoring students in the online environment (Lo & Hew, 2017a). These challenges can be addressed by having open and constant communication between students and teachers, providing professional development for teachers and institutional support for technology (Lo & Hew, 2017a).

Motivation in the flipped classroom can be addressed through the ARCS model of motivation. This model was developed by John Keller and has been used in both traditional and online learning environments (Huang et al., 2004; Loorbach et al., 2015).
Keller’s work has led to the development of two surveys called the IMMS and the RIMMS, which have both been validated (Loorbach et al., 2015).
CHAPTER 3

METHOD

The purpose of this action research was to examine the impact of the flipped classroom model on fourth-grade students’ achievement in a geometry unit, and on their motivation towards mathematics, and their perceptions of the flipped model at an elementary school in the Southeast United States. The following research questions were addressed in this study:

**RQ1:** Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ2:** What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ3:** What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?

**Research Design**

Action research is research done by teachers for themselves (Mertler, 2019). A reflective and collaborative process with the goal of improving classroom practices, action research is used by teachers and practitioners to improve the quality or effectiveness of their teaching. It is a scientific way of conducting social research (Greenwood & Levin, 2007). This type of research can lead to advocacy for social
justice to provide equal and fair opportunities for all learners (Kemmis et al., 2014; Mertler, 2019). As an interventionist in a Title I school, it was my responsibility to improve my practice which will ultimately lead to improved academic achievement and opportunities for my students. Action research was appropriate for the purpose of this study because the data collected from my students allowed me to critique existing conditions, develop options for transformation, and improved my effectiveness as a math educator (Tracy, 2020).

Classroom action research uses qualitative data, interpretive modes of inquiry, and data collection by teachers which allows them to make judgments about the data and make informed decisions about their practice (Kemmis et al., 2014; Mertler, 2019). There are some goals which can only be achieved through action research according to Kemmis et al. (2014). Only action research allows researchers to work from within, have a shared language, participate in, and develop the action (Kemmis et al., 2014). Researchers can work within their communities of practice as well as transform the action and consequences (Kemmis et al., 2014; Tracy, 2019). This gives the researcher the ability to shape the research in a way which is fair and just. A well-formulated action research study follows a cycle as described in the seminal work of Kurt Lewin (1946). The cycle includes the planning stage, the action stage, the observation stage, and the reflection stage. During the planning stage, the researcher identifies a problem, develops a hypothesis, and makes a plan. During the action stage of the cycle, interventions are implemented. The observation stage includes collecting and recording the data. Finally, during the reflection stage, the researcher reviews the data which can lead to new inferences and new cycles of research (Lewin, 1946; Rudestam & Newton, 2015).
This action research was conducted using a mixed methods approach. Quantitative data was collected from a pretest and posttest, a motivation questionnaire, and a perception questionnaire combined with qualitative data collected from the focus group interview and field notes. The two types of data were collected concurrently in hopes that the two types of data would validate each other (Rudestam & Newton, 2015). The mixed methods approach allowed for a look at different aspects of the flipped classroom within the same study. The use of multiple methods also helped to offset any weaknesses which may have been present in each of the individual instruments (Creswell, 2014; Rudestam & Newton, 2015). Using both quantitative and qualitative data led to a stronger understanding of the research questions and helped to overcome the limitations of the study and led to better credibility and greater overall findings (Creswell, 2018; Mertler, 2019).

A triangulation mixed methods design was used. This method was chosen because qualitative and quantitative data were collected concurrently during this study, and all data sources had equal importance. The data sources were analyzed individually and then compared to determine if the results were found to be similar (Mertler, 2019). Triangulation of the data gave this research more credibility as the results were shared with administrators and colleagues in hopes of leading effective change in the learning community.

**Settings and Participants**

**Setting.** The intervention occurred in a fourth-grade class. This class was one of six, fourth-grade classes at an elementary school in the Southeast United States. This elementary school is a STEAM (Science, Technology, Engineering, Arts, and Math)
Magnet School with about 725 students. I was an instructional coach and interventionist and did not have my own classroom. I worked with several teachers in the building. One fourth-grade teacher allowed me to work with her students during intervention for this study.

The school was well-equipped with technology, a technology coach, and an administrative team which supported the use of technology through funding and training. Technology at the school included new Clear Touch Boards which had recently been acquired and installed in the school. Clear Touch Boards are interactive boards used to present content to the students. The school also had one-to-one Chromebooks for students in all grades. Technology had been used in many areas throughout the school including all academic subjects and some related arts classes. The school and district have provided several programs for direct instruction, review, rote memorization of facts, intervention, communication, and design. The flipped classroom strategy however is one that had not been explored at this elementary school.

Prior to this study, intervention happened daily for math and reading. Intervention consisted of three tiers or groups of students. Tier one and two instruction took place in the students’ homeroom class. While tier three instruction was a pull-out program. Tier one instruction is the general instruction that all students received. Tier two instruction, meaning the students needed targeted instruction because they were not successful in tier one or general instruction, occurred during intervention time. Tier two students were pulled into small group lessons within the classroom environment. The remaining tier one students spent their time focused on digital learning. This study provided tier one students with in-person as well as digital instruction during intervention
time. This meant that as the interventionist for these students, I provided the in-person geometry instruction for them as well as assigned the digital lessons to them.

**Participants.** The students who participated in this study were a purposeful sample (Creswell, 2014; Tracy, 2019). The participants were considered purposeful because they were the students at this elementary school who were assigned to the chosen fourth-grade class at the time of the study. These students best helped me to understand the problem and met the goal of answering the research questions. The students at this elementary school had experience with the math curriculum and the online resources available for use with the curriculum. The students also had experience with using Chromebooks. The students were on average 10 years old at the time of the study. Of the 17 students, nine were black males and eight were black females.

**Intervention**

The intervention provided to the students in this action research was the flipped classroom model of instruction. The researcher instructed the students for eight weeks using Mission 4, Construct Lines, Angles, and Shapes unit of the Zearn.org curriculum. Permission to use this platform for this study was obtained from Zearn (Appendix J). There were 16 lessons in this unit. The students were randomly divided into two groups: Group A and Group B. The students received both in-person instruction and digital lessons in a weekly cycle (Figure 3.1). On the days when the students in Group A had digital lessons (Figure 3.2), the students in Group B had in-person lessons. On the days when students in Group A had in-person lessons, the students in Group B had in-person lessons. The lessons, objectives, and standards for this unit are listed in Table 3.2.
## Table 3.2

*Topics and Lesson Objectives for Mission 4*

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objective</th>
<th>SC State Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topic A: Lines and Angles</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson 1</td>
<td>Identify and draw points, lines, line segments, rays, and angles. Recognize them in various figures.</td>
<td>4.G.1</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>Use right angles to determine whether angles are equal to, greater than, or less than right angles. Draw right, obtuse, and acute angles.</td>
<td>4.G.1</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Identify, define, and draw perpendicular lines.</td>
<td>4.G.1</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>Identify, define, and draw parallel lines.</td>
<td>4.G.1</td>
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<tr>
<td><strong>Topic B: Angle Measurement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson 5</td>
<td>Use a circular protractor to understand a 1-degree angle as 1/360 of a turn. Explore benchmark angles using the protractor.</td>
<td>4.MDA.5</td>
</tr>
<tr>
<td>Lesson 6</td>
<td>Use varied protractors to distinguish angle measures from length measures.</td>
<td>4.MDA.6</td>
</tr>
<tr>
<td>Lesson 7</td>
<td>Measure and draw angles. Sketch given angle measures, and verify with a protractor.</td>
<td>4.MDA.6</td>
</tr>
<tr>
<td>Lesson 8</td>
<td>Identify and measure angles as turns and recognize them in various contexts.</td>
<td>4.MDA.6</td>
</tr>
<tr>
<td><strong>Topic C: Problem-Solving with the Addition of Angle Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson 9</td>
<td>Decompose angles using pattern blocks.</td>
<td>4.MDA.7</td>
</tr>
<tr>
<td>Lesson 10</td>
<td>Use the addition of adjacent angle measures to solve problems using a symbol for the unknown angle measures.</td>
<td>4.MDA.7</td>
</tr>
<tr>
<td>Lesson 11</td>
<td>Use the addition of adjacent angle measures to solve problems using a symbol for the unknown angle measure.</td>
<td>4.MDA.7</td>
</tr>
<tr>
<td><strong>Topic D: Two-Dimensional Figures and Symmetry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson 12</td>
<td>Recognize lines of symmetry for given two-dimensional figures. Identify line-symmetric figures, and draw lines of symmetry.</td>
<td>4.G.4</td>
</tr>
<tr>
<td>Lesson 13</td>
<td>Analyze and classify triangles based on side length, angle measure, or both.</td>
<td>4.G.3</td>
</tr>
<tr>
<td>Lesson 14</td>
<td>Define and construct triangles from given criteria. Explore symmetry in triangles.</td>
<td>4.G.3</td>
</tr>
</tbody>
</table>
Lesson 15  Classify quadrilaterals based on parallel and perpendicular lines and the presence of absence of angles of a specified size.  4.G.2

Lesson 16  Reason about attributes to construct quadrilaterals on square or triangular grid paper.  4.G.2

Figure 3.1. Weekly Lesson Cycle
Figure 3.2. Independent Digital Lesson
At the beginning of the study, the students received their login information for Zearn.org. They were given a tutorial on how the platform works and what the expectations were for our class. The students received a weekly calendar to help them to remember the schedule for the week (Figure 3.3). The students also received a notebook with pre-printed pages of the notes they used to complete the digital lessons (see Figure 3.4). There was a learning log in the notebook for students to check off the videos watched and lesson activities completed in the digital lessons (see Figure 3.5). Additionally, students received paper copies of the materials which were used in class for our in-person lessons.

<table>
<thead>
<tr>
<th>Week of March 7 - March 11, 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monday 3-7-22</strong></td>
</tr>
<tr>
<td>Group B: Lesson 4</td>
</tr>
</tbody>
</table>

*When you see the word “Lesson” by your group name, you will be with Mrs. Smalls. When you see the word “Video” by your group name, you will watch that video in class during RTI time. Be sure to do the pages in the book that go along with the lesson.*

Figure 3.3. Weekly Schedule
Figure 3.4. Zearn Student Notes Example

Figure 3.5. Zearn Learning Log
The students completed the Independent Digital Lessons on a rotating schedule as shown in Figure 3.1 during the intervention. The digital lessons took the students about 30 minutes each day. Each digital lesson explained the math concepts students used in class. There are pause points built into the lessons which allowed the students time to do the math on paper and take notes. The pause points came up automatically, however, students controlled the amount of time for the pause points and were allowed to move on when they were ready. The lessons included problem-solving with interactive math models. The interactive models allowed students to manipulate the digital math materials on the computer screen (Figure 3.6). The students received real-time feedback on the problems and there were built-in math tips if the students needed them. For example, when the students missed a question, the instructor in the video came back on the screen to model for the student and gave the student another opportunity to answer the question (Figure 3.7). The students watched the videos during the scheduled 30-minute intervention time in class (Figure 3.8).

Figure 3.6. Interactive Math Models
Students attended in-person instruction with the researcher for 30 minutes as a small group on alternating days. The lessons engaged students in the use of hands-on
materials such as manipulatives, protractors, and rulers. For example, in one lesson, students learned how to line up the protractor and read it to find angle measures. Students also engaged in conversation and used cooperative learning strategies during this time. Cooperative learning strategies included activities such as think-pair-share, rally coach, and four corners. Think-pair-share allowed students to think individually first and then pair up to share their learning and ideas. Rally coach helped students develop math language when one student coached and praised as the other student worked out the problems. Students then switched roles so both students had the opportunity to coach and write. The four corners strategy was used to build student reasoning as they chose one of four answers to a problem. The student had to go to the corner which had the answer they chose and be prepared to explain and defend their choice. At the end of the lessons, students completed an exit ticket to check for understanding.

Each Independent Digital Lesson completed on Zearn.org included four types of practice: adaptive fluency, lesson-aligned fluency, guided practice, and independent practice, (Figure 3.9) which students completed in this order. Students could only move forward once the previous practice type was completed. Students earned an online badge awarded by the software after completing each lesson. A detailed description of each of those practice types is provided below.

**Adaptive Fluency**

Students practiced number sense fluency in each adaptive fluency session which provided a gamified way for students to build foundational number sense. In this section, previously learned skills were reinforced. The questions adapted to the student’s ability
to successfully complete the tasks. As the student demonstrated proficiency with a skill, the program adapted to give them more complex number sense activities.

**Aligned Fluency**

In the next section of the lesson, students completed lesson-aligned fluency. This fluency practice was based on the concept the students would learn for the day. For example, in the lesson where students compared the sizes of different angles to right angles, the lesson-aligned fluency practice included comparing whole numbers as a review.

**Guided Practice**

Next, students completed the guided practice section of the lesson. During guided practice, the students watched the video, answered questions, and received computer-generated feedback on their responses. This feedback was both written and verbal. Students were expected to take notes during the guided practice section of the digital lesson. The researcher checked for completed notes daily before class begins.

**Independent Practice**

Finally, the students completed independent practice. Independent practice provided an opportunity for students to demonstrate their understanding of the lesson. The students had to correctly answer all of the questions in this section in order to access the next lesson in the unit. Zearn offered support for a student struggling with a concept by providing embedded remediation which may have included manipulative or additional interactive videos that modeled the lesson differently.
Figure 3.9 Four Types of Practice in Zearn

The Zearn.org platform stored data on which digital lessons were completed by the students as well as student performance on the lessons. Two lessons in the Zearn.org Mission did not have digital lessons. For Lesson 11 and Lesson 16, I used YouTube videos created by Duane Habecker that I have used in the past with students. These videos were about 14 – 16 minutes long each. Students took notes for these two lessons. The researcher used Edpuzzle to track the students’ activity for these two videos. Edpuzzle is a free platform that allows educators to upload videos from YouTube or instructor-created videos. The researcher checked to see that students watched the videos and answered the questions in the Edpuzzle platform before the in-person sessions took place for those lessons.
Data Collection

Three data sources were used to evaluate the implementation of the flipped classroom model on the achievement and motivation towards math for fourth-grade students at this elementary school. Both qualitative and quantitative data were collected during this study. The types of data collected were a pretest and posttest, a motivation questionnaire, a perception questionnaire, a focus group interview with the participants and field notes. Table 3.1 shows the alignment between the research questions and the types of data collection methods used.

Table 3.1

<table>
<thead>
<tr>
<th>Data Collection Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question</td>
</tr>
<tr>
<td>RQ1: Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?</td>
</tr>
<tr>
<td>RQ2: What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RQ3: What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Pretest and posttest.** The students participating in the study took a pretest and a posttest (Appendix D). The pretest was administered at the beginning of the 8-week period, before the intervention. The assessment addressed seven geometry standards with two to seven questions addressing each standard (Table 3.3). The assessment measured the prior knowledge of the students in geometry and consisted of 25 multiple-choice
questions. A perfect score on the test was 25 points. The posttest was administered at the end of the 8-week period. It was the same assessment as the pretest. Both the pre- and post-test were taken by each student individually in the Mastery Connect online platform during class time. The posttest measured if there was a statistically significant difference between the participants’ scores before and after the intervention.

All questions were created by the company TE21, CASE (Collaborative Assessment Solutions for Educators). TE21’s CASE Benchmark Assessments were designed to gauge the academic progress of students and to provide timely feedback which can be used by teachers to guide instruction (CASE Benchmark Assessments, 2020). Validity addresses the issue of measuring what was intended to be measured based on the focus of the research (Buss & Zambo, 2014; Creswell, 2014; Mertler, 2019). The pretest and posttest used for this study was created by the researcher using questions from the TE21’s CASE Item Bank. The questions in the item bank were created by teams of educators. The questions were continuously reviewed to ensure they continue using best practices in assessing the standards, and to ensure the questions were fair and unbiased before they are published in the item bank for teachers to use in assessments. Mertler, (2019) suggests content validity be the focus for classroom-based action research. Because the questions in the item bank have been used by students and reviewed by teachers and other educational experts, validity has already been established for this instrument.

Reliability is an important method for rigor and trustworthiness. Reliability refers to consistency during the research process (Heale & Twycross, 2015; Mertler, 2019). Once the quantitative data has been collected, Mertler (2019) suggests the use of internal consistency or a statistical estimate of how a reliable a test is when administered only
once. For this study, Kuder-Richardson formula 20 (KR-20) was used. The KR-20 is an acceptable formula for this test because the difficulty of the problems on the test were labeled in the database as easy, medium or hard. They were also labeled with a DOK level of one, two, or three. The statistics from this formula ranged from 0.00 to 1.00, as reliability increased if the score was closer to 1.00 and decrease if the score was closer to 0.00 (Heale & Twycross, 2015; Mertler, 2019).

The questions on this assessment were chosen from the company’s test bank. Questions in the test bank were created by teams of educators who consistently review questions for bias. Permission to use questions from the item bank has been obtained from the company (Appendix E). Sample questions from the assessment include: Which figure has both parallel and perpendicular lines? Which angle measures 65º? and Which letter has at least two lines of symmetry? The number of items per standard varied due to the time length of the units and the number of skills taught under each standard. Therefore a standard with more items on the assessment covered more topics and took more class time to learn.

Table 3.3

Assessment Items on the Pretest and Posttest

<table>
<thead>
<tr>
<th>Standard Number</th>
<th>SC State Standard</th>
<th>Number of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.G.1</td>
<td>Draw points, lines line segments, rays, angles i.e., right, acute, obtuse), and parallel and perpendicular lines. Identify these in two-dimensional figures.</td>
<td>7</td>
</tr>
<tr>
<td>4.G.2</td>
<td>Classify quadrilaterals based on the presence or absence of parallel or perpendicular lines</td>
<td>3</td>
</tr>
<tr>
<td>4.G.3</td>
<td>Recognize right triangles as a category, and identify right triangles.</td>
<td>2</td>
</tr>
<tr>
<td>4.G.4</td>
<td>Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into</td>
<td>2</td>
</tr>
</tbody>
</table>
Surveys. The students in this study completed a motivation questionnaire and a perception questionnaire. The motivation questionnaire was based on the RIMMS (Loorbach et al., 2015) (Appendix F). The questions were adapted by the researcher to address motivation toward math. The motivation questionnaire (Appendix G) consists of 12 questions related to motivation after the use of the flipped classroom model. There are three questions representing each of the four subscales of the ARCS model. The students rated their responses using a 5-point Likert Scale ranging from strongly disagree (1) to strongly agree (5). The questionnaire was administered after the completion of the flipped classroom model lessons and stored electronically using Google Forms. Sample items from the questionnaire included: “The way the math materials are written helped to keep my attention” (attention); “I understand how the math material is related to things I have already learned” (relevance); “When I am working on math, I am confident that I can learn the material” (confidence); and “I really like learning math” (satisfaction).

The perception questionnaire (Appendix H) was created by the researcher. The questions were developed based on elements of the flipped classroom model such as the enjoyment of watching videos and note-taking. A research methods expert with experience in flipped learning reviewed the questionnaire with the researcher. The students rated their responses using a 5-point Likert Scale ranging from strongly disagree
(1) to strongly agree (5). The questionnaires were completed and stored electronically using Google Forms after the completion of the flipped classroom model lessons. Cronbach’s alpha coefficient was used to determine the reliability of the perception questionnaire items.

The motivation questionnaire and the perception towards the flipped classroom model questionnaire was created by the researcher. The motivation questionnaire is based on The Reduced Instructional Materials Motivation Survey (RIMMS), which is a 12-item instrument used to measure reactions to instructional materials (Loorbach et al., 2015). RIMMS is a shortened version of the Instructional Materials Motivation Survey (IMMS), which has 36 items. Both the IMMS and the RIMMS have been validated (Loorbach et al., 2015). The researcher modified the wording of the RIMMS to adjust them to the reading level of elementary students and the content area of math without changing the meaning of the questions. Both the motivation questionnaire and the perception towards the flipped classroom questionnaire were critically reviewed by math teachers and research experts in the field (Mertler, 2019) prior to implementation.

**Focus group interview.** Focus group interviews are well suited for research which seeks to develop and measure services that meet the needs of a particular group (Mack et al., 2005). For this research, the focus group interview was used to further explore the experiences and perceptions of the students participating in this study. Six students from the study were randomly selected to participate in the focus group at the conclusion of the study. The suggested size of the focus group is six to eight people since smaller groups allow for diverse ideas while still giving everyone a chance to share (Krueger & Casey, 2000). The data collected from the focus group interview included
audio and video recordings, transcription of the recording, and handwritten notes as suggested by Mack et al. (2005). The interview was conducted by the researcher. The researcher asked the questions (Appendix I) and gave each of the six students an opportunity to respond. Examples of these questions are: What are your likes and dislikes about the flipped classroom model? Did you prefer the flipped learning model or the traditional learning model?

**Data Analysis and Representation**

The data analysis in this study was both quantitative and qualitative in nature. The quantitative data that were analyzed were the pretest and posttest and the questionnaires. The qualitative data source was the focus group interview and the field notes. Table 3.4 shows the methods of data collection and the type of analysis that were used with each method.

**Table 3.4**

*Research Questions, Data Collection Methods, and Data Analysis*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Collection Methods</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1: Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?</td>
<td>• Pretest and posttest - Mastery Connect assessment</td>
<td>• Paired samples t-test</td>
</tr>
</tbody>
</table>
| RQ2: What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States? | • Motivation Questionnaire  
• Focused group interview  
• Field notes | • Descriptive statistics  
• Inductive and thematic analysis |
RQ3: What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?

- Perception questionnaire
- Focused group interview questions
- Field notes
- Descriptive statistics
- Inductive and thematic analysis

Quantitative data analysis. Quantitative data from the multiple-choice pretest and posttest were automatically scored as correct or incorrect in the Mastery Connect Platform. The scores were reported as the number of items correct out of 25. The data was then exported to an Excel spreadsheet. The average number of items correct on the pretest by each student was compared to the average number of items correct on the posttest for each student. The averages of the pretest and posttest of the entire data set was also compared. The data from the pretest and posttest assessments were used to run a paired samples t-test (Adams & Lawrence, 2018) in JASP to determine if there was a statistically significant difference in the data. An alpha level of $\alpha = 0.05$ was used to compare the means. Descriptive statistics including measures of central tendency (mean) and measures of dispersion (standard deviation and range) were reported (Gavin, 2008; Mertler, 2019).

Research questions two and three were both answered using quantitative data from the questionnaires and the field notes. Quantitative data collected with the questionnaires were Likert scale items. "Likert scale items are created by calculating a composite score (sum or mean) from four or more Likert-type items; therefore, the composite score for Likert scales should be analyzed at the interval measurement scale (Boone & Boone, 2012, p. 3). The RIMMS-based questionnaire and the perception questionnaire were given at the end of the flipped learning unit. Descriptive statistics
included the mean for central tendency and standard deviation for variability (Boone &
Boone, 2012).

**Qualitative data analysis.** Research questions three and four were also partly
answered with qualitative data from the focus group interview and field notes. The video
interview was listened to multiple times and then transcribed using Temi.com., an audio
to text transcription service, and the field notes were reviewed. It was important to
become familiar with the transcribed notes by reading and rereading the notes, becoming
familiar with the data as a whole before breaking it into parts and making notes in the
margins (Creswell, 2017). After this process, the data was winnowed by focusing on the
most important parts of the data (Guest et al., 2012). This step allowed me to focus on
similarities found in the data. Qualitative software programs can be used to organize and
sort the data (Creswell, 2014). I used Delve, a computer-assisted qualitative data analysis
software (CAQDAS) to aid in the management of the data. Delve was used to apply
codes to excerpts of text. Coding helped to analyze the data by organizing and keeping
track of patterns and themes, checking for biases or discrepancies, and finding excerpts or
quotes quickly (Mertler, 2019). I used inductive analysis to develop general themes and
interpret the meaning of the data (Creswell, 2014). This primary cycle of coding was
used to develop first-level codes for the data (Tracy, 2020). Multiple rounds of reading
and coding occurred. The codes were combined looking for similarities to create
overarching categories. Themes were created to explain the experiences of the
participants. Upon completion of the coding process, the themes were used to develop
tables, graphs, and a narrative description of the findings from this study (Creswell,
2014).
Procedures and Timeline

This study took place in the spring of the 2021-2022 school year. The students were invited to participate in the study by sending home parental consent forms at the beginning of the spring semester. The consent form included a written description of the study and what the participants in the study would be doing (Drew et al., 2007; Mertler, 2019; Tracy, 2020). This form was given to the students to take to their parents as well as emailed to the parents of the students in the study. Once the forms were returned and I had received written consent from a parent or guardian, students were given assent forms to complete since they were under the age of 18. The assent forms were written in a child-friendly language the students could understand (Mertler, 2019; Tracy, 2020).

Once parental consent and student assent were obtained, students took the geometry assessment on Mastery Connect as a pretest. The test was taken on the students’ Chromebooks at school during their regularly scheduled math intervention time.

Upon completion of the pre-intervention assessment, students began the flipped classroom modules on Zearn.com. The students were expected to complete one lesson on alternating days before attending the in-person classes with the researcher on the following day. Flipped learning took place over an eight-week period. The researcher taught the in-person lessons each day to the alternating groups of students.

During week nine, students completed the geometry posttest. They also completed a Likert scale questionnaire on motivation and a Likert scale perception questionnaire. Finally, six randomly selected students participated in the focus group interview (Table 3.5).
Table 3.5

_Procedures and Timeline_

<table>
<thead>
<tr>
<th>Week</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week one</td>
<td>• Recruitment: consent and assent forms</td>
</tr>
<tr>
<td></td>
<td>• Pretest on geometry</td>
</tr>
<tr>
<td></td>
<td>• Flipped learning begins</td>
</tr>
<tr>
<td>Weeks two-eight</td>
<td>• Flipped learning lessons</td>
</tr>
<tr>
<td>Week nine</td>
<td>• Posttest on geometry</td>
</tr>
<tr>
<td></td>
<td>• Motivation questionnaire</td>
</tr>
<tr>
<td></td>
<td>• Perception questionnaire</td>
</tr>
<tr>
<td></td>
<td>• Focused group interview</td>
</tr>
</tbody>
</table>

_Rigor and Trustworthiness_

To ensure trustworthiness in a study, it is common practice to use a variety of methods, instruments and sources to collect data (Mertler, 2019). This study included both quantitative and qualitative methods of data collection. Several rigor and trustworthiness methods were used for the data collected in this study including data triangulation.

Methodological triangulation was used to strengthen the credibility of this study. Triangulation is the collection of multiple types of data as a means to minimize research bias (Tracy, 2019). The multiple data sources included the pretest and posttest, the motivation and perception questionnaires, the focus group interview, and the field notes. The results from the data were informally compared to determine if there are similar results. Once themes were determined based on the converging of this data, the process of triangulation added rigor and credibility to the study (Creswell, 2014).
Peer debriefing was also used to improve the accuracy of the findings from the research (Creswell, 2014). This process involved the review of the quantitative and qualitative findings by a peer and dissertation chair (Mertler, 2019). This debriefing required colleagues to ask questions of the researcher, critique the process, and review the analysis and interpretation. For this study, peer debriefing was conducted with a member in my Doctoral cohort and the dissertation chairperson. This question and answer process added validity to the study (Creswell, 2014).

Another trustworthiness strategy used in this study was the presentation and analysis of negative or discrepant information that was not congruent with other findings from the study (Creswell, 2014). It helps us to avoid cherry picking the data and to show that a wide range of viewpoints are included in the study (Tracy, 2020). Tracy (2020) also suggested including a comparison of the typical data to the discrepant data helps to improve claims or theories created by the researcher. Sharing this contradictory evidence improved the trustworthiness of the data and made it seem more realistic (Creswell, 2014).

Finally, rigor and trustworthiness were established with the use of an audit trail. An audit trail provided a methodological description of the decisions made and procedures used in this study (Shenton, 2004). Wolf (2003) described the three parts of the audit trail as: (1) raw data such as transcribed interviews, artifacts, and field notes; (2) data reduction and analysis items such as codes and themes; and (3) findings such as narratives, tables, and figures. The researcher’s notes included dates, locations, and other memos allowed for an opportunity to look to the audit trail for review of the notes or further clarification (Wolf, 2003).
Plan for Sharing and Communicating Findings

Sharing and communicating research findings is an important part of action research, even though the findings of action research are not meant to be generalized to other settings (Mertler, 2019). However, sharing the findings from action research can impact the practices of the colleagues in your local setting (McAteer, 2013). Sharing the findings of your research with colleagues can also encourage them to do their own research which can empower them and lead to professional growth (Mertler, 2019).

The findings of this research were summarized and will be shared with all stakeholders using a detailed presentation. The written presentation was created using Google Slides. When possible, the presentations will be shared orally with groups of stakeholders. The presentation followed the outline suggested by Mertler (2019) which included background information, the purpose of the study, methodology, results, conclusions, an action plan and a time for questions and answers. This presentation will be shared with students and their families at our school’s curriculum night; colleagues and school administrators during a designated faculty meeting; district-level administrators at our monthly math professional development; and at the SC Midlands Summit and other professional platforms with educators from across the state. Each presentation will be modified to fit the needs of the audience while providing information on how the findings can be applied to each target audience (Tracy, 2020). To protect the identity and confidentiality of all participants in the presentations, the researcher will avoid using the names of participants or settings as well as race, gender, and special needs placements. Pseudonyms will be used in place of actual names in the findings (Mertler, 2019).
CHAPTER 4
ANALYSIS AND FINDINGS

The purpose of this action research was to examine the impact of the flipped classroom model on fourth-grade students’ achievement in a Geometry unit, on their motivation towards mathematics, and their perceptions of the flipped model at an elementary school in the Southeast United States.

The data collection was aligned with the following research questions:

**RQ1:** Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ2:** What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?

**RQ3:** What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?

This chapter details the quantitative and qualitative data analysis and findings for the implemented geometry unit utilizing the flipped classroom model. The data includes a pretest and a posttest on the geometry content taught in the unit; a perception questionnaire developed by the researcher; and a motivation questionnaire based on RIMMS (Loorbach et al., 2015). A focus group interview also included six randomly chosen students from the group and field notes written during the study.
There were 17 student participants in this study. The data from one participant was removed from the geometry pretest and posttest due to the student not completing the pretest before the beginning of instruction. All 17 students were able to complete the two questionnaires used in this study and therefore all of their data was used in the data analysis.

This chapter includes three main sections. The first section presents the quantitative data analysis and findings about the geometry pretest and posttest, as well as the motivation and perception questionnaires. The second section of this chapter includes the analysis process and findings of the qualitative data, the focus group interviews. Finally, the quantitative and qualitative data were integrated for triangulation.

**Quantitative Findings**

This section presents the findings from the three quantitative data collection tools used in this action research, which includes the geometry pretest and posttest, and the motivation and perception questionnaires. The data from the geometry pretest was collected before the flipped classroom lessons. All other data were collected after the completion of the flipped classroom lessons. The findings are presented in the following order: The pretest and posttest data, followed by the perception questionnaire, and finally the motivation questionnaire.

**Geometry Pretest and Posttest**

The pretest was administered to students before the flipped classroom lessons began. The students were given the same geometry test as a posttest at the end of the unit. The geometry test included 25 questions covering seven South Carolina state math
standards. Each question was worth one point, and the maximum possible score for the assessment was 25 points.

Using a Microsoft Excel Spreadsheet, the pretest and posttest data were both tested for reliability using the Kuder-Richardson Formula 20 (KR-20). The KR-20 method is a calculation used to determine the internal consistency reliability for quantitative assessments with only two possible results, either right or wrong (Cortina, 1993). The questions on this assessment had varying levels of difficulty and were dichotomous, therefore the KR-20 method was used to determine the reliability of the instrument. The reliability of the pretest and the posttest is presented in Table 4.1. The reliability coefficients of the pretest and posttest were .48 and .47 for the pretest and posttest respectively. Both of these scores have unacceptable reliability.

**Table 4.1**

*Kuder-Richardson Formula 20 Test for Reliability*

<table>
<thead>
<tr>
<th>Content Test</th>
<th>KR-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.48</td>
</tr>
<tr>
<td>Posttest</td>
<td>.47</td>
</tr>
</tbody>
</table>

*Note.* Significant results (p > .70) indicate acceptable reliability.

**Descriptive Statistics**

The geometry test scores were analyzed in JASP using descriptive statistics. The overall posttest had higher values (\(M = 14.25, SD = 2.96\)) than the pretest (\(M = 8.88, SD = 3.01\)) as presented in Table 4.2. The pretest minimum score was 4.00 and the maximum score was 18.00. The posttest minimum score was 10.00 and the maximum score was 22.00. Fifteen of the 16 students in the study experienced an increase in the number of correct items from the pretest to the posttest as seen in Figure 4.1, while one student scored the same on the pretest and the posttest.
There was an increase in the mean for each geometry standard presented in the test (Table 4.3). The highest increase in mean was experienced in the skills of Draw Geometric Figures (1.75) and Angle Measurement and Circles (1.19). The least increase was experienced in Identify Lines of Symmetry.

Table 4.2

**Descriptive Statistics Overall Test**

<table>
<thead>
<tr>
<th></th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>8.88</td>
<td>3.01</td>
</tr>
<tr>
<td>Posttest</td>
<td>14.25</td>
<td>2.96</td>
</tr>
</tbody>
</table>

Table 4.3

**Descriptive Statistics by Skill**

<table>
<thead>
<tr>
<th>Skills</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.G.1 Draw Geometric Figures</td>
<td>Pretest 2.81</td>
<td>.83</td>
</tr>
<tr>
<td></td>
<td>Posttest 4.56</td>
<td>1.50</td>
</tr>
<tr>
<td>4.G.2 Classify Quadrilaterals</td>
<td>Pretest .88</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>Posttest 1.25</td>
<td>.78</td>
</tr>
<tr>
<td>4.G.3 Identify Right Triangles</td>
<td>Pretest .75</td>
<td>.68</td>
</tr>
<tr>
<td></td>
<td>Posttest 1.19</td>
<td>.66</td>
</tr>
<tr>
<td>4.G.4 Identify Lines of Symmetry</td>
<td>Pretest 1.00</td>
<td>.37</td>
</tr>
<tr>
<td></td>
<td>Posttest 1.25</td>
<td>.68</td>
</tr>
<tr>
<td>4.MDA.5 Angle Measurement and Circles</td>
<td>Pretest 1.25</td>
<td>.86</td>
</tr>
<tr>
<td></td>
<td>Posttest 2.44</td>
<td>1.15</td>
</tr>
<tr>
<td>4.MDA.6 Measure and Draw Angles</td>
<td>Pretest .81</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>Posttest 1.50</td>
<td>.73</td>
</tr>
<tr>
<td>4.MDA.7 Find Unknown Angles</td>
<td>Pretest 1.38</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Posttest 2.00</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Note: Each standard had a different number of items. The maximum score for each skill is: 4.G.1 = 7; 4.G.2 = 3; 4.G.3 = 2; 4.G.4 = 2; 4.MDA.5 = 4; 4.MDA.6 = 3; 4.MDA.7 = 4
Figure 4.1 Geometry Pretest and Posttest. This chart compares the individual pretest scores to the posttest scores. The scale ranged from 0 to 25.

**Shapiro-Wilk Normality Test**

Using the overall scores for the geometry pretest and posttest, JASP was used to conduct the Shapiro-Wilk test to measure the normality of the distribution. A $p$-value of .05 was used as the threshold level of significance. Results showed the $p$-value of the difference is higher than .05, which indicates the data were normally distributed. Since the data were normally distributed, a paired samples t-test was administered to assess if there were differences between the students’ pretest and posttest scores. The geometry test included items from seven different state math standards. JASP was used to run a paired samples t-test for each data set.
**Paired-Samples t-Tests**

A t-test for dependent samples was administered for the overall test and showed this difference was statistically significant, between the pretest \( (M = 8.88, SD = 3.01) \) and the posttest \( (M = 14.25, SD = 2.96) \), \( t(15) = 7.25, p = <.001 \) (Table 4.4). The effect size was also calculated in JASP. Cohen’s \( d \) was used to determine the effect size which represents the strength of the difference in the data (Creswell, 2014). According to Cohen (1998), a value of .8 or higher has a large effect size. The effect size for the overall pretest and posttest had a value of 1.81, indicating a large effect size for the flipped learning math lessons.

Since I performed multiple \( t \)-tests within the geometry assessment data to analyze each of the seven standards, the risk of Type I errors increased. The Bonferroni Correction was applied to address this issue by adjusting the significance level of the \( p \)-value. The adjusted value of \( p = .007 \) was used to determine the level of significance. A \( t \)-test for dependent samples showed the difference between draw geometric figures, pretest \( (M = 2.81, SD = .83) \) and posttest \( (M = 4.56, SD = 1.50) \), \( (t = 4.46, p = <.001, df = 15) \) was statistically significant.

The remaining six standards showed no statistically significant difference in the pretest and the posttest when the Bonferroni adjusted \( p \)-value of .007 was used. Classify quadrilaterals \( t = 1.57, p = .138, df = 15 \); identify right triangles \( t = 1.70, p = .110, df = 15 \); identify lines of symmetry \( t = 1.46, p = .164, df = 15 \); angle measurement and circles \( t = 3.05, p = .008, df = 15 \); measure and draw angles \( t = 3.15, p = .007, df = 15 \); and find unknown angles \( t = 2.08, p = .055, df = 15 \) all had \( p \)-values equal to or higher than .007.
Table 4.4

Paired Samples T-Tests

<table>
<thead>
<tr>
<th>Skill</th>
<th>Pretest M</th>
<th>Pretest SD</th>
<th>Posttest M</th>
<th>Posttest SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw Geometric Figures</td>
<td>2.81</td>
<td>.83</td>
<td>4.56</td>
<td>1.50</td>
<td>4.46</td>
<td>15</td>
<td>&lt; .001</td>
<td>1.11</td>
</tr>
<tr>
<td>Classify Quadrilaterals</td>
<td>.88</td>
<td>.62</td>
<td>1.25</td>
<td>.78</td>
<td>1.57</td>
<td>15</td>
<td>.138</td>
<td>.39</td>
</tr>
<tr>
<td>Identify Right Triangles</td>
<td>.75</td>
<td>.62</td>
<td>1.19</td>
<td>.66</td>
<td>1.70</td>
<td>15</td>
<td>.110</td>
<td>.42</td>
</tr>
<tr>
<td>Lines of Symmetry</td>
<td>1.00</td>
<td>.37</td>
<td>1.25</td>
<td>.68</td>
<td>1.46</td>
<td>15</td>
<td>.164</td>
<td>.37</td>
</tr>
<tr>
<td>Angle Measurement/Circles</td>
<td>1.25</td>
<td>.86</td>
<td>2.44</td>
<td>1.15</td>
<td>3.05</td>
<td>15</td>
<td>.008</td>
<td>.76</td>
</tr>
<tr>
<td>Measure and Draw Angles</td>
<td>.81</td>
<td>.66</td>
<td>1.50</td>
<td>.73</td>
<td>3.15</td>
<td>15</td>
<td>.007</td>
<td>.79</td>
</tr>
<tr>
<td>Find Unknown Angles</td>
<td>1.38</td>
<td>1.15</td>
<td>2.00</td>
<td>1.03</td>
<td>2.08</td>
<td>15</td>
<td>.055</td>
<td>.52</td>
</tr>
<tr>
<td>Total Test</td>
<td>8.88</td>
<td>3.01</td>
<td>14.25</td>
<td>2.96</td>
<td>7.26</td>
<td>15</td>
<td>&lt; .001</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Perception Questionnaire

The perception questionnaire was administered at the end of the study after all of the geometry lessons were completed. The questionnaire consisted of 10, 5-point Likert-type scale items. The participants in the study indicated their level of agreement with each statement by choosing one of the following choices: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, or (5) strongly agree.

Using the data analysis software JASP, the perception questionnaire was tested for reliability (n=17) using Cronbach’s alpha. The reliability coefficient for the perception questionnaire was .75. Coefficients of .70 and above have acceptable reliability (DeVellis, 2016).

Descriptive Statistics

The perception questionnaire data were analyzed using descriptive statistics as presented in Table 4.5. The mean of student responses ranged from 3.76 to 4.47 on all items on the questionnaire. The highest-rated items concerned the use of videos in the flipped classroom. The students agreed they watched the videos before class (M = 4.41, SD = .94) and that watching the videos before class helped them better understand the
math lesson ($M = 4.47, SD = .86$). However, there was less agreement, and hence a lower mean score when students were asked if they enjoyed watching the videos ($M = 3.94, SD = .97$) and if they re-watched the videos when they did not understand the lesson ($M = 3.76, SD = 1.03$). Students agreed they liked using the flipped classroom model to learn ($M = 4.41, SD = .62$), however, when asked if they preferred the flipped classroom model over the traditional model of learning the mean score was one of the lowest scores on the questionnaire ($M = 3.82, SD = .88$).

**Table 4.5**

*Perception Questionnaire Descriptive Statistics*

<table>
<thead>
<tr>
<th>Perception</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning with the flipped classroom model helps me to be more engaged in the lesson than the traditional learning environment.</td>
<td>4.24</td>
<td>.75</td>
</tr>
<tr>
<td>I would like to use the flipped classroom model in other subjects.</td>
<td>4.24</td>
<td>.90</td>
</tr>
<tr>
<td>Watching videos before class helped me better understand the math lesson.</td>
<td>4.47</td>
<td>.87</td>
</tr>
<tr>
<td>I enjoyed watching math videos before the lesson.</td>
<td>3.94</td>
<td>.97</td>
</tr>
<tr>
<td>I usually watch the videos before the lesson.</td>
<td>4.41</td>
<td>.94</td>
</tr>
<tr>
<td>I would recommend the flipped classroom model to my friends.</td>
<td>4.12</td>
<td>1.11</td>
</tr>
<tr>
<td>Taking notes while watching the videos helped me understand the lesson.</td>
<td>4.35</td>
<td>.86</td>
</tr>
<tr>
<td>I like using the flipped classroom model to learn.</td>
<td>4.41</td>
<td>.62</td>
</tr>
<tr>
<td>I re-watched the videos when I did not understand the lesson.</td>
<td>3.76</td>
<td>1.03</td>
</tr>
</tbody>
</table>
I prefer the flipped classroom model over the traditional model of learning 3.82 .88

Adapted RIMMS Questionnaire

The Adapted RIMMS Questionnaire was administered to the participants at the end of the study once all of the geometry lessons were completed. The adapted RIMMS questionnaire consisted of twelve 5-point Likert-type scale items. The Likert-type scale choices were (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. The items were broken down into four subscales: attention, relevance, confidence, and satisfaction. Each subscale included three items.

Descriptive Statistics

The data from the adapted RIMMS Questionnaire were analyzed using descriptive statistics in JASP. The mean scores of the items ranged from 3.94 to 4.20 as seen in Table 4.6. Confidence had the lowest mean \( (M = 3.94, SD = .86) \) with relevance and satisfaction each having the same mean \( (M = 4.18, SD = .84 \) and \( .97 \) respectively). Attention had the highest mean \( (M = 4.20, SD = .72) \). All of the means fell at or above 4, which suggests agreement among students that they were motivated to learn using the flipped classroom model.

<table>
<thead>
<tr>
<th>Subscales</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>4.20</td>
<td>.72</td>
</tr>
<tr>
<td>Relevance</td>
<td>4.18</td>
<td>.84</td>
</tr>
<tr>
<td>Confidence</td>
<td>3.94</td>
<td>.86</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>4.18</td>
<td>.97</td>
</tr>
</tbody>
</table>
Qualitative Findings

This study used one source of qualitative data. The qualitative data were collected through a focused group interview. The data from the interview was collected during a whole group, face-to-face meeting with six randomly chosen students from the study at the end of the intervention. The focus group was asked eight open-ended questions, with each person in the group having an opportunity to respond. During the interview, two additional questions and a time for additional comments arose from the conversation. The total interview was about 15 minutes in length. The interview was recorded using Google Classroom and transcribed using Temi. The transcript from Temi was then proofread, and uploaded into Delve, which is a web-based qualitative data analysis tool.

Focus Group Interview

There was a total of 17 research participants in this study. Of those 17 students, six were chosen randomly to participate in the group interview. The six students in the group included three male and three female participants. All interviewed students identified as African American (Table 4.7).

Table 4.7

Demographics for the Focus Group

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevor</td>
<td>9</td>
<td>Male</td>
<td>African American</td>
</tr>
<tr>
<td>Dana</td>
<td>10</td>
<td>Female</td>
<td>African American</td>
</tr>
<tr>
<td>Lauryn</td>
<td>10</td>
<td>Female</td>
<td>African American</td>
</tr>
<tr>
<td>Erykah</td>
<td>10</td>
<td>Female</td>
<td>African American</td>
</tr>
<tr>
<td>Christopher</td>
<td>9</td>
<td>Male</td>
<td>African American</td>
</tr>
<tr>
<td>Shawn</td>
<td>10</td>
<td>Male</td>
<td>African American</td>
</tr>
</tbody>
</table>
The interview was recorded on two devices, with one recording directly on the laptop and the other being recorded in Google Classroom. The recording completed in Google Classroom was the one uploaded to Temi as it produced the better of the two sound qualities. Once the transcript was digitally transcribed by Temi, I went through the recordings and transcript line by line using the time stamp data on the document to clean up any miscommunication or unclear areas, and to improve the accuracy and validity of the transcripts. The inaccuracies that occurred during the transcription process were due to factors such as student volume, students wearing masks, and the audio quality of the devices being used. In some cases where the speech was unclear or inaudible, it is indicated with an ellipsis or the word inaudible in brackets, such as in the following example:

Researcher: All right. My other, my next question is what were some things about the flip classroom that you didn't like? Were there some things you did not like?

Trevor: I didn't like how it [inaudible] and it does nothing.

Researcher: Okay. Sometimes your computer did not have connection. Okay.

In these instances, the researcher often restated the students’ talking points in a follow-up statement. The students’ names and the name of the teacher were removed and replaced with pseudonyms assigned to protect the identity of the students and the regular education classroom teacher in the study (Kaiser, 2009; Mertler, 2019).

The complete interview was uploaded into Delve. Figure 4.2 shows a sample of the qualitative data in Delve, which includes the interview uploaded in the left column, the questions and responses in the middle column, and an example of the codes that were developed in the right column.
Figure 4.2. Dissertation Data in Delve

First Cycle Coding

According to Saldana (2016), the first cycle of coding is analysis of the data or taking the data apart. In this study, the first cycle of coding involved two rounds including initial coding and simultaneous coding. Initial coding entails breaking down the qualitative data into parts for the purpose of locating similarities and differences (Saldana, 2016). Simultaneous coding involves applying two or more codes to the same passage (Saldana, 2016). The data collected from the focus group interview were analyzed using inductive analysis or a ground-up approach to derive codes from the data, deriving themes as the data was read during the analysis process (Creswell, 2014; Mertler, 2017). Prior to and during the coding process, the researcher gained familiarity with the focus group responses by frequently rereading the transcript. During this reading and rereading process, the data were examined line by line to develop first-level or initial codes for the data (Saldana, 2016; Tracy, 2020). Initial coding allowed the
researcher to analyze the data and determine codes based on patterns found within the data (Mertler, 2017; Saldana, 2016).

During the first iteration of coding, broad terms were created by the researcher in Delve, naming phrases based on my initial interpretation of the data (Saldana, 2016). Value coding, which involves describing some of the perspectives and opinions of the students as well as attribute coding, which entails describing some of the features of the flipped classroom model were used to develop the codes (Saldana, 2016). Some of the codes developed during the first iteration of coding include group work, independent learning, likes, and improvements. The researcher read through the data multiple times ensuring each important piece of data had an initial code. The second iteration of coding involved the use of simultaneous coding or providing two or more codes to a single piece of qualitative data (Saldana, 2016). During this process, the researcher reread the transcript to add additional codes to the data based on the initial codes that were already created. One example of this is a response from Trevor when asked about the benefits of the flipped classroom model, “[I like] the videos. I would say the videos and the games because the games helped me. . . I mean I do the Tower of Power (a game in Zearn) and the video also helped.” The codes designated to this statement were games and fun, improvements, and videos.

**Second Cycle Coding**

The second cycle of coding involves synthesizing the data and putting codes together into categories to create meaning for research findings (Saldana, 2016). Structural coding was administered by directly connecting responses to research questions two and three (Saldana, 2016). Codes developed during this round focused on
motivation and perception of the flipped classroom model. One code was renamed from \textit{like} to \textit{satisfaction}. Some of the other codes modified during this process include \textit{confidence}, \textit{attention}, and \textit{improvements/benefits}. Using pattern coding, codes were slightly modified and regrouped during this process. Pattern coding entails grouping similarly coded snippets from the data together into a smaller number of categories that are used to develop themes and explanations (Saldana, 2016). This process led to focused codes or themes in the data. During this cycle, codes were grouped into categories for research question 1, based on the ARCS model of motivation. The categories were (1) Attention: Students’ curiosities must be captured and sustained; (2) Relevance: Students must feel that the instruction relates to their personal values or will be instrumental in accomplishing desired outcomes; (3) Confidence: Students must feel that they will be able to succeed based on their ability and not on luck; (4) Satisfaction: Students must feel that the outcomes of the learning experiences are in line with their personal incentives and includes a mix of intrinsic and extrinsic rewards or outcome (Simsek, 2014; Keller, 2016). Figure 4.3 shows how these codes were organized in Delve.
Perception codes were also reorganized in this round of coding. Aspects of the flipped classroom model were used to organize codes to address research question two. Perception codes included *technology, independent learning, and preference*. In this round of coding, codes such as *games and fun, tech feedback, and videos* were grouped together to address the overall technology benefits as described by the participants in this study.

**Developing Themes**

Theming of the data was done categorically. Categorical theming involves explaining the patterns that were observed during the coding process (Saldana, 2016). The themes for this study were developed around research questions two and three.

Data was taken from Delve and placed into tables in a Word document. Codes, snippets of participant quotes related to the code, and notes from researcher observations were organized to support the themes that were developed. One theme emerged for
research question two. Table 4.8 shows the categories of the ARCS model of motivation, the quotes and field notes that were used to develop the theme. The themes developed for research question three are shown in Table 4.9.

**Table 4.8**

*Alignment Table for Research Question Two*

<table>
<thead>
<tr>
<th>ARCS Category and Definition</th>
<th>Codes</th>
<th>Quotes</th>
<th>Field Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention:</strong> Students’ curiosities must be captured and sustained</td>
<td>-Attention</td>
<td>Lauryn: [My attention] Increased because Ms. Freeman has a lot of students. Researcher: So, the smaller group helps is what you’re saying. Lauryn: I love them (the games). They were really fun activities.</td>
<td>There were no behavior issues. They worked in groups and independently. Students were focused on completing their assignments.</td>
</tr>
<tr>
<td><strong>Relevance:</strong> Students must feel that the instruction relates to their personal values or will be instrumental in accomplishing desired outcomes</td>
<td>-Relevance</td>
<td>Dana: Like I have to get ready for what’s coming next and what kind of math we’re doing the next day [in the] math book. So, whenever that comes up, I'll just be ready. Erykah: I started understanding more.</td>
<td>Students reported to their homeroom teacher that they learn a lot using the flipped classroom model. They emphasized to her that it was important to get their digital assignments done before coming to the in-person instruction.</td>
</tr>
<tr>
<td><strong>Confidence:</strong> Students must feel that they will be able to succeed based on their ability and not on luck</td>
<td>-Improved confidence</td>
<td>Lauryn: I think it’s good. [Be]Cause I used to not be able to answer questions in class and I'd be scared that I was gonna get it wrong. But after doing Zearn, it built my confidence. [Be]Cause if you get a question wrong.</td>
<td>Students were eager to participate in the lessons and answer questions. They asked questions of the teacher and of each other.</td>
</tr>
</tbody>
</table>
everybody makes mistakes. Dana: I think mine [confidence] increased because whenever I do Zearn, I like [that] it helps me practice what I'm getting ready for.

<table>
<thead>
<tr>
<th>Satisfaction:</th>
<th>- Satisfaction</th>
<th>- Note taking</th>
<th>- Games and fun</th>
<th>- Tech feedback</th>
<th>- Videos</th>
<th>- Independent Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students must feel that the outcomes of the learning experiences are in line with their personal incentives and includes a mix of intrinsic and extrinsic rewards or outcome</td>
<td>Trevor: I liked how when we got the questions wrong, you got to go back and do it. Christopher: [I like] The tower because we can go back and see what we did wrong and they would break it down.</td>
<td>Extrinsic rewards: Stickers for completing the digital lesson and notes prior to the in-person class; Earning badges in the Zearn online program Intrinsic: Students would be excited when it was their day to attend in-person classes; several students were ahead in their digital lessons and finished the lessons early.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research Question 2: The ARCS Model of Motivation

Theme: Using the flipped classroom model positively affected the four components of the ARCS model of motivation. The thematic analysis of the qualitative data showed that the students valued the learning strategies used to promote the ARCS model of motivation during the flipped classroom instruction. Students in the focus group interview shared positive thoughts about attention, relevance, confidence and satisfaction.

Attention. Attention refers to the ability of the materials to capture and sustain student curiosities. In this study, five of the six students interviewed, stated that their attention increased when they were doing the math activities in Zearn on the computer.
Five out of the six students also said that their attention increased when they were in the small group, in-person class with the researcher.

The in-person lessons happened on alternating days for the students. When students did in-person classes with the researcher, there were only eight or nine students in the classroom. The students were asked if their attention improved or decreased when using the flipped classroom model. Lauryn stated, “[My attention] increased because Ms. Freeman has a lot of students in her class.” The researcher responded with, “So the smaller group helps is what you’re saying.” The student was referring to the number of students in her traditional classroom, which was around twenty-two students.

Requiring learner participation, providing visuals and concrete materials, and varying presentation are strategies that gain and retain student attention (Francom & Reeves, 2010). When asked about the hands-on materials, the games and the types of activities that we did in class, Dana and Trevor agreed with Lauryn when she stated that, “I love them. They were really fun activities. Cause we got to do 'em together.” The field notes describe the students as attentive and focused on completing their assignments during the in-person sessions. Students were particularly involved when we used hands-on materials and interactive games that were played on the Clear Touch Board in teams. All but four students in the study were able to complete the lessons in Zearn before the end of the flipped classroom model sessions. The student’s homeroom teacher often stated that the students seemed to enjoy working on the video lessons during RTI time in the classroom.

Relevance. Relevance addresses the personal value that students feel or the ability to accomplish the desired outcome during instruction. Present worth and future
usefulness are both strategies that Francom and Reeves (2010) share for addressing relevance. Multiple students in the focus group expressed a feeling of relevance by discussing the importance of completing the digital assignments in Zearn prior to coming to class. Trevor stated, “Every time we would come to you, we would already understand it.” Similarly, Christopher said, “Well we do the videos and when we come to you, we already know what [you’re] gonna teach us.” Lauryn also stated, “I think it (the flipped classroom model) helped, because you don't have to keep telling us what we didn't get, we should have done it before we came to you. That's what we're supposed to do.” Lauryn reiterated later in the interview that, “It helped us understand what we, were gonna do.” Dana addressed future usefulness when she stated, “Our next chapter in our math book is actually about what you taught us.” The field notes also included information about future usefulness. During the in-person lessons the examples that were used and the models presented in the lesson used real world or familiar experiences to make the lessons more meaningful to the students. The conversations that students had around the topics demonstrated that the topics were relevant to them.

**Confidence.** Confidence addresses how students feel about their ability to succeed. Five of the six students in the focus group stated that their confidence increased when they used the flipped classroom model. Dana said, “When we came back with you, we got a lot more better about doing math.” Along those same lines, Lauryn stated, “I think it’s good. Cause I used to not be able to answer questions in class and I'd be scared that I was gonna get it wrong. But after doing Zearn, it built my confidence cause if you get a question wrong, everybody makes mistakes.” Christopher also stated that, “It has improved more cause you taught us more than what we did [before].” Erykah shared
that, “Sometimes when like writing the notes down it, helps me remember it a little.” These comments support the idea that students felt good about their ability to succeed using the flipped classroom model. Only one student in the focus group felt that his confidence decreased when using the flipped classroom model. Shawn said his confidence decreased, “Because I am low on Zearn.” The field notes indicate that this student was behind on his digital lessons and had to be given support multiple times in order to move ahead to the next lesson.

Allowing learners to become more independent and gradually increasing the difficulty level of materials are examples of strategies that can be used to improve student confidence (Francom & Reeves, 2010). The students in the focus group interview expressed thoughts about both of these concepts. Lauryn stated, “I like your way, because it's easier and more, um, teaching us to be independent by us learning to learn by ourselves, then come to do it with you.” Erykah added, “I think it's independent to us, yeah to us, but some of us don't really understand it like that, so we help each other.” Lauryn also went on to say, “It helps us take notes instead of our teacher just tell[ing] us, oh, you know, you have to do this, you have to do that. It helps us be more independent and [think] for ourselves.” Dana also commented on independence by stating, “The one thing I liked was when Ms. Freeman let us like sometimes go ahead to another lesson.” This student was referring to the ability to be able to move ahead in Zearn if they were done with the lesson for the day. The option to move at their own pace by being allowed to move forward, note-taking and promoting the concept that students can learn on their own were strategies that supported confidence for these students.

One student also spoke about the levels of Zearn. Dana shared:
So my first part of the question is, was Zearn easy for me, and I'll say yes, but in the meantime, uh, the levels go up and it teaches you more things and they get more difficult than like what you did at first.

Although the levels in the program got more difficult for the students, there was support within Zearn to help them continue moving forward. Christopher stated, “[In] the tower (a game in Zearn), we can go back and see what we did wrong and they would break it down.” Students understood that the difficulty would increase in the lessons, but there was support to help them continue to move forward and build their confidence.

**Satisfaction.** Satisfaction explains how the outcomes of the learning experience must be in line with their personal incentives. These incentives can be intrinsic or extrinsic rewards or outcomes. The students stated that they were satisfied with many aspects of the flipped classroom model including note-taking, the games, and the videos. Trevor remarked, “I liked how when we got the question wrong, you got to go back and do it.” While Christopher explains, “[I like] the tower because we can go back and see what we did wrong and they would break it down. Both of these instances describe positive outcomes, which is a motivational strategy for improving satisfaction (Francom & Reeves, 2010). Students were not deterred, but supported by the program even when they made a mistake. Additional positive outcomes were that students felt like they were learning with the Zearn program and the students described parts of the learning as fun. Dana noted, “Zearn was easy for me. . . the levels go up and it teaches you more things.” Lauryn specifically stated what she learned by stating, “I like when we did it in class, we were learning about 360, 180, 270.” This was a reference to the lesson relating angle degrees to a circle. Dana continued, “I think flip learning was fun to do cause we
separated the class and you let us learn with each other and we got to do it with more people.” Erykah shared, “Whenever we go to your class and whenever we finish the thing (lesson), we play games and stuff.” Lauryn also shared, “It is easy. My favorite part was when we got to do the two little games before we started.”

Extrinsic rewards that the students received were stickers and badges. Students received Zearn stickers when they came to class and had completed their lesson, as well as notes prior to the in-person part of the instruction. Students also earned badges within the Zearn program when they completed digital lessons. The students were always excited to get their stickers and would remind me as soon as they entered the classroom. Many students displayed their stickers on their note-taking journals.
Research Question 3: The Perception of the Flipped Classroom Model

Table 4.9.

*Themes Addressing Research Question Three*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Categories</th>
<th>Codes</th>
<th>Quotes</th>
<th>Field Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme 1: The students used strategies that supported independent learning, engagement, and concept development.</td>
<td>Independent Learning</td>
<td>-Independent Learning -Note-taking</td>
<td>Lauryn: Yes, because it helps us be more independent. Like I said earlier, and it helps us take notes instead of our teacher just tell[ing] us, oh, you know, you have to do this, you have to do that. It helps us be more independent. Trevor: Every time we would come to you, we would already understand it.</td>
<td>Ten out of the 17 students always completed or were on the current lesson when it was time for the in-person lesson. Thirteen students completed all of the digital lessons in the unit.</td>
</tr>
<tr>
<td>Instruction</td>
<td></td>
<td></td>
<td>Researcher: What did you all think about the hands-on and the games and the types of activities that we did in class? Lauryn: I love them. They were really fun activities. Cause we got to do ‘em together.</td>
<td>Students were able to defend answers. Students actively participated in the lessons, games, and group work. Students made connections to real-life experiences.</td>
</tr>
<tr>
<td>Theme 2: Students identified perceived benefits of using the flipped</td>
<td>Benefits</td>
<td>-Relevance -Improvements/Benefits</td>
<td>Dana: I think that overall my improvement is understanding, like all the different kind of angles and how much degrees</td>
<td>The students were mostly able to do the assignments and activities in class. The researcher did</td>
</tr>
</tbody>
</table>
classroom model.

Technology - Technology
Games - Videos - Feedback

Lauryn: I love them (the games). They were really fun activities.
Researcher: Did y'all find any benefits in the flip classroom model?
Trevor: The videos. I would say the videos and the games because the games helped me.
Christopher: The part that I like was when we did the Math chat videos in class.

The students mostly did the digital lessons in their homeroom during their RTI time. Most of the other students that were not pulled also worked on digital activities. Students were able to take devices home as well, until Lesson 7. At this time, the school transitioned back to leaving all devices at school after returning from the pandemic.

Theme 3:
Students did not prefer the flipped classroom model over the traditional model of learning math.

Preference - Preference
Researcher: Okay. The next question is, were you motivated to learn when using the flip classroom model or the traditional model?
Trevor: It's like, [it] didn't really matter.
Shawn: Neutral.
Christopher: Both.
**Theme 1: The students used strategies that supported independent learning, engagement, and concept development.** The first theme that emerged for research question three was based on the learning activities that the students participated in. During the qualitative data analysis process, several codes and categories emerged that addressed the types of learning strategies that were used during the lessons in the flipped classroom model. The strategies used promoted independent learning, engagement, and concept development.

**Independent learning.** Students in the focus group shared their thoughts on the independent digital lessons they used during the flipped classroom model. The students responded positively to being independent learners when participating in the lessons. When asked if the computer program Zearn was useful in helping to learn the math material, Lauryn remarked, “Yes, because it helps us be more independent. Like I said earlier, and it helps us take notes instead of our teacher just tell[ing] us, oh, you know, you have to do this, you have to do that.” Erykah, goes on to describe the usefulness of notetaking when using Zearn. She stated, “Whenever we do it on a Chromebook and we write it down in a little book, and we come to you, we already have the stuff down.” Shawn also added that taking notes supported his learning. The field notes documented that ten students in the study were either on the current lesson or had completed it prior to coming to class. All but four students in the study completed the digital lessons before the end of the study.

**Engagement:** Technology that students used independently as well as the games, hands-on materials and in-class technology were used to engage students during the learning process. When the students were asked about the hands-on materials, the games
and the types of activities we did in class, Lauryn replied, “I love them. They were really
fun activities. Cause we got to do 'em together.” Trevor and Dana agreed with this
statement. Working together was another aspect of the lessons that the students enjoyed.
Dana said, “I think flip learning was fun to do cause we separated the class and you let us
learn with each other and we got to do it with more people.” Lauryn also explained that
she liked learning math with the flipped classroom model as it helped her to stay focused.
Christopher further reiterated working together as a viable strategy by stating, “I like
when we all got to work together, so we gotta do the problem first. Then we will go over
it to make sure that everybody got it” The field notes supported the importance of the
students working together in small groups. The students were noted as working well
together and they were able to defend their answers when problem solving. It was also
noted that students were very engaged when hands-on tools such as the circular
protractors and the two-dimensional shapes were used during the lessons.

Concept Development. Supporting students in developing an understanding prior
to coming to class was an important goal of this research. Concept development prior to
class, depended on the students completing and understanding the video lessons. Dana
explained, “I think it (Zearn) helped. Cause like whenever you get a question wrong, it
(Zearn) will help you understand it (the lesson) better. Trevor stated, “Every time we
would come to you, we would already understand it.” Christopher went on to share the
importance of the videos that were watched before class. “The part that I like was when
we did the Math chat videos in class. Well, when we, came to you we just went over the
lesson.” Dana expanded on this idea by stating specific content that she learned. “I think
that overall, my improvement is understanding like all the different kind of angles and how much degrees they are and what kind of line segments.”

When asked if anything should be changed about the flipped classroom model, Christopher stated, I like it the way it is.” Lauryn further explained, “I like it the way it is. Cause when we come to you, we already know what you're teaching and we already understand.” Having an understanding or at least an introduction to the math concepts prior to coming to class was an important aspect of the flipped classroom model as referenced by these students in the focus group interview.

During the in-person sessions, the field notes describe that the students were eager to participate in the learning and answer questions. Students were able to answer the questions and make connections to real life experiences. Students actively participated in the lessons, games, and group work. Students showed their work in their practice notebooks and worked diligently during the exit ticket prior to the end of class. All of these practices along with in class discussions and activities supported the students’ development of the concepts.

**Theme 2: Students identified perceived benefits of using the flipped classroom model.** During the interview, most of the participants were able to share the benefits they perceived from the flipped classroom model. Through the conversation and the data collection, five of the six students interviewed shared that they had a positive experience learning with the flipped classroom model.

Students shared their opinion of the digital aspect of learning with the flipped classroom model. When asked about the benefits of the flipped classroom model, Trevor shared his thoughts about Zearn, stating, “I would say the videos and the games because
the games helped me. I do the tower of power and the video also helped.” Christopher shared, “The part that I like was when we did the Math Chat videos in class.” Dana went on to say, “I think my [confidence] increased because whenever I do Zearn, I like [that] it helps me practice what I’m getting ready for.” Dana also shared her thoughts on the support offered in Zearn when she needed help with a topic. She said, “So when you go back to the question to understand it more, and that really helped with like [inaudible] how like to figure out the problem.” Lauryn shared her impression of Zearn, stating, “It is easy. My favorite part was when we got to do the two little games before we started.” Dana felt that, “Zearn teaches you a lot of more new stuff to do.”

The students also found benefits from the in-person lessons that were done after the digital lessons. When asked about the in-person activities, Lauryn stated, “I love them. They were really fun activities.” Trevor and Dana agreed with Lauryn’s statement. Erykah concurred, “Whenever we go to your class and whenever we finish the thing (lesson), we play games and stuff. Christopher believes that his confidence improved stating, “It has improved more [be]cause you taught us more.” The field notes indicate that the students shared with their homeroom teacher that they learned a lot when they went to the in-person sessions.

Lauryn mentioned, “I would recommend it to other teachers and students to do. Cause it is really easy and fun.” The researcher inquired about other subjects she thought would work well and Lauryn suggested, “Science.”

Two students mentioned that when they do math in the traditional classroom they have to complete homework. They like that there is no homework when using the flipped classroom model. Trevor stated, “The regular way in class you have to get homework.
Christopher agreed, “I like your class more because if it was in a regular class, we would have to break it down and do homework with it.”

**Theme 3: Students did not prefer the flipped classroom model over the traditional model of learning math.** During the focus group interview, students were asked if they were motivated to learn when using flipped classroom model or the traditional model of learning math. All of the students in the focus group stated that they had no preference. Trevor stated, “It's like, [it] didn't really matter.” Erykah responded, “Both”, with Lauryn stating, “I agree with Trevor”. The three remaining responses were, “Neutral”, “Both” and “Both”. Although there were aspects of the flipped classroom model that the students enjoyed, they also shared some aspects that they did not enjoy.

Lauryn shared, “Oh, I'll tell you what I didn't like, it was when, as soon as we start the lesson, it'd be that one question. As soon as we started, we just get a question rather. We just started the lesson.” As the researcher clarified in the interview, Lauryn felt like she did not know enough information at the beginning of the lesson to successfully answer the question. Erykah simply stated, “I didn't like whenever I got the answers wrong.” Lauryn agreed with her statement. Christopher expanded on this by stating, “With The tower thing? Whenever I like get a question wrong, it just like sends me back to Math Chat. It don't let me get like a chance to like choose an option.” Although the students stated previously that some parts of Zearn gave them the opportunity to go back and try again or give them an opportunity for re-teaching, there were other parts of the program that did not offer this feature.

There was also one aspect of the in-person lesson that a few students did not enjoy. Although some students enjoyed being able to work together and support each
other, there were some students who did not. Trevor shared, “I kind of liked it and I kind of didn’t, the only part I liked about it was we got the lesson before, but what I didn't like [when] we got in our groups sometimes.” Dana explained, “I'm just thinking in my mind, you know, we can just work together and think about it. But nobody wants to think about it [be]cause they have permanent partners.” Dana was referring to the opportunities that sometimes allowed the students to choose their partners for in-person math activities. She felt that some students only wanted to work with particular people. Dana also went on the say that, “Some people just don't really do that well with partners.” The field notes indicate that disagreements sometimes arose within the groups, particularly when the group was functioning independently, without the researcher’s direct involvement.

**Triangulation of Quantitative and Qualitative Data**

Triangulation is the collection of multiple types of data to minimize research bias (Tracy, 2019). The data sources in his research were analyzed individually and then compared to determine if the results were found to be similar (Mertler, 2019). Data from the RIMMS questionnaire, the perception questionnaire, and the focus group interview were used to triangulate the findings in this research. The quantitative data from the RIMMS questionnaire was compared with the qualitative theme that was developed for research question two. The quantitative data from the perception questionnaire was compared with the qualitative themes that were developed for research question three. Comparing the different data sources in this way adds rigor and credibility to the study (Creswell, 2014). It also helps to better understand and explain the relationship between the collected data. Alignment for the data collected in this research was organized by research question.
Research Question 2: The ARCS Model of Motivation

The quantitative data from the RIMMS questionnaire along with the qualitative themes developed from the focus group interview were compared to triangulate the research for this research question. On the overall RIMMS questionnaire, all of the means for each of the four categories, fell at or above four on a five-point Likert scale. This implies agreement among students that they were motivated to learn using the flipped classroom model. The overall focus group interview collected data that was mostly positive about the students’ experiences with the flipped classroom model. The subcategories of the RIMMS survey are presented for triangulation.

Theme: Using the flipped classroom model positively affected the four components of the ARCS model of motivation.

Attention

During the focus group interview, five out of the six students interviewed, stated that their attention increased when using the flipped classroom model. There were three questions on the survey that addressed attention. The subcategory of attention had the highest mean ($M = 4.20$, $SD = .72$) on the RIMMS questionnaire. Student statements about attention focused on working in a smaller group, using hands-on materials, and playing games. Working in smaller groups meant that the students were learning with less students than when they were learning math traditionally. Smaller numbers of students in the group allowed the researcher to be able to check in more frequently with the students and have enough materials so that each student had what they need for instruction. The hands-on materials were more likely to keep the students engaged and keep their attention during the lesson. The games were especially fun for the students as
it gave them the opportunity to get up out of their seats, move around the room, and work with others. All of these types of activities supported attention levels. It was also noted in the field notes that students were mostly able to complete the Zearn lessons before the end of the study. Thirteen of the seventeen students in the study were successful in this task, showing they were able to attend and stay focused in order to complete the lessons.

**Relevance**

Multiple students in the focus group expressed a feeling of relevance by sharing the importance of completing the digital assignments in Zearn prior to coming to class. Students talked about how completing the assignments made them feel prepared for class and one student even spoke about how the learning was important for future use in her regular math class. On the RIMMS questionnaire relevance had a mean above four ($M = 4.18$, $SD = .84$). The mean from the questionnaire along with the statements from the students and the data from the field notes, shows that there is a connection between the students’ statements and how they scored the three items on the questionnaire.

**Confidence**

During the focus group interview, five of the six students in the focus group stated that their confidence increased when they used the flipped classroom model. Although confidence had the lowest mean ($M = 3.94$, $SD = .86$) on the RIMMS questionnaire, it was still close to a four, demonstrating that the students did feel confident when using the flipped classroom model. The students shared during the interview that they felt better about doing math and they were not afraid to make mistakes. Zearn offered feedback within the program that helped them to move on if they
made a mistake. The students also referenced notetaking which helped them to remember what they were learning in math. One student in the study, however, did feel that his confidence decreased during this research. He shared that he was behind on the lesson in Zearn and that affected his confidence level overall.

**Satisfaction**

Data from the focus group interview showed that students spoke positively about aspects of the flipped classroom model that showed they were satisfied with the learning experience. Students described the learning as fun and easy in some instances. The students liked having access to the materials and a chance to understand the material before attending class. Students also spoke positively about the games that they played in the digital lesson as well as the games and activities that they did during the in-person lessons. The data from the RIMMS questionnaire showed that satisfaction had a mean above four ($M = 4.18$, $SD = .97$). This shows that the students were satisfied with the flipped learning environment using both data collection methods.

**Research Question 3: Perception of the Flipped Classroom Model**

The quantitative data from the perception questionnaire, the pretest and posttest data along with the qualitative themes developed from the focus group interview and the field notes were compared to triangulate the data for this research question. The data from the overall perception questionnaire showed that each question had a mean at or above four on a five-point scale with the lowest score being 3.76 and the highest mean being 4.47.

The paired samples t-test that was administered for the overall test and showed that there was a statistically significant difference between the pretest ($M = 8.88$, $SD = 93
3.01) and the posttest ($M = 14.25, SD = 2.96$), $t(15) = 7.25, p < .001$. The effect size for the overall pretest and posttest had a value of 1.81, indicating a large effect size for the flipped learning math lessons.

During the focus group interview, the students mostly shared positive reflections of the flipped classroom model except for their preference for learning math using the flipped classroom model.

**Theme 1: The students used strategies that supported independent learning, engagement, and concept development.**

Data from the perception questionnaire, the pretest and posttest, the focus group interviews and the field notes were used to triangulate the findings for theme one. Five items from the perception survey addressed theme one. Four of the five items had a mean higher than four on a five-point Likert scale, with only one falling slightly below four, demonstrating agreement among the students.

**Independent Learning**

Independent learning was addressed by two items on the perception questionnaire. The fifth item on the questionnaire stated: I usually watch the videos before the lesson ($M = 4.41, SD = .94$). The students agreed that they did watch the videos before coming to class with the mean falling in between agree to strongly agree. The field notes indicated that thirteen of the 17 students in the study were able to complete their digital lessons before the end of the study. Ten students consistently completed or were working on the current lessons prior to coming to class. The seventh item on the questionnaire stated: Taking notes while watching the videos helped me understand the lesson ($M = 4.35, SD = .86$). This mean also indicated that the students agree with this statement. During the
focus group interview, the students discussed the importance of being independent
learners when using the flipped classroom model. They discussed taking notes on their
own and being able to move forward in the digital lessons if they wanted to. The field
notes indicate that the students did work independently to complete the lessons with
several students being ahead on their lessons prior to attending the in-person lesson.
Students also completed their notes on their own prior to coming to class.

**Engagement**

One item addressed engagement on the perception survey. Item one on the survey
stated: Learning with the flipped classroom model helps me to be more engaged in the
lesson than the traditional learning environment ($M = 4.24$, $SD = .75$). The students
agreed that using the flipped classroom model helped them be more engaged in the lesson
than when using the traditional model of learning math. Engagement was demonstrated
during the focus group interviews when students stated that they liked the activities such
as the hands-on materials and the games that they participated in during the in-person
lessons as well as the digital platform Zearn, describing them as fun. They also shared
positive thoughts about being able to work together in small groups within our classroom,
but also having a smaller number of students in the classroom at one time. The field
notes suggested that students were engaged in problem solving, answering and asking
questions and defending their answers during the in-person lessons.

**Concept Development**

There were two items on the perception questionnaire that addressed concept
development. Item three on the perception questionnaire stated: Watching videos before
class helped me better understand the math lesson ($M = 4.47$, $SD = .87$). Item nine on the
perception questionnaire stated: I re-watched the videos when I did not understand the lesson ($M = 3.76, SD = 1.03$). Students agreed that watching the videos before class helped them understand the lesson. However, the mean for re-watching the videos when students needed help fell slightly below a four falling between neutral and agree.

Concept development was also supported by the pretest and posttest data. The overall posttest had higher values ($M = 14.25, SD = 2.96$) than the pretest ($M = 8.88, SD = 3.01$). There was a statistically significant difference between the pretest and the posttest.

During the focus group interview, students shared their experience with understanding the concepts prior to coming to class. They also expressed their satisfaction with the way that the digital learning supported them in understanding the material by giving the students another chance to get the question correct and explaining items that they missed during the games.

**Theme 2: Students identified perceived benefits of using the flipped classroom model.**

Three items on the perception questionnaire addressed theme two. Item two stated: I would like to use the flipped classroom model in other subjects ($M = 4.24, SD = .90$). Item six stated: I would recommend the flipped classroom model to my friends ($M = 4.12, SD = 1.11$). Item eight stated: I like using the flipped classroom model to learn ($M = 4.41, SD = .62$). All of these items had a mean higher than four, showing agreement among the students about the positive experiences that they had using the flipped classroom model.
The students also shared many positive experiences in the focus group interview. Five of the six students interviewed had a positive experience learning with the flipped classroom model. They felt that the videos and the games helped them to learn and understand the concepts. Students also expressed that they felt their confidence increased, with some saying that Zearn was easy and fun.

**Theme 3: Students did not prefer the flipped classroom model over the traditional model of learning math.**

There were two items on the perception questionnaire that addressed theme three. Item four stated: I enjoyed watching math videos before the lesson ($M = 3.94$, $SD = .97$). Item 10 stated: I prefer the flipped classroom model over the traditional model of learning ($M = 3.82$, $SD = .88$). Although the mean scores for these two items fell between neutral and agree, they were two of the lowest scores on the ten-item survey. This coincides with the focus group interviews, as all of the students shared that they had no preference when asked if they were motivated to learn using the flipped classroom model or the traditional model. One student shared that it did not matter and the others shared that they were motivated in both types of learning and one stated that they were neutral.

The students also shared some parts of the flipped classroom model that they did not enjoy such as computer issues from glitching to connectivity issues. Some students felt like parts of the program did not offer them an opportunity for correction or further understanding. One instance of this is when the students are asked a question at the beginning of the lesson before they have learned any of the material.
Conclusion

This chapter shared the quantitative and qualitative findings for the data collected during this research. Quantitative data were collected through a geometry pretest and posttest, an adapted RIMMS questionnaire, and a perception questionnaire. The analysis of the quantitative data was conducted using the KR-20 test for reliability, descriptive statistics, a paired samples t-test, the Shapiro-Wilk test to measure the normality of the distribution, and the Cohen’s d to determine effect size. Qualitative data were collected through a focus group interview with six students from the study. The qualitative data were analyzed using initial coding, simultaneous coding, and structural coding.

Research question one was answered by analyzing the geometry pretest and posttest data. The KR-20 determined that the pretest and posttest were not reliable. The descriptive statistics showed an increase in the achievement scores of the students from the pretest to the posttest. The Shapiro-Wilk test determined that the data were normally distributed, which allowed for the use of a paired samples t-test. The paired samples t-test showed that there was a significant difference in the achievement of the students. Cohen’s d indicated that there was a large effect size for the flipped classroom lessons.

Research question two was answered by analyzing the data from the RIMMS questionnaire, the data from the focus group interview, and field notes. The means for each subcategory of attention, relevance, confidence, and satisfaction fell at or above 4, which suggests agreement among students that they were motivated to learn using the flipped classroom model. The theme developed from the focus group interview showed that using the flipped classroom model positively affected the four components of the ARCS model of motivation. Five of the six students interviewed shared that their
attention increased during the lessons. They expressed that working with a smaller group of students helped to maintain their attention. The field notes showed that the students were on task during the lessons and involved when there were hands-on materials and games. Relevance was addressed by students sharing positive thoughts about completing the digital lessons prior to coming to the in-person class which helped them to better understand the lesson. Five of the six interviewees stated that their confidence increased when using the flipped classroom model. The students also shared that they felt satisfaction with the program by sharing that they enjoyed working on the digital lessons as well as participating in the in-person lessons.

Research question three was addressed by analyzing the data from the perception questionnaire, the data from the focus group interview, and field notes. Using Cronbach’s alpha, the reliability coefficient for the perception questionnaire was determined to have acceptable reliability. The descriptive statistics showed that the students enjoyed many of the aspects of the flipped classroom model. The mean of student responses ranged from 3.76 to 4.47 on all items on the questionnaire, meaning that they agreed that they had a positive perception of the model. Three themes were developed for research question three from the focus group interviews. The students agreed that the strategies they used supported independent learning, engagement, and concept development. They also shared that there were many benefits of the flipped classroom model, including the use of videos and games to help them learn math. Finally, the data showed that the students did not prefer the flipped classroom model over the traditional model of learning math, with all students giving a neutral response to this question.
CHAPTER 5

DISCUSSION, IMPLICATIONS, AND LIMITATIONS

The purpose of this action research was to examine the impact of the flipped classroom model on fourth-grade students’ achievement in a geometry unit, and on their motivation towards mathematics, and their perceptions of the flipped model at an elementary school in the Southeast United States. Qualitative and quantitative data were collected and analyzed to address the following research questions: (1) Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States? (2) What is fourth-grade student’s motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States? (3) What are fourth-grade students’ perceptions of the flipped classroom model after attending a flipped classroom model at an elementary school in the Southeast United States? This chapter presents a discussion of the findings, contextual implications and recommendations, limitations of this study and finally, the conclusion.

Discussion

Qualitative data and quantitative data were collected concurrently during this study and analyzed individually. Both data types were triangulated to understand the impact of the flipped model classroom on fourth-grade math student achievement, motivation, and perceptions. The discussion is organized by the three research questions and connects the findings to previous research and literature.

Research Question 1: Is there a difference in fourth-grade students’ achievement scores in geometry before and after attending a flipped classroom model at an elementary school in the Southeast United States?
This research question examined the impact of the flipped classroom model on the academic performance of fourth-grade math students. The students were given a geometry pretest and posttest, before and after the flipped classroom model videos and in-person lessons. The results showed that there was a statistically significant difference in the pretest and posttest scores.

Participants in this study showed improvement in learning performance as measured by the geometry pretest and posttest. The 25-question assessment showed that the posttest had higher values ($M = 14.25, SD = 2.96$) than the pretest ($M = 8.88, SD = 3.01$). A t-test for dependent samples was administered for the overall test and showed that this difference was statistically significant between the pretest and the posttest.

Fifteen of the 16 students participating in the study improved on the posttest, with one student maintaining his original score. A large effect size for the flipped learning math lessons was found.

The findings from this study are consistent with findings from previous research on the use of the flipped classroom model. Akcayir and Akcayir (2018) reviewed 71 studies and found that more than 52% reported that using the flipped classroom model improved student learning performance as measured by GPAs, standardized test scores, and course grades. In a comparison study of three classroom models, including traditional, distance and flipped learning, by Karabatak and Polat (2020), they found that students learning with the flipped classroom model outperformed the students learning with the remaining two models. The students in the flipped learning classroom obtained a higher mean score on the posttest than the traditional classroom and distance education.
The study also reported that the flipped classroom model had the largest effect size when compared to distance education and the traditional classroom.

Research has attributed this growth to the different strategies used in the flipped classroom model such as technology, small-group instruction and note-taking. One online learning resource, Khan Academy has been used as a part of the intervention when using the flipped classroom model and the researchers reported significantly higher posttest scores when compared to the pretest (Zengin, 2017). Another study by Zhao et al. (2021), compared a gamified flipped learning model, a conventional flipped learning model, and a traditional classroom model for third grade students learning fractions. The gamified flipped model included a gamified e-book and a 15-minute video before class. During class, they focused on problem based learning using the interactive e-book and peer-discussion. The students using the conventional flipped model only watched the 15-minute video before class. During class, this group focused on problem based learning. The students learning with the traditional model were required to preview the textbook before class and they did problem-based learning in class. The students using the gamified flipped model had posttest scores that were significantly higher than both the students using the conventional flipped and those using the traditional classroom. The difference in posttest scores can be attributed to the difference in the types of activities offered in the three models of learning.

A study done by Lo and Hew (2017b) examined the math performance of underperforming 12th grade geometry students. The study also used a pretest – posttest design and found that there was a significant difference in student scores after using the flipped classroom model. The digital lessons for the students included two - three videos,
digital manipulatives, and completing online follow-up activities. The in-class lessons included teacher review of the concepts, student application of the new knowledge, and student discussion of more advanced and real-world problems.

In the current study, many of the same types of learning strategies occurred in both the digital lessons and the in-person lessons as the studies previously mentioned. Digital lessons include opportunities for students to watch videos, interact digitally with materials such as games and manipulatives, and an opportunity to re-watch the videos if needed. The in-class activities often include teacher support, student conversation and a connection to real-world problem solving. All of these strategies support student learning and increased posttest scores in this current study as well as the studies previously mentioned.

**Research Question 2: What is fourth-grade students’ motivation toward math after attending a flipped classroom model at an elementary school in the Southeast United States?**

This research question sought to determine student motivation toward math after completing the flipped classroom model. To answer this question, the results from the modified RIMMS questionnaire and the theme that emerged from the focus group interview were examined. The results of the questionnaire showed that the students were motivated to learn. The categories of ARCS were used to describe student motivation in their own words from the focus group interview. The results of the focus group interview also showed that students were motivated to learn when using the flipped classroom model.
Motivation is an important component of the learning process (Simsek & Keller, 2014). The Gale Encyclopedia of Psychology defines motivation as “the process that initiates, directs, and maintains a goal-directed behavior” (Longe, 2016, p. 152). Many practitioners have explored the flipped classroom model to improve student motivation and engagement (Kumar et al., 2016).

A study on learning motivation in the flipped classroom was done by Kumar et al. (2016). The students in the control group learned trigonometry in a traditional classroom while students in the experimental group learned in a flipped classroom. Students in the traditional class spent 30-40 minutes of a 50 minute class listening to a lecture, with the remaining time spent on problem solving. They had homework that consisted of problems from the textbook. The students in the flipped classroom watched 15-20 minute videos before class. During class, the students engaged in activities based on the videos and they were divided into groups to discuss the textbook problems. The students were given the Course Interest Survey, created by John Keller, at the end of the unit to measure motivation. The researchers found a statistically significant difference in the subcategory scores of ARCS between a control group and an experimental group of low achieving high school math students.

In another study by Karabatak and Polat (2020), the researchers designed their instruction according to ARCS to determine its effects on motivation and academic achievement of undergraduate students. They compared the flipped classroom model to distance education and the traditional classroom model. They found that using the ARCS to develop their curriculum lead to a statistically significant difference in student achievement and student motivation.
For this current study, the descriptive statistics from the Adapted RIMMS questionnaire showed that each of the four subcategories had means at or above four on a five-point scale Likert scale. This implies agreement among the students participating in the study that they were motivated to learn.

**Attention.** The subcategory of attention had the highest mean ($M = 4.20, SD = .72$) on the questionnaire. The attention items on the questionnaire asked about topics such as: the way the materials were written, the presentation of the information, and the variety of materials and activities available to help students learn. Keller’s (2016) research on attention includes the learner’s curiosity, interests, and boredom. When asked directly about their attention during the intervention in this research, five out of six students responded that their attention increased while using the flipped classroom model. When speaking about attention during the focus group interview, the students shared their thoughts on working in small groups, using hands-on materials, and playing games.

Some educational games have positive effects on motivation (Say & Bag, 2017). An important motivational reason for people playing video games is to experience achievement. Achievement occurs when students can advance and gain understanding while playing the game (Barreto et al., 2017). The digital lessons on Zearn provided students with the opportunity to move on to the next lesson once they successfully completed the previous lesson, earning badges as they progress. The students could choose to earn additional badges by playing bonus games in the platform.

A combination of technology and hands-on materials helps to improve the comprehension skills of students (Kukey, et al., 2019). A few lessons in Zearn required the students to have hands-on materials during the digital lessons. However, most of the
hands-on materials were used during the in-person lessons. The students were actively engaged when we used the hands-on materials. They were also engaged when we used the digital materials during whole class games that were played on the Clear Touch Board.

Students in the focus group interview also shared their thoughts about working in small groups when learning the math content. They spoke about being able to talk to each other if they needed help and having less students in the class than their regular classroom setting. Splitting the participants into two smaller groups and alternating instruction gave the researcher more time to spend with students as they worked together in the in-person lessons. This also allowed time to work one-on-one with students and help them move ahead if they needed help on something in the digital lesson.

The field notes showed that most of the students in the study completed all the digital lessons on Zearn prior to the end of the study. Of the 17 students in the study, 13 were successful in this task. This shows that the materials used were mostly able to keep the students attention during the study.

**Relevance.** The subcategory of relevance on the RIMMS questionnaire had a mean above four ($M = 4.18, SD = .84$). The relevance items on the questionnaire asked about topics such as: the math materials being related to things the students already knew, a feeling that the content was important, and the usefulness of the topics they were learning. Relevance is the learners’ perceptions that what they are being required to do aligns with their goals and learning styles (Keller, 2016). During the focus group interview, the students spoke about feeling prepared for class by watching the digital lessons prior to coming to class. They also spoke on the importance of getting the
lessons done before class, even reporting to their homeroom teacher that it was important for them to get the lessons done and that they were learning a lot from using the flipped classroom model. One student shared how learning the lessons would help in her traditional classroom in the future. The field notes reported that the students used real-world and familiar experiences during the in-person lessons which helped connect to the math for them (Lo & Hew, 2017b). This was evident in the math conversations that students had during the in-person lessons.

Confidence. The subcategory of confidence on the RIMMS questionnaire had a mean right at four ($M = 3.94$, $SD = .86$). It was the lowest mean reported by the instrument, however, it still shows that students felt confident when using the flipped classroom model. The items on the questionnaire asked about topics such as: students feeling confident when they are learning math, feeling confident that they will pass the math test on the material, and if learning with well-organized content helps with confidence when learning the material. Keller (2016) refers to confidence as a positive expectation for success. When asked directly about success, five out of six students in this study stated that they felt their confidence improved while using the flipped classroom model. They spoke about how and what they were learning in both the digital platform and the in-person lessons. One thing that some of the students attributed to their confidence was the support they were given in the digital platform. The students felt supported when they got an incorrect answer in Zearn, the platform would offer re-teaching and another opportunity to get the question correct.

The students felt that they were learning and becoming more independent. Many of the students talked about being independent and being responsible for doing the work
on their own. They shared that having a place to write notes also helped them be more independent and confident. Allowing students to become independent is a strategy that can lead to improved student confidence (Francom & Reeves, 2010).

**Satisfaction.** The subcategory of satisfaction on the RIMMS questionnaire had a mean above four \((M = 4.18, SD = .97)\). The satisfaction items on the questionnaire inquired about topics such as: enjoying the material and wanting to know more about it, enjoying math, and being happy to work on well-organized lessons. Satisfaction encompasses the use of intrinsic and extrinsic rewards to sustain desirable behaviors and discourage behaviors that are deemed undesirable (Keller, 2016). The students in this study expressed satisfaction with many of the design elements of the flipped classroom model. The students modeled desirable behaviors such as completing lessons before coming to class, participating in whole-class lessons, and completing the in-person assignments. The students also received rewards within the digital platform Zearn by receiving badges. They received extrinsic rewards when they came to class. The researcher checked their notes before each in-person lesson. The researcher also checked to see that they completed the lesson in Zearn prior to class. The students received a Zearn sticker that many of them collected on the front of their Zearn notebook.

The students shared that they felt satisfaction when using the flipped classroom model. The students felt they were learning new material and they were not deterred when they made a mistake because the learning platform, Zearn offered them support to continue on.

**Research Question 3:** What are fourth-grade students’ perceptions of the flipped classroom model at an elementary school in the Southeast United States?
This research question sought to determine the students’ feelings toward the flipped classroom model. To address this question, data from the perception questionnaire and three themes that emerged from the focus group interviews were examined. Data from these tools showed that students had positive perceptions and feeling about the flipped classroom model, however, the students did not prefer the flipped classroom model over traditional math instruction.

**Independent Learning.** There were two items on the perception questionnaire, field notes and data from the focus group interview used to address independent learning during the flipped classroom model. The two items on the perception questionnaire addressed the students watching the videos before class ($M = 4.41, SD = .94$) and the students taking notes helped them understand the material ($M = 4.35, SD = .86$). This data shows that students were independent during the flipped classroom model.

Previous research of the flipped classroom model has noted a change from instructor centered responsibility for student learning to an increased responsibility for the students to take ownership of their learning (Arnold-Garza, 2014). The feeling of student responsibility was evident in this research. Most of the students in this study were always eager to come to the in-person lessons and were excited when they were picked up to attend the in-person lessons. All of the students except four, completed all digital lessons before the end of the study. Several of the students were even ahead of where they needed to be on the digital lessons before reporting to the in-person lessons.

Notetaking as well as requiring the students to turn in their notes, holds students accountable. (Bergman & Sams, 2012). The students in this study showed me their notes at the beginning of each class and I kept a checklist of who did it and who did not. One
study by Wei et al. (2020), found that implementing notetaking along with the flipped classroom model led to significantly better learning performance than students in the traditional math classroom. In the current study, the students felt that notetaking was important and doing so supported their learning.

**Engagement.** There was one item on the perception questionnaire that addressed engagement. Focus group interview data and field notes also addressed engagement in this research. The questionnaire reported that learning with the flipped classroom model helped the students be more engaged in the lesson than the traditional learning model ($M = 4.24, SD = .75$). Previous research states that providing student-centered learning activities improves learning outcomes for students (Lai & Hwang, 2016). Hands-on materials, games, and working together were some of the topics that students stated as they discussed engagement in the lessons.

In previous research, teachers felt that in-class discussion time was improved as students were given the information beforehand to prepare for the discussion (Hultén & Larsson, 2018). In this study the students participated in whole-group and small group discussions.

A study done by Bottia et al. (2014) found that students in kindergarten had higher achievement levels when they had more exposure to interactive group activities. Like this study, the students in the current study, often worked in pairs or small groups during the in-person learning time. They used this time to give and receive help during their interactions with each other. The students in the current study expressed that they had mostly positive experiences when working with each other in small groups.
The field notes from this research indicate that the students were attentive when working with hands-on materials and sometimes requested to use them if they were not already out. During whole class games, students showed excitement and readily participated in the whole group activities. During the focus group interview, the students stated that they liked the hands-on activities and even described them as fun.

**Concept Development.** Concept development was achieved by having the students watch videos prior to the in-person lessons. There were two items on the perception questionnaire that addressed concept development. The students agreed that watching the videos before class helped them better understand the lesson ($M = 4.47, SD = .87$) and that they re-watched the videos when they did not understand the lesson ($M = 3.76, SD = 1.03$). Videos can be beneficial to students who can stop and start as needed or even go back and re-watch the video if needed (Bergman & Sams, 2012; Kelly & Denson, 2017; Moran & Young, 2015) Online resources can help educators monitor students’ online behavior by monitoring their progress within the platform (Moran & Young, 2015). In this study, the Zearn platform allowed the researcher to monitor online student behaviors such as lesson completion and the amount of time spent on each lesson.

Concept development was also supported by the pretest and posttest data. The students scored higher on the posttest ($M = 14.25, SD = 2.96$) than they did on the pretest ($M = 8.88, SD = 3.01$). There was a statistically significant difference between the pretest and the posttest. This showed that students gained a better understanding of the concepts by showing improvement on the test.

**Benefits.** There were three items on the perception questionnaire that addressed perceived benefits of the flipped classroom model. One item inquired about
recommending the flipped classroom model for other subjects ($M = 4.24, SD = .90$). The second item asked about recommending the flipped classroom model to friends ($M = 4.12, SD = 1.11$). Finally, the third item asked students if they liked using the flipped classroom model to learn ($M = 4.41, SD = .62$). All of the items have a mean above four, showing that students had positive experiences learning with the flipped classroom model.

During the focus group interview, students shared their thoughts on the features of the flipped classroom model that were beneficial to them. They shared that the videos and games were beneficial in helping them learn the material. These digital tools supported their learning and built their confidence. Using technology that is adaptive allows content to be adjusted in real-time and give immediate feedback to the students (Fazal & Bryant, 2019). This was one of the benefits that the students shared was important to them when using Zearn. Students also shared that working together and not having to complete homework for these lessons was a benefit that they enjoyed.

Preference. Preference of the flipped classroom model was addressed by two items on the perception questionnaire. The first item inquired if students enjoyed watching math videos before the lesson ($M = 3.94, SD = .97$). The second item asked if the students preferred the flipped classroom model over the traditional model ($M = 3.82, SD = .88$). The mean scores for both items fell slightly below four, between neutral (3) and agree (4) on the Likert scale. Although these are not considered low scores, these two items were scored the lowest on the perception questionnaire by the students in this study.
When asked directly about their preference during the focus group interview, none of the students preferred the flipped classroom model. Some of the students stated that it did not matter, and others stated that they were motivated in both settings. This is supported by research done by Akcayir and Akcayir (2018). They reviewed eight studies and found that six of those studies reported that students did not prefer the flipped classroom model. Some of the issues that students stated during the present study were technical issues such as computer glitches and internet connectivity issues. Some students simply did not like getting an incorrect answer. In a few instances, particularly at the start of the digital lessons, the students did not like having to answer a question that they felt they had no knowledge about yet. This question was an introductory question to the lesson. It was typically related to the previous lesson and sometimes the students were unable to make that connection.

**Implications**

This research has implications for the researcher, the research context and future studies by researchers and scholarly practitioners. This study and its findings add to the existing research on the flipped classroom model. It provides evidence that using this model can support student achievement and motivation. The model in the current study also offers a slightly different approach than most previously researched flipped classroom models by allowing the students an opportunity to complete the digital learning lessons during a designated time during the school day on alternating days. The following sections address the personal implications, recommendations for practice, and implications for future research.
**Personal Implications**

During the data collection process for this research, I served in the role of an instructional coach to new teachers and an interventionist supporting students from the classes of those new teachers. Since then, my role has changed slightly as I am now the Technology and Learning Coach. This has expanded my reach as a coach but eliminated my role as an interventionist. This work still has importance for me as I now review the types of technology we use in the school and support teachers in using it to best support their learners. Furthermore, I am a member of the leadership team for my school and we are responsible for reviewing the data of all students, including those students who are a part of our multi-tiered systems of supports. As a member of this team, we look at the individual data of students who are struggling behaviorally and/or academically and use data to make decisions for them. As an elementary educator, my experience in collecting and analyzing data has been limited mostly to quantitative data in the form of student test scores, ranging from in-district benchmark testing to state testing. Completing this research has given me practice in, and an understanding of the use of qualitative data and how it can be used in addition to quantitative data to analyze and improve instruction within my school setting.

The members of the leadership team are sometimes tasked with taking observational notes. This research has given me the confidence to take a more active role in collecting and analyzing the qualitative data that I need to collect as a part of my professional duties. Now that I have an improved perspective on the importance of qualitative data and its relationship to quantitative data, I can make better informed decisions for students as a member of the leadership team.
In my current role as a Technology and Learning Coach, I work with teachers to integrate technology into the curriculum, explore applications that can be beneficial to staff, and work with staff on their needs in the classroom. This role allows for many opportunities to use action research to continue to improve my practice. I can continue to use quantitative and qualitative tools to collect and analyze data for students, but I can also collect and analyze data from the teachers that I work with. Working at large elementary school means that I have the opportunity to work with over 40 certified teachers, in addition to the administrators, educational leaders, and other coaches. Learning multiple ways to collect data and triangulate the data will help me to support teachers in the decisions they make for their class, the decisions we make for the technology we will use, and the types of professional development and support that I provide. Data collection after the implementation of these initiatives and professional development is also key in continuing to grow and support our school and our educators.

**Implications for Practice**

This research has implications for practice including, using the flipped classroom model to support intervention and improving student engagement in the traditional classroom.

Since the pandemic, there has been an influx of students needing more academic support. At the same time, many schools have suffered a decrease in teachers and teaching assistants. With the current issue of teacher and faculty shortages in the public school system, employing the flipped classroom model to support intervention could help reach more students that are in need of academic support. One model for this instruction could be modeled after the current research. This would mean that instead of seeing an
interventionist daily, the students would attend intervention on a rotating schedule. This type of rotation could allow the interventionists to support more students instead of putting them on a waiting list. Since many districts already financially support digital learning platforms for schools, this could be a way to optimize their use and improve student achievement. Many of these digital programs require students to use them for a predetermined amount of time. Most of these platforms also suggest that teachers check in with students to support them on tasks or concepts that they may be struggling with. In some cases, students who attend intervention will work on one curriculum during class, then work on a different curriculum with their interventionist. Using the flipped classroom model would streamline the number of different programs that students are using as well as offer support to teachers. The teachers will have a prescription of what to teach the students based on their weaknesses as determined by the platform. It will also give the students an opportunity to have access to the material before attending class, which may improve their confidence and achievement.

Curriculum requirements continue to grow and instructors must make efficient use of class time. Practitioners can get more out of class time by focusing on practical application instead of inactive lecture (Arnold-Garza, 2014). The students in this research spoke about their engagement with the digital platform as well as the in-person lessons with the researcher. They also made a point to say that they did not engage with hands-on materials and have small group interactions in the regular classroom as much as they did when learning with the flipped classroom model. The use of the flipped classroom model encourages student-centered learning. This includes active learning, peer-assisted learning, and collaborative learning. The use of these strategies promotes
higher-order thinking skills and moves students from passive to active learners (Akcayir et al., 2018). With or without the use of the flipped classroom model, teachers must improve the interactions among students in the learning environment. The surveys in this research and the focus group interview showed that this is an important feature in the learning environment for students.

The use of the ARCS model of motivation is useful in planning instruction for students to ensure that they are motivated to learn in all educational environments. This current research used the ARCS model of motivation to determine if the use of the flipped classroom model motivated students to learn math. This tool can be used to look at materials that we are currently using and to develop technology learning units for students that include aspects of each category to fully engage students in the learning. In my role as the Technology and Learning Coach, I can evaluate technology materials using ARCS by surveying students using the RIMMS questionnaire for materials that we are currently using.

Another way that this research can be used is to think about an alternative approach to assigning homework as a part of the flipped classroom model. Some schools and districts have moved away from assigning homework to students. This research provided an in-class opportunity to complete the digital lessons unlike most that offer the digital lessons as homework. Previous research has shown that students using the flipped classroom model, sometimes do not complete the out of class assignments. A study by Yang and Chen (2020) required the students to watch three videos outside of class and between 17-19% did not complete this task. It was noted by de Araujo et al. (2017) that students who did not complete traditional homework assignments, also did not complete
the flipped learning assignments. Many students in poverty have extenuating circumstances that keep them from completing homework. This was very eye-opening during the COVID-19 pandemic where we saw students not attending virtual class due to parents being at work and students being left alone to care for themselves. This continues to happen even after the pandemic, with students going home after school with no supervision. Providing in-class time for students to complete the assignments could lead to increased participation in the flipped learning environment and thus lead to improved academic success for students.

**Implications for Future Research**

This study focused on the implementation of the flipped classroom model with fourth grade students learning geometry. One of the questions on the perception questionnaire asked if the students would recommend using the flipped classroom model in other subjects. The flipped classroom model has been researched in other subjects before. However, much of this research was conducted at the high school and college level. Future action research could focus on language arts, science and social studies at the elementary school level. The findings from such research could be compared with results from other subjects taught at the elementary level to determine if one subject or another might be better suited for use with the flipped classroom model.

Future research on a larger scale could include a control and an experimental group of students. Since many schools currently use some type of digital tool to support student learning during intervention time, research could be conducted to determine if there is a statistically significant difference in the performance of students who are using the lessons in the digital platform as well as receiving support from in-person lessons as
opposed to those students who are only receiving the digital lessons or students who are only receiving in-person lessons.

This research focused only on the student aspect of the flipped classroom model including their academic achievement, their motivation, and their perception of the flipped classroom model. Future research could also include qualitative and quantitative data from the teachers’ perspectives. When the flipped classroom model is administered the way it was implemented in this research, two teachers are involved. One teacher has these students in her homeroom and the students are completing the digital lessons in the classroom with that teacher. A second teacher or interventionist is teaching the in-person lessons to the students. Future research could include the thoughts and opinions of these teachers by having them complete surveys or interviews about the process, the lessons, and student observations, documenting the interactions in each of the two learning environments.

Limitations

While this study was well planned and implemented, as with any research, there are limitations to this study. For this study, methodological limitations and contextual limitations were addressed. One methodological limitation of this study is the use of the action research approach. Action research is done by the researcher for the researcher, with the purpose of improving their own practice or the quality of their instruction (Mertler, 2019; Tracy, 2020). The findings are intended to address the needs of the specific population being studied and inform future decision making for that setting. This also means that there are typically smaller sample sizes when addressing a specific population, such as the 17 students that participated in this research. Because of this
specific use of the data and small sample size, this type of research does not allow the data to be generalized to other settings (Mertler, 2019).

Another methodological limitation of this research was the use of a focus group interview. While there are advantages to using interviews such as providing the opportunity for the researcher to probe deeper and ask clarifying questions (Mertler, 2019), the use of interviews in the data collection process led to some limitations in this study. Creswell (2014) suggests a few limitations that can occur during interviews. The first limitation in this research is that the interview was conducted in the researcher’s office and not the natural field setting. This change in environment could have affected the students’ level of comfort and the responses that were given during the interview. Another limitation is that the researcher was present in the interviews which can cause bias. My position as an insider and the instructor for the in-person lessons could have caused the students to answer more positively about the intervention.

The limitation of the interview process seemed to be the most prevalent. Not all of the students were equally perceptive and able to freely express their ideas. Due to the limited responses, the interview process only took about 15 minutes. Some students repeated the same answers as the person who answered before them. They also made statements like, “I agree with her.” Mask were also worn during the interview, which made it difficult to understand all the student responses in person, and especially on the recorded interview. There were many instances in the recorded interview that were inaudible or unintelligible. Students were not required to wear a mask at the time of this research, however most still did after a recent mandate to wear masks was recently lifted. Teachers were not allowed to advise students to put on or remove a mask during this
time. The students often needed me to restate the questions and explain what they meant for them to answer. The limited conversation and responses from students can also be attributed to the change from their regular school routine for about two years prior to this research due to the pandemic. Students were still getting used to being back in school full time and engaging in academic conversation. In future studies, researchers should prepare prewritten follow-up questions to elicit better feedback from younger students who may have limited responses.

Another methodological limitation of this research is the use of the RIMMS questionnaire that was modified by the researcher. The language in the questionnaire was slightly adjusted to the reading level of elementary students and the content area of math without changing the meaning of the questions. The original RIMMS survey was validated in other studies. However, the researcher did not run the reliability analysis for this questionnaire since there was a small size in this research. In future studies, using a larger sample size, it is recommended that a reliability analysis is completed for this questionnaire.

Both the RIMMS and perception questionnaires are surveys administered to students that were rated using a 5-point Likert scale. A limitation of the surveys is that they are simply a snapshot of the flipped classroom model based on the opinions of the students currently involved in the study and cannot be taken as a constant (Mertler, 2019). The students’ opinions of the flipped classroom model can change from one moment to the next. Given these questionnaires at another time, could have led to different results.
The pretest and posttest used in this research were also a limitation of the study. When tested for reliability using the Kuder-Richardson Formula 20 (KR-20), the reliability coefficients of the pretest and posttest were .48 and .47 respectively. Both of these scores have unacceptable reliability.

There were also contextual limitations in this study. The context of this research was an elementary school in the southeast United States. My positionality as an insider could have swayed the students’ perceptions of the flipped classroom model.

During this research, I was operating in the time limits of the scheduled time for (Response to Intervention) RTI, the time when intervention was taught. I was limited to 30 minutes for each in-person and digital lesson. Although 30 minutes should have been enough time for the in-person and digital lessons, that did not allow any extra time for students who may have needed more time to complete or better understand the lessons. Students were able to work on the digital lessons whenever they had time in class. However, as stated previously, students were still getting accustomed to being back in the traditional school setting and many struggled with completing their regular classroom assignments. Additionally, at about the halfway point of this research, the school transitioned from students taking the Chromebooks home daily, to leaving them at school full time. Although learning for the digital lessons at home was not required, this removed the option for students to be able to work on the lessons at home.

Since I was not a homeroom teacher during this research, my purposive sample came from one class of students that I was granted permission to work with. This one class had about 22 students. Of those students, I was not able to include any students that were receiving RTI instruction from their homeroom teacher or any other interventionists.
during the time of my lessons. This reduced the number of participants to 17 students. Because these were not my students, there was not a strong relationship prior to the beginning of the research which could have affected the performance of students in the group.

**Conclusion**

As the new Technology and Learning Coach at my school, it is my vision to best use technology in ways that support student growth and achievement. As our school continues to grow in population, our percentage of students in poverty also continues to rise. Couple that with students who are in need of specialized social-emotional and academic support after the COVID-19 pandemic during a time when it is difficult to find certified and qualified teachers. The strategies employed during this research could offer a viable solution to address some of the issues we are currently facing in public education.

The purpose of this research was to examine the flipped classroom model to determine its impact on students learning math in a school that has a high population of students classified as Pupils in Poverty (PIP) according to the State Department of Education. This current research shows that the flipped classroom model was successful in impacting both student achievement and motivation. The flipped classroom model involves the use of many strategies that have been proven effective in past research. There is research on using digital materials, hands-on materials, note-taking, and cooperative learning strategies that shows using these tools supports student learning. Using these strategies also promotes students learning 21st Century skills that students will need to use in the future when they enter the workforce.
As educational stakeholders continue to look for ways to improve student achievement and motivation in public education, we must consider best practices in utilizing technology including the use of the flipped classroom model and the strategies that are incorporated in the model to engage and motivate students in a meaningful way. Making a more-efficient use of class time, engaging learners in problem-based learning, accommodating different learning styles and levels, as well as encouraging students to take a more active role and responsibility for their learning are benefits of the flipped classroom model (Arnold-Garza, 2014) that we must continue to explore.

Certainly more research is needed to better understand the effects of the flipped classroom model on students in elementary school. Although there is limited research in these grade levels, there have been numerous studies conducted at the high school and college levels. Many of these studies have shown positive results, however, these students are older, more mature and better able to take on the responsibility of the requirements of the flipped classroom model. Because of this, elementary educators should consider some adaptations to the flipped classroom model such as the modification that was made in this study. This research eliminated the need to complete the lessons at home by planning for in-school time to work on the videos and games each day. Other modifications could include the length of time students are spending on digital lessons or using digital materials that students are already using in school and providing additional in-person lessons to further support student learning.
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APPENDIX A

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INSTITUTIONAL REVIEW BOARD FOR HUMAN RESEARCH
DECLARATION OF NOT RESEARCH

Kimberly Smalls
120 Walnut Wood Trail
Blythewood, SC 29016

Re: Pro00117764

Dear Mrs. Kimberly Smalls:

This is to certify that research study entitled THE IMPACT OF THE FLIPPED CLASSROOM MODEL ON ELEMENTARY STUDENTS' ACHIEVEMENT AND MOTIVATION FOR LEARNING GEOMETRY was reviewed on 1/29/2022 by the Office of Research Compliance, which is an administrative office that supports the University of South Carolina Institutional Review Board (USC IRB). The Office of Research Compliance, on behalf of the Institutional Review Board, has determined that the referenced research study is not subject to the Protection of Human Subject Regulations in accordance with the Code of Federal Regulations 45 CFR 46 et seq.

No further oversight by the USC IRB is required. However, the investigator should inform the Office of Research Compliance prior to making any substantive changes in the research methods, as this may alter the status of the project and require another review.

If you have questions, contact Lisa M. Johnson at lisaj@email.sc.edu or (803) 777-8670.

Sincerely,

Lisa M. Johnson
ORC Assistant Director and IRB Manager
APPENDIX B

CONSENT FORM

UNIVERSITY OF SOUTH CAROLINA

CONSENT TO BE A RESEARCH SUBJECT

THE IMPACT OF THE FLIPPED CLASSROOM MODEL ON ELEMENTARY STUDENTS’ ACHIEVEMENT AND MOTIVATION FOR LEARNING GEOMETRY

KEY INFORMATION ABOUT THIS RESEARCH STUDY:

You are invited to volunteer for a research study conducted by Kimberly Smalls. I am a doctoral candidate in the Department of Curriculum and Instruction-Educational Technology, at the University of South Carolina. The purpose of this research study is to determine how using the flipped classroom model can help improve student motivation and academic achievement in math. You are being asked permission for your student to participate in this study because they are a student in Ms. Ferguson’s fourth-grade classroom during the Spring semester of 2022. This study is being done at Killian Elementary School and will involve approximately 20 volunteers.

The following is a short summary of this study to help you decide whether to allow your student to be a participant in this study. More detailed information is listed later in this form.

- The study will last approximately eight weeks.
- During the study, the students will learn geometry based on the SC State Standards using the flipped classroom model. This means that the students will watch videos in class on Mondays and Wednesdays and have in-person lessons on Tuesdays and Thursdays where we will have hands-on activities and class discussions. The students will use Fridays to complete any incomplete videos or assignments.
- Risks to students will be minimal, with the interview process being the main risk presented in this study.
• Students may benefit from this study by experiencing increased learning and motivation from using the flipped classroom model, which is a different learning method than they usually experience in elementary school.

PROCEDURES:

If you agree to participate in this study, you will do the following:

1. Students will take a geometry preassessment and a survey that measures their current motivation towards math. Neither of these tasks will be calculated as a part of the students’ grades.
2. The students will be entered into the Google Classroom and Zearn.org, where they will be able to access all materials for the course.
3. The students will take part in the lessons presented with the flipped classroom model for about eight weeks. Students will watch videos on Zearn.org on Mondays and Wednesdays. They will have in-person lessons with Ms. K. Smalls on Tuesdays and Thursdays. Fridays will be used for completing assignments.
4. After the unit is completed, the students will take a geometry posttest and a survey that measures their motivation towards math after completing the flipped classroom model unit.
5. Six students will be chosen to participate in focus group interviews. Students will be chosen randomly to participate. The interviews will be in-person and video recorded.

DURATION:
Participation in the study involves eight weeks of geometry math lessons. The lessons are about 30 minutes each for in-person and the on-line digital lessons.

RISKS/DISCOMFORTS:
Risks in this study are unlikely but may include (a) discomfort with the flipped classroom model (b) discomfort that outcomes of the study may influence their math grade (c) discomfort speaking about the flipped classroom model if the student is selected for an interview. Every effort will be made to make sure that students are comfortable using the Zearn and Google Classroom platforms during this study. Grades from this study will not be calculated in the students’ class grade. Measures will be taken to help participants feel comfortable sharing in the focus group interviews.

Focus Groups:
Others in the group will hear what you say, and it is possible that they could tell someone. The researchers cannot guarantee what you say will remain completely private, but the
researchers will ask that you, and all other group members, respect the privacy of everyone in the group.

Loss of Confidentiality:
There is the risk of a breach of confidentiality, despite the steps that will be taken to protect the participants’ identities. Specific safeguards to protect confidentiality are described in a separate section of this document.

BENEFITS:
Your student may benefit from participating in this study by participating in a way of learning that involves the use of videos to support classroom instruction. Students will have access to the videos and may rewatch them when needed or watch them if they miss class. This experience may show improved learning outcomes for some students.

Study findings will provide a better understanding of how the flipped learning classroom model impacts student motivation to learn math and math achievement.

COSTS:
There will be no cost to you or your student for participating in this study.

PAYMENT TO PARTICIPANTS:
Students participating in this study will not be paid for their participation.

COLLECTION OF IDENTIFIABLE PRIVATE INFORMATION:
Your students’ information collected in this study as a part of the research will remain confidential.

CONFIDENTIALITY OF RECORDS:
Information obtained about your student during this research will remain confidential. All data collected will only be accessible by Mrs. K. Smalls and his major professor. Data will be securely stored on an encrypted and password-protected network. After data collection, pseudonyms will be used to replace participants’ real names, which will be destroyed. Data for this study will be destroyed after 3 years. Results of this research study may be published or presented at seminars; however, the reports or presentations will not include the name of your student or other identifying information.

VOLUNTARY PARTICIPATION:
Participation in this research study is voluntary. You are free not to participate, or to stop participating at any time, for any reason without negative consequences. In the event that you
do withdraw from this study, the information you have already provided will be kept in a confidential manner. If you wish to withdraw from the study, please call or email Mrs. K. Smalls, listed on this form.

I have been given a chance to ask questions about this research study. These questions have been answered to my satisfaction. If I have any more questions about my participation in this study, or a study related injury, I am to contact Mrs. Kimberly Smalls at 803-493-0495 or email kismalls@richland2.org.

Concerns about your rights as a research subject are to be directed to, Lisa Johnson, Assistant Director, Office of Research Compliance, University of South Carolina, 1600 Hampton Street, Suite 414D, Columbia, SC 29208, phone: (803) 777-6670 or email: LisaJ@mailbox.sc.edu.

I agree to participate in this study. I have been given a copy of this form for my own records.

If you wish to participate, you should sign below.

________________________________________  __________________________
Signature of Subject / Participant                        Date

________________________________________  __________________________
Signature of Qualified Person Obtaining Consent            Date
APPENDIX C
ASSENT FORM
UNIVERSITY OF SOUTH CAROLINA

ASSENT TO BE A RESEARCH SUBJECT

THE IMPACT OF THE FLIPPED CLASSROOM MODEL ON ELEMENTARY STUDENTS’ ACHIEVEMENT AND MOTIVATION FOR LEARNING GEOMETRY

I am Mrs. Kimberly Smalls, an instructional coach at Killian Elementary School. I am also a researcher from the University of South Carolina. I am working on a study about the flipped classroom model and I would like your help. I am interested in learning more about how the flipped classroom model can help improve student motivation and math performance. It is up to you and your parent/guardian to choose if you are willing to participate in the study.

If you want to be in the study, you will be asked to do the following:

- Complete surveys about how you feel about the math and the flipped classroom model.
- Complete a pre- and posttest on geometry skills.
- Participate in computer based and face-to-face lessons for eight weeks.
- You may also be asked to participate in an interview with your peers about the flipped classroom.

Any information you share with me will be private. No one except me and my professor will know what your answers to the questions were. The data from the study will be stored on a password protected computer. The interviews will be video recorded, and your identity will be protected.

You do not have to help with this study. Being in the study is not related to your regular class work and will not help or hurt your grades. You can also drop out of the study at any time, for any reason, and you will not be in any trouble and no one will be mad at you.

Please ask any questions you would like to about the study.

*For Minors 13-17 years of age:
My participation has been explained to me, and all my questions have been answered. I am willing to participate.

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<thead>
<tr>
<th>Print Name of Minor</th>
<th>Age of Minor</th>
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APPENDIX D

GEOMETRY PRETEST AND POSTTEST

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Question #1
A ball thrown towards a wall bounces off at a different angle after hitting the wall, as shown in the figure. The sum of the three angles is equal to 180°.

What is the value of x, in degrees?

A 70°
B 80°
C 100°
D 110°

Question #2
Study the figures.

Which statement about the figures is true?

A Figure 1 is made up of two perpendicular lines because the lines cross each other and form a right angle.
B Figure 2 is made up of two parallel lines because the lines are next to each other and will never cross.
C Figure 3 is made up of two parallel lines because the lines cross each other and form a right angle.
D Figure 4 is made up of two perpendicular lines because the lines are next to each other and will never cross.

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Question #3
The sum of the angles formed in a straight line is 180°.

What is the measure of the angle $x$?

A 30°
B 60°
C 120°
D 140°

Question #4
The figure shows a right angle.

How many one-degree angles make up a right angle?

A 15 one-degree angles
B 30 one-degree angles
C 60 one-degree angles
D 90 one-degree angles
Question #5
What is the measure of $\angle M$ in the diagram?

A 245°
B 115°
C 35°
D 25°

Question #6
The pieces to a puzzle are shown in the box.

Which piece of the puzzle is a right triangle?

A Piece 1
B Piece 2
C Piece 3
D Piece 4
**Question #7**

Which figure has both parallel and perpendicular lines?

A  

B  

C  

D

**Question #8**

Which angle measures 65°?

A  

B  

C  

D

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**Question #9**
At which time on a clock would the angle of the minute and hour hands measure 90°?

A. 3:00
B. 3:15
C. 3:25
D. 3:45

**Question #10**
Which dotted line shows a line of symmetry?

A. [Diagram A]
B. [Diagram B]
C. [Diagram C]
D. [Diagram D]
Question #11
A student is using a protractor to draw a 145° angle. Which angle does the student draw?

A

B

C

D

Question #12
Which figure has a right angle?

A

B

C

D

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Question #13
Study the figure. Angle WYX measures 60°.

What is the measure of angle XYZ?

A 120°
B 100°
C 60°
D 30°

Question #14
Study the figure.

How many acute, obtuse, and right angles are there in this shape?

A 1 acute angle, 2 obtuse angles, and no right angles
B 1 right angle, 2 acute angles, and no obtuse angles
C 1 obtuse angle, 2 acute angles, and no right angles
D 1 right angle, 1 acute angle, and 1 obtuse angle
Question #15

Study the clock.

At 6:30, the angle of the minute and hour hands measures _____ degrees.

A 30
B 45
C 90
D 180

Question #16

Use the information to answer the question.

Anthony draws \( \angle XOY \) and uses a protractor to measure it.

What is the measure of angle \( \angle XOY \)?

A 141°
B 139°
C 41°
D 39°
Question #17
Consider the figure. Angle $IJK$ is equal to $22^\circ$. Angle $HJK$ is equal to $90^\circ$.

What is the measure of angle $HJI$?

- A $38^\circ$
- B $68^\circ$
- C $112^\circ$
- D $158^\circ$

Question #18

Of what are $JN$ and $ML$ both examples?

- A rays
- B points
- C line segments
- D angles

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Question #19
Which shape can be described as always having at least one pair of perpendicular sides?

A parallelogram
B rectangle
C rhombus
D trapezoid

Question #20
Which is the best term to use to describe a triangle with angles that measure 20°, 70°, and 90°?

A acute triangle
B obtuse triangle
C right triangle
D straight triangle

Question #21
Which letter has at least two lines of symmetry?

A
B
C
D

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Question #22
Which shape contains parallel lines?

A  circle
B  triangle
C  square
D  star

Question #23
Study the figure.

Which two points form a ray?

A  point Z and point Y
B  point X and point W
C  point T and point U
D  point S and point Y
Question #24
Which figure can best be described as a line?

A

B

C

D

Question #25
Which figure has perpendicular lines?

A

B

C

D

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APPENDIX E

PERMISSION TO USE CASE ITEM BANK QUESTIONS

Sarah Bassett

to Lisa, Nancy, Gena, me

Greetings, Kimberly -

I enjoyed speaking with you this morning. As we discussed, we at Instructure are granting permission for you to use the CASE Item Bank test items to develop a single or multiple fourth-grade Math tests (pre and post) that you will use in your dissertation study. You are aware that if for some reason the CASE Item Bank were not available to you through the Richland 2 contract with Instructure, you would lose access to the items. Knowing your general timeline, there does not seem to be much risk of that.

Further, thank you for attributing our assessment content in your published dissertation. If you are creating a reference or appendix, could you kindly cite the following: "CASE Item Bank test items are the property of Instructure, Inc. Copyright 2021. All rights reserved."

Again, I'd love to follow up with you at the conclusion of your study and if you need assistance or have questions in the meantime, please feel free to reach out.

Many thanks,

Sarah Bassett
APPENDIX F

REDUCED INSTRUCTIONAL MATERIALS MOTIVATION SURVEY (RIMMS)

1. It is clear to me how the content of this material is related to things I already know.
2. The quality of the writing helped to hold my attention.
3. As I worked on this lesson, I was confident that I could learn the content.
4. I enjoyed this lesson so much that I would like to know more about this topic.
5. The way the information is arranged on the pages helped keep my attention.
6. I really enjoyed studying this lesson.
7. The content and style of writing in this lesson convey the impression that its content is worth knowing.
8. After working on this lesson for awhile, I was confident that I would be able to pass a test on it.
9. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.
10. The content of this lesson will be useful to me.
11. The good organization of the content helped me be confident that I would learn this material.
12. It was a pleasure to work on such a well-designed lesson.
APPENDIX G

THE RIMMS ADAPTED FOR THIS STUDY

1. I understand how the math material is related to things I have already learned.
2. The way the math materials are written help to keep my attention.
3. When I am working on math, I am confident that I can learn the material.
4. I enjoy math so much that I want to know more about what I am learning.
5. The way that the information is presented helps me pay attention.
6. I really like learning math.
7. What I am learning and how I am learning it, makes me think the content is important.
8. After working on math lessons in class, I feel confident that I will pass the test on the material.
9. The variety of materials, practice, activities, and illustrations helps me to pay attention.
10. The topics that I am learning in math will be useful to me.
11. The well-organized content helps with my confidence in learning the material.
12. I am happy to work on lessons that are organized well.
APPENDIX H

PERCEPTION QUESTIONNAIRE

Perception Questionnaire
Use the following values to indicate your response to each item.

1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

1. Learning with the flipped classroom model helps me to be more engaged in the lesson than the traditional learning environment.
2. I would like to use the flipped classroom model in other subjects.
3. Watching videos before class helped me better understand the math lesson.
4. I enjoyed watching videos before the lesson.
5. I usually watch the videos before the lesson.
6. I would recommend the flipped classroom model to my friends.
7. Taking notes while watching the videos helped me understand the lesson.
8. I like using the flipped classroom model to learn.
9. I re-watched the videos when I did not understand the lesson.
10. I prefer the flipped classroom model over the traditional model.
APPENDIX I

STUDENT INTERVIEW QUESTIONS

Student Interview Questions

1. What are your likes and dislikes about the flipped classroom model?
2. Did you prefer the flipped learning model or the traditional learning model? Why?
3. Were you more motivated to learn when using the flipped classroom model or the traditional model? Why?
4. Do you think the computer program Zearn was useful in helping you learn the material?
5. In what ways did using the flipped classroom model help or hurt your learning?
6. How can the flipped learning model be improved to help you learn?
7. How has your confidence for learning math improved or decreased since using the flipped classroom model?
8. Did your attention when learning math improve or decrease while using the flipped classroom model?
APPENDIX J
PERMISSION TO USE THE ZEARN PLATFORM

Will (Zearn)
Sep 21, 2021, 1:51 PM EDT

Hi Kimberly,

Thank you for your patience!

We will allow your use of our materials for your dissertation as described below, however, please confirm that your dissertation will not be published and shared beyond your University community.

We would need to review and approve of any such broader distribution.

Best,
Will
Zearn School Account Support

Kimberly Smalls
Sep 14, 2021, 5:47 PM EDT

Hi Will,
Thank you for your response. I am a doctoral student at The University of South Carolina in Columbia S.C. I am currently taking EDET 899 which is a dissertation preparation course. At this time I am working on getting the needed
permissions to reference your materials, use screen shots of the website, handouts, etc. to explain the process.

For this study, students will participate in flipped learning. In this process, the students will watch the video and complete the Independent Digital Lessons on Mondays and Wednesdays in class during our intervention time. They will participate in the small group lessons on Tuesdays and Thursdays during our intervention time. Fridays will be used to get caught up on any missing assignments. The data collection process will involve a pre and posttest using a different platform (Mastery Connect) as well as a pre and post survey about the students' motivation toward math before and after flipped learning and finally some of the students will participate in a focus group interview about their perceptions of the flipped learning classroom model. I will use your platform to keep track of how students are completing the assignments. All of this data will be reported and shared with my dissertation team. This information will also be published in my dissertation.

I am hopeful that this quick write up addresses all of the questions that you have asked. Please feel free to contact me again for further details. We can talk, video chat or send emails. All are good forms of communication for me. I will need written permission to use your materials should you grant it. I have used your materials in the past and would love to continue to use them with my students and to help me achieve a goal that I have set for myself.

Thank you so much for your help with this matter,
Kimberly M. Smalls, M. Ed., National Board Certified Teacher