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The Flipped Mastery Model in Secondary Mathematics Classroom: A Mixed Study to Determine the Effects on Student Satisfaction, Engagement, and Learning Achievement

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Update from Proposal

Due to Covid-19 and conflict of course scheduling during registration, the proposal's participants section was changed from three Algebra II classes (N=75+) to a single Algebra II class, thus reducing the sample size to N = 21 participants. To corroborate the quantitative and qualitative research findings on student satisfaction and student engagement, the researcher gathered more data by interviewing participants (Walton, 2019). The semi-structured interviews of individual students were designed to explore further the students' experiences of the flipped-mastery method (Muir, 2016).

The instrumentation section's modification included the pretest and posttest unit tests of a score of 100 primarily consisting of problem-solving inquiries. There were no multiple-choice and true-false questions on the unit tests, but a relatively short answer problem-solving items at Bloom's higher-order thinking such as analysis and evaluation (Bloom, 1956). Moreover, the unit lessons covered during the implementation phase commenced with Linear Function Unit and Quadratic Function Unit, for the traditional direct instruction methods and flipped-mastery, respectively, following Algebra II curriculum and NAD math standards. Moreover, the simple random sampling method used for the observational study replaced labeling each student with a number and using the IPAD random number generator with drawing names one at a time from a hat or box without replacement.

Since there was only one section of Algebra II class, as modified in the research's procedural portion, there were five observational studies – three randomly chose students and two classroom observations – to assess student engagement. One-way ANOVA was not used but the two inferential statistical tests used were paired-samples *t* test and independent samples *t* test.

Abstract

Although many studies are on the flipped classroom, they are currently gaps and limited research conducted on flipped-mastery models. This mixed study implemented the repeated-measures design with few qualitative and quantitative studies on flipped-mastery in the secondary mathematics classroom. The purpose of the study aimed to examine the flipped mastery model's effects on student satisfaction, engagement, and learning achievement. The study site was the researcher's private school with purposive sampling of twenty-one high school Algebra II students. Pre-posttest unit tests and weekly quizzes assessed student learning achievement. The independent-samples *t* test results yielded no significant differences between achievement performance for the flipped mastery model and the traditional face-to-face instructional teaching. Qualitative and quantitative studies were used to determine the effects on student engagement and satisfaction. The adapted Student Perception of Instruction Questionnaire (SPIQ) pre-post surveys and observation protocol form determined student perceptions (satisfaction) and student engagement. The independent-samples *t* test compared the means of student satisfaction and student engagement, resulting in no significant difference between flipped mastery and traditional teaching methods on student engagement and satisfaction. However, researcher observations, student interviews, and comprehensive researcher journal entries revealed more student engagement and satisfaction. The lack of significance of results may be influenced by Covid-19, the small sample size, and the study duration of eight weeks.

The Flipped Mastery Model in Secondary Mathematics Classroom: A Mixed Study to Determine the Effects on Student Satisfaction, Engagement, and Learning Achievement

After COVID-19 flipped the world upside down - with schools closing, parents “home schooling” their children, and teachers moving to distance learning, to flip, or not to flip? The math classroom is - in a virtual or face-to-face environment. Buzzwords like “Google Classroom,” “distance learning,” and “Zoom” floated around in the educational discussion settings. What would learning look like? And how to create an optimal active learning environment via an online interface?

In recent months, schools around the world have been thrust into remote learning and online classes. Technology usage exploded exponentially. For instance, over 90,000 schools in 20 countries used Zoom to teach remotely during the Covid-19 outbreak (Zoom, 2020). Amidst this pandemic crisis, the importance of integrating technology was critical to all learners of all ages (Roth, 2020).

Piggybacking on the rapid advancement of technology and educators wanting alternative strategies and teaching methods to empower students effectively to engage in the teaching-learning process (Talan & Gulsecen, 2019), the flipped classroom is regarded as one of these alternatives (Bhagat, Chang, & Chang, 2016). Numerous studies have shown the positive impact of the flipped classroom model to improve student engagement and performance by moving lecture outside the classroom via digital technology and moving homework and exercises in class (Bhagat et al., 2016; Bergman & Sams, 2012; Clark, 2015; Talan & Gulsecen, 2019).

Although there are many studies on the flipped classroom as an instructional strategy, there are currently gaps and limited research conducted on flipped-mastery models. Moreover, there are few qualitative and quantitative studies regarding the impacts on students' academic achievement, learning, and teaching processes, especially in secondary mathematics classes (Cabi, 2018).

"In many of the secondary classrooms across the country, students are passively engaged in the mathematics content, and academic performance can be described, at best, as mediocre" (Clark, 2015, p. 91). According to the 2018 Programme for International Student Assessment (PISA), an international assessment administered every three years to measure 15-year old students in math, reading, and science, United States ranked 30th out of 64h industrialized countries (National Center for Education Statistics, 2019; OECD, 2019). Moreover, the United States results revealed 41% of fourth-graders and 34% of eighth-graders scored proficient in math in 2019 (National Center for Education Statistics, 2019). That's not significantly different from 2017, and students have made little improvement since the early 2000s (National Center for Education Statistics, 2019).

With the nation's current performance and achievement in mathematics, possibly attributed to passive learning experiences in the classroom, effective mathematics instruction emphasizes student-centered learning strategies (Clark, 2015). The flipped learning method can meet these secondary mathematics challenges and enhance its practices (Muir, 2019).

Purpose of the Study

The purpose of the study is to examine the flipped-mastery classroom model's effects on student satisfaction, engagement, and learning achievements in secondary mathematics classrooms using mixed methods data collection and analyses. The study fills the gaps in limited research and adds to previous research on the flipped mastery approach. The study addresses the following research questions:

1. Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method in students' academic achievement scores?
2. Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method regarding students' engagement or active participation?
3. Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method regarding students' satisfaction levels?

The independent variable is the type of teaching method with two levels: flipped-mastery and traditional teacher instruction. The dependent variables are student satisfaction and learning achievement. These parameters purport that this study will be relevant to the educator and researcher by enhancing effective classroom practices to increase student engagement, motivation, and academic learning performance. Students may also benefit from the study in the secondary mathematics classroom by developing their academic achievement and continual learning.

Delimitations and Limitations

The delineated parameters that the researcher wants to focus on are high school and math students. Some limitations could be different such as the sampling method of wanting to implement a rigorous approach. For example, convenient sampling achieves in acquiring the participants for the study by using the researcher's Algebra II class at the researcher's worksite. Additionally, more time to carry out the research may be necessary instead of eight weeks of study for a 50-minute class meeting four times a week. Also, students may not be readily adaptable to a new teaching method, such as the flipped-mastery model. For some students, coming off an online distance learning may not be as appealing as it would have been before COVID-19.

Review of Literature

What is a flipped classroom? In 2007, science educators Jonathan Bergman and Aaron Sams gave birth to the idea of a flipped classroom in which online and Youtube was in its infancy (Bergman, 2011). The intent was to provide recorded chemistry lectures to the absent students (Bergman, 2011). They observed that their teachers needed to be present to answer students' questions or provide help, but they don't need their teachers present to listen to a lecture or review (Bergman and Sams, 2012). Thus, flipped classroom, although originally termed as an inverted classroom, in which lessons and homework are "flipped" – lectures watched on online videos for homework and problems practiced in class (Baggley, 2015; Bergman and Sams, 2012; Strayer, 2012).

Many researchers have described flipped classrooms in which the students access online video lectures prepared by teachers before class and use class time for active learning that is student-centered rather than teacher-centered (Baghett et al., 2016; Bergman and Sams, 2012; Chen, Wang, Kinshuk & Chen, 2014; Talan & Gulsecen, 2019). In their studies, Talan and Gulsecen (2019) posit that flipped classroom pedagogical models through technological infrastructure emphasize student-centered, support active learning, and increase study time in class.

Once educators were flipping their classrooms with full library resources to meet individualized students' needs, the next step was mastery (Johnson, 2018). Revisiting Benjamin Bloom's learning for knowledge, students could reach high levels of understanding and academic performance if educators at all levels differentiated instruction to meet the students' learning styles (Bergman and Sams, 2013; Gustkey, 2007). This self-paced mastery learning enabled students to demonstrate that they have mastered a specific set of objectives before moving on to the next lesson (Bergman and Sams, 2013; Johnson, 2018). Assessing for mastery also changed from a single exam with a permanent grade to multiple attempts until the ability is achieved, thus meeting a set criterion before proceeding in the curriculum (Bergman and Sams, 2013; Johnson, 2018).

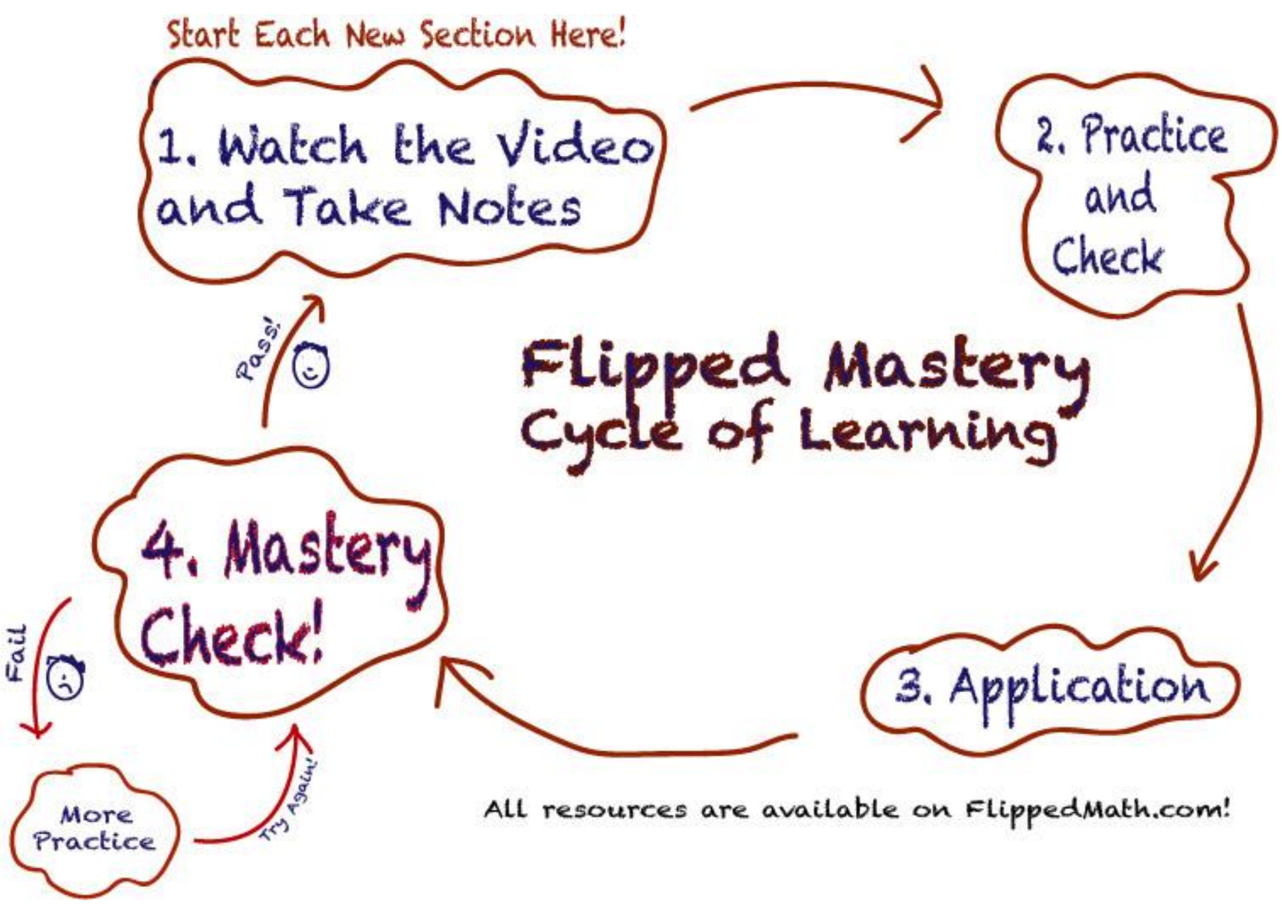
Marrying the principles of mastery learning and flipped class model instructions, Bergman and Sams developed the flipped-mastery education model (Bergman and Sams, 2013). Students reach a preset self-paced mastery level of course objectives in the flipped-mastery model with a flipped class model of instruction (Bergman, 2017). Bergman (2017) states, "flipped-mastery learning is a way to manage a true mastery system and provide individual feedback for students, give them the challenges they need, differentiate for each student, and provide appropriate feedback for all students" (p. 45).

A student-centered approach reflects Bloom's Taxonomy complimenting the flipped-mastery model, thus transforming students' learning experiences (Walton, 2019). The traditional lecture model of teaching and recitation and rote learning techniques convert to an active, hands-on, collaborative, and interactive learning model (Walton, 2019). Bergman and Sam (2013), pioneers of the flipped-mastery model, posit," in this model, students work through course content at a flexible pace, receiving direct instruction asynchronously when they're ready for it. When they get to the end of a unit, they must demonstrate mastery of the learning objectives before they move on" (p.25).

Research study shows there are five components to the flipped-mastery classroom: 1) define clear learning targets, 2) determine ways to implement the goals through direct instruction or problem-solving, 3) student accessibility to videos, 4) assimilate interactive and engaging learning activities during class, and 5) create multiple versions of summative assessments for corrective measures for each student (Bergman & Sam, 2012; Laoha & Piriyasurawong, 2018). See Figure 1 for a graphical representation of a flipped-mastery classroom model by Bean, Brust, Kelly, & Sullivan (n.d):

Figure 1

Flipped-Mastery Model Schematic



Effect on Student Satisfaction

How does flipped-mastery classroom affect student satisfaction? With a limited study on the flipped-mastery model in the mathematics classroom, Muir and Geiger (2016) provided two cases of 10 senior secondary mathematics classrooms using the flipped-mastery model. In those two cases, the students would view teacher-created videos that were readily accessible on the internet. Once they saw these videos out of class, the students would complete assigned work from class, take a test to demonstrate mastery of the topic and then move on to the next concept for the skill with minimal teacher-centered involvement. Students who used this approach reported increased satisfaction with the material's relevancy through surveys and interviews. Talan and Gulsecen (2019) report from their study that students were generally satisfied with flipped classrooms compared with traditional classrooms. There are limitations to this study since it didn't include a flipped-mastery model, and the participants consisted of university students in a computer class.

Previous studies indicate that students viewed flipped learning as "a convenient, and comfortable" manner to understand and were far more favorable to flipped learning rather than traditional methods (Avery & Huggan, 2018; Baepler, Walker, & Driessen, 2014; Bergman & Sams, 2013; Luo, Yang, Xue, & Zuo, 2019). Zhai, Gu, Liu, Liang, & Tsai (2017) suggest from their study that the learners' prior learning experience is a far more significant indicator for predicting their satisfaction and favorable perceptions.

Effect on Student Engagement

Classroom engagement is the student's active involvement in classroom activities in which students spend effort in learning, listening, actively helping, and participating (Clark, 2015; Wang, Bergin, & Bergin, 2014). Engagement plays a significant role in learning and influences student learning in which the instructors still have control in the classroom (Steen-Utheim & Foldness, 2018). Student involvement in classroom activities and completing assigned homework or classwork tasks indicate a student's academic engagement (Talan & Gulsecen, 2019). Full academic engagement is strongly related to positive student-teacher relationships (Conner & Pope, 2013).

Several studies have reported positive learning experiences and increased student engagement with a flipped classroom when compared to the traditional class (Clark, 2015; Steen-Utheim & Foldness, 2018; Merlin-Knoblich, Harris, & Mason, 2019). However, there are few studies on a flipped-mastery classroom that indicate student engagement in math classrooms. For example, one such study includes Walton's (2019) case study depicted in a sixth-grade mathematics flipped-mastery class. The study used an observational protocol recording the students' engagement level in learning from three observational field sessions, using multiple-choice questions and two Likert scales. Furthermore, Walton (2019) used journal notes to record engagement behaviors during the observations. Overall, the results from these observations showed that students were actively engaged in whole group and small group discussions, problem-solving, and technology usage (Walton, 2019). Moreover, student-teacher interactions were frequently observed in the flipped-mastery classroom, and most students appeared to be actively paying attention and making valid attempts to participate in class activities (Walton, 2019).

Hence, a flipped-mastery classroom cultivates higher levels of student engagement (Walton, 2019). Although few limitations exist with this study of using a small sample size of 26 student observations and interviews, an important finding emerges from this study that the students were determined to have high self-efficacy and engagement in the flipped-mastery classroom (Walton, 2019).

Effect on Learning Achievement

A quasi-experimental study done by Unal and Unal (2017) adopts the flipped method in their five-day unit lessons to demonstrate learning achievement effectiveness. The study used pretests, posttests, and a descriptive survey focusing on 16 in-service teachers' experiences. The teachers converted their five-day lessons from traditional to flipped teaching and compared students' learning performance and satisfaction with regular students (Unal & Unal, 2017). The study results showed that the flipped classroom approach could help students perform significantly better than traditional formats (Unal & Unal, 2017).

Another study compared the flipped classroom with the traditional teaching method of presenting trigonometry to determine the learning achievement effectiveness among 82 high school students between ages 14 and 15 (Bhagat et al., 2016). This study's statistical results indicated that students in the traditional teaching method group outperformed them in the traditional teaching method (the control) (Bhagat et al., 2016). Because the flipped classroom method allows the student to learn at their own pace by winding and rewinding the recorded lectures and using productive class time for any remedial help, they had better learning achievements (Bhagat et al., 2016).

The results of previous studies from Bhagat and et al. (2016), Talan and Gulsecen (2019), Guy and Marquis (2016), and Orhan (2019) are consistent in which students in the flipped classroom outperformed academically than those in the traditional class. In other words, the flipped classroom model produces positive effects on students' learning achievements. On the contrary, Vang (2017) and Clark (2015) studies indicated no statistical difference regarding academic results between the flipped and traditional instructional methods among high school students enrolled in math.

Previous studies primarily focus on the flipped classroom model, mainly in postsecondary settings, such as colleges and universities. Hence, the current study will fill the gap or holes in the scant literature on the effectiveness of learning achievement implementing the flipped-mastery model, especially in the secondary mathematics classroom.

Methodology

Research Design

The current study extends past research that has focused on the flipped model classroom but left out flipped-mastery in secondary mathematics classrooms using mixed methods to determine the effectiveness of flipped-mastery on student satisfaction, engagement, and learning achievement. The research design is the mixed methods study, which provides an opportunity to explore factors that contribute to the flipped-mastery teaching model's effects on student satisfaction, engagement, and learning achievement in a secondary mathematics classroom. According to Creswell and Guetterman (2019), mixed methods build on both quantitative and qualitative data strengths, which expands a greater understanding of the research problem than either approach by itself.

Additionally, the mixed methods design type implements a repeated-measures design. All the participants in a single group participate in all the experimental treatments while becoming control (Creswell & Guetterman, 2019). Moreover, the individual group's performance under one experimental treatment will compare with its outcome under another experimental treatment (Creswell & Guetterman, 2019). Furthermore, the repeated-measures design threats to internal validity are not affected by comparing groups, such as selection and treatments (Creswell & Guetterman, 2019). However, potential extraneous influences may occur that may affect the outcome measure, such as previous online learning use during Covid-19. See Figure 2 for a graphical representation of the Repeated-Measure Design.

Figure 2

Repeated-Measures Design.

Repeated-Measures Design					
Time →					
Select Participants for group	Measure or observation	Experimental Treatment 1	Measure or observation	Experimental treatment 2	Measure or observation

Note: Adapted from Creswell & Gutterman, 2019, p. 319.

Participants

The participants included students from an Algebra II class (N=21) from a private Christian high school consisting of 315 students at the researcher site in Collegedale, Tennessee. The school utilized a one-to-one iPad-to-student ratio. The majority of students have access to internet availability at home. Thus the flipped-mastery approach is supported as all participants have the necessary resources. The school has a student-teacher ratio of 15:1 with an average class size of 25 students or less. The study participants are between 16 and 17 years of age, sophomore or junior high school.

Variables

The quantitative data used pretest and posttest teacher-created unit tests and weekly mastery concept quizzes and a Likert scale to examined student learning achievement and satisfaction. The teaching method or classroom instruction is the independent variable for quantitative data with two levels, flipped mastery, and traditional direct instruction. The dependent variables included student satisfaction and learning achievements. The hypotheses include:

1. H_0 (Null): There are no significant differences between flipped-mastery and traditional direct instruction in students' learning achievement.
2. H_0 (Null): There are no significant differences between flipped-mastery and traditional direct instruction in students' satisfaction.

The qualitative data encompassed the observational protocol, student interviews, and in-depth notes documented in the researcher's journal to explore students' academic engagement and satisfaction for the flipped mastery approach and traditional direct instruction.

Instrumentation

The study's research instruments comprised pretest and posttest unit tests (achievement learning tests) and weekly quizzes to measure the dependent variable, student academic learning achievements. At the beginning and end of each intervention (traditional method followed by flipped-mastery model) spanning over an eight-week study, the researcher gave a unit test using the repeated measures design method.

The researcher consulted experts from the research site's mathematics department for the content validity of the achievement learning tests (pretests and posttests). The pretest and posttest unit tests have a score of 100. Short answer problem-solving items aim at Bloom's (1968) higher-order thinking such as analysis and evaluation. Most items are selected or adapted from the test banks of Big Ideas Math Algebra 2 standardized to common core standards to ensure curricular validity and internal consistency reliability.

The first four weeks of the study implemented the traditional direct instruction methods, which cover the Linear Function Unit. The remaining four weeks used the flipped-mastery process comprising Quadratic Equations Unit. The students with both approaches would not have in-depth prior knowledge of the concepts presented during the study, i.e., the ideas are generally new material for the participants.

To measure student satisfaction, students completed a Likert scale survey used in previous studies to examine the efficacy of traditional and blended courses, such as flipped-mastery teaching methods. The adapted Student Perception of Instruction Questionnaire (SPIQ) surveys (see Appendix A and B) determined student perceptions (satisfaction) in the areas of content and course, assessment, and evaluation (Araño-Ocuaman, 2010; Johnson & Renner, 2012). Thus, the use of the instrument by previous studies, such as Johnson and Renner (2012), Araño-Ocuaman (2010), and Clark (2015), supported the reliability and validity of the SPIQ surveys. Each of the sixteen questions in the Likert scale survey required the participants to respond with *strongly agree, agree, agree or disagree, disagree, or strongly disagree*. The sixteen questions' mean scores for each item provided a comparative analysis between the students to determine the efficacy of traditional and flipped-mastery methods on student satisfaction.

Furthermore, to explore student satisfaction, student interviews were implemented using the interview protocol (see Appendix C). The average student interview was about eight minutes. According to Jacob and Furgerson (2012), an interview protocol is more than merely posing interview questions to participants. Instead, it extends to the procedural level of collecting data by developing a script to guide the researcher and the participant. Using Creswell and Guetterman (2019) steps in conducting interviews such as gathering audio, in this case, video recording of the questions and responses, and using probes were collected to elicit more information on student satisfaction.

Finally, to measure student engagement, the researcher employed observational data such as field notes and drawings as a journal entry. The researcher's role served as a participant-observer when the researcher participates in activities in the setting they observe (Creswell & Guetterman, 2019). The data recorded by the researcher applied an observation protocol form (see Appendix D) for all the Algebra II classes. Five field observations took place individually and corporately for each implementation method: traditional method and flipped-mastery approach, a total of ten field observations. Also, the researcher conducted student interviews to assess further student engagement.

Moreover, implementing the simple random sampling method, the researcher placed each Algebra II students' names in a box choosing three to four students for an in-depth observational qualitative study. Simple random sampling uses an equal probability of being selected from the population, and any bias will equally distribute among the class chosen (Creswell & Guetterman, 2019).

Procedure

Participants and their parents/guardians signed a consent form (see Appendix E) detailing the research study. Any minors of the study included an assent form (see Appendix F). Also, permission from the Institutional Review Board (IRB) was obtained. The timeline for the study lasted eight weeks using the repeated-measures design. Part of the first week of the traditional face-to-face direct instruction method was dedicated to informing the research study participants and acquiring participant and parent/guardian consent.

The first four weeks began with the traditional face-to-face direct instruction method. The participants took a pretest unit test on the Linear Function unit on day one using the full 50 minutes of scheduled class time. The pretest unit test was documented within the following day and returned to participants for immediate feedback, and kept secure. Then direct instruction in the classroom took place with classroom-based lectures and discussions of thirty to forty minutes of the total class time of 50 minutes—the remaining time allowed for homework problems from the textbook or worksheet. The participants completed their homework before the next class on their own time.

During the four weeks, weekly concept mastery quizzes assessed the concepts of the unit. At the end of the fourth week, a posttest unit test determined academic learning. Also, a pre-survey questionnaire (SPIQ) evaluated student satisfaction. Furthermore, qualitative observations took place within the three weeks through five field observations as a participant-observer using an observation protocol form, and researcher journaling students' engagement. Furthermore, the researcher recorded in a journal and on observation protocol form the behaviors, patterns, and themes, specifically of three randomly chosen students, and two class observations, to further assess student engagement in the classroom.

The researcher implemented the flipped-mastery model for the next four weeks. In the first week, the students were educated and prepared for the flipped-mastery concept, followed by a pretest unit test on Quadratic Equations. The flipped-mastery model uploaded pre-recorded teacher-created video lessons to Google Classroom one to two days before class. The video lessons' average time ranged from 8 minutes to 30 minutes, broken into smaller videos. Before the participants came to school the following day, the participants watched the pre-recorded teacher-created video lessons, took notes, and wrote questions about experiences on the discussion forum posted on Google Classroom linked to the videos. During class time, participants engaged in whole class or minimal small group activities (limited by Covid-19), discussing or working on problems based on the video lessons, reinforcing concepts, or dispelling any misunderstandings through face-to-face support by the teacher.

Similar to traditional methods, at the end of the intervention or treatment 2 (flipped-mastery model), the participants took the posttest unit test, weekly concept mastery quizzes, post-survey (SPIQ), and five field observations to collect scores for learning achievement, satisfaction, and student engagement, respectively. As aforementioned in this proposal's instrumentation section, reliability and validity were maintained for quantitative and qualitative data throughout this study.

Possible data collection problems occurred when the researcher observed for qualitative data while implementing the traditional and flipped-mastery interventions. In other words, the researcher is also the teacher for the Algebra II classes. As the researcher and teacher, it was difficult to observe a student thoroughly without being interrupted for class content assistance. Thus, for qualitative data collection, the researcher triangulated data across various sources such as journaling, observations, and interviews to establish credibility and construct validity and minimize biases. While observing the participants in this qualitative data collection, the researcher avoided making assumptions and generalizations by becoming objective as a researcher rather than the teacher's role in the classroom.

Data Analysis Procedures

Since this study uses a mixed-methods design, both quantitative and qualitative data analyses occurred. Quantitative analysis included both descriptive statistics such as central tendency (mean, mode, and median) and variability (variances, standard deviation, and range) followed by inferential statistics (Creswell & Guetterrman, 2019) to determine the effect on learning achievement and student satisfaction. On the other hand, qualitative analysis analyzed data through observational field notes from the researcher's journal, observation protocol, and students' interviews to identify themes affecting students' engagement and student satisfaction.

Quantitative inferential statistics such as paired-samples *t* test and independent-samples *t* test were used to determine if there were significant differences in the students' achievement and satisfaction scores between flipped-mastery and traditional methods. Additionally, percentages and frequencies reflected student satisfaction. A paired samples t-test compared the pretest and posttest unit test scores in flipped mastery and traditional methods to determine if there were significant differences in student learning and growth in the flipped-mastery and traditional interventions.

Results of pre and posttest scores and surveys were analyzed using the Statistical Package for the Social Sciences, Version 26 (SPSS 26) to determine if there are significant differences in academic achievement and student satisfaction using the flipped-mastery model or traditional teaching method. The null hypotheses include: there is no significant difference between flipped-mastery and traditional methods in learning achievement and student satisfaction. The statistical significance level is set at $p < 0.05$ (alpha = 0.05).

Qualitative data analysis transpired through the researcher's observations, reflective journaling, and interviews. Hence, the researcher utilized the inductive text analysis. From the start of observation and journaling, the researcher noted recurring themes. Furthermore, coding schemes were applied to expand, delete, or add categories to capture keywords and coding responses from observations for each intervention of traditional and flipped-mastery approaches. By comparing keywords to the researcher's journal, observations, and interviews, themes emerged, such as "active learning," "engagement," "class time," "collaboration," "experience with the flipped method," and "satisfaction of flipped mastery model."

Ethics and Human Relations

There are minimal risks this study poses for the research participants. Obtaining permission before starting to collect data, protecting individuals' anonymity by assigning numbers to returned instruments, and maintaining the confidentiality of the participants are ethical issues that preserve throughout the study (Creswell, 2019). The researcher shared the benefits and risks of the study with the participants, and participants can discontinue the research at any time.

Institutional Review Board (IRB)

An IRB was obtainable from Southern Adventist University. The IRB process is extensive to ensure the protection and rights of human participants in this study. It includes the rationale, purpose, and methodology for this study. Furthermore, content sensitivity, confidentiality, privacy, risks, and results emphasized protecting the participants. Finally, IRB required permission from the participants, parents/guardians (if participants are minors), and from applicable authorities involved in this study, such as the principal of the research site, school board, and research faculty advisor. Since the researcher was conducting the study at the researcher's site, entry to the site was not an issue. Also, informed consent and informed assent from the research participants and parents/guardians were accessible.

Timeline and Budget

The timeline is outlined in an 8-week research study for 50-minutes class four days a week (see Appendix G). No expenses involved except printing surveys and pre-posttests.

Results of the Study

Description of Setting

This study's research site is readily accessible to the researcher, where school practices and policies, students, and school community are familiar. The site is a private school with approximately 315 students located in Collegedale, Tennessee, with about 12,000 people. The school utilizes a one-to-one iPad-to-student ratio. The majority of students have access to internet availability at home. The school has a student-teacher ratio of 15:1 with an average class size of 25 students or less.

The student population demographics include Caucasians 60.31%, Latino 17.14%, African-American 5.71%, Asian 8.57%, Pacific Islander 0.95 %, and Other 7.30%. Since the study is purposive sampling, the researcher used one Algebra II class at the research site for this study as the teacher. The Algebra II class with a sample size of 21 students (N=21) who voluntarily agreed to participate with parental consent consisted of eight males and thirteen females. The sample demographics include Caucasians 52.38%, Latino 23.81%, African-American 14.29%, Asian 4.76%, and Other 4.76%. This Algebra II class is considered a regular Algebra II math course with varying and diverse learning abilities, as evidenced by 28.57% of Sophomores (ages 15 to 16 years old) and 71.41% of Juniors (ages 16 to 17 years old).

Findings and Analysis

The findings are presented to address the study's research questions using quantitative and qualitative results.

Research question one. Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method in students' academic achievement scores?

Quantitative data analysis was conducted on pre-posttests (Appendices H and I) and weekly quizzes(Appendix J and K) for traditional direct instruction and flipped mastery model. The results reported descriptive statistics. Moreover, several inferential tests were used to determine any statistically significant differences between the flipped mastery model and the traditional face-to-face learning method in students' academic achievement scores. Such tests included a paired-samples *t* test used to determine statistically significant differences between repeated measurements on a single sample (Creswell & Guetterman, 2019). Furthermore, independent samples *t* test was employed to compare the teaching methods to determine whether there is statistical evidence the means are significantly different. The independent variable was the teaching methods, and the dependent variables included the quizzes and unit posttest scores.

Table 1 and Table 2 show the descriptive statistics and the paired-samples *t* test results for pretest and posttest data for traditional face-to-face direct and flipped-mastery teaching methods.

Table 1

Descriptive Statistics Traditional Face-to-Face Direct Pretest and Posttest Scores

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	pretest traditional method	5.5476%	21	4.16205	.90823
	posttest traditional method	78.3810%	21	15.36384	3.35267

Table 1 (continued)

Comparison of Means for the Tests

		Paired Differences					T	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	pretest - posttest	-72.8333	12.95794	2.82766	-78.7317	-66.9349	-25.75	20	.000

From the pretests and posttests, student growth in academic learning took place for the Linear Functions Unit. The traditional direct instruction mean percent of test score points was significantly higher (t(20)= -25.58, p=0.001) from pretest (M= 5.5476%, SD=4.16205) to posttest (M=78.3810%, SD=15.36384).

Table 2

Descriptive Statistics for Flipped-Mastery Pretest and Posttest Scores

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	21.9286%	21	4.30490	.93941
	Posttest	72.3810%	21	24.92083	5.43817

Comparison of Means for the Tests

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Pair 1	pretest - posttest	-50.4523	21.95729	4.79147	-60.4472	-40.4575	-10.53	20	.000

From the pretests and posttests, applying the flipped-mastery approach, student growth in academic learning took place for the Quadratic Functions Unit. The flipped-mastery mean percent of test score points was significantly higher (t(20)=-10.530, p=0.001) from pretest (M= 21.9286%, SD=4.30490) to posttest (M=72.3810%, SD=24.92083). The traditional direct instruction had a higher posttest mean percentage of 78.3810% than a flipped-mastery intervention of 72.3810%.

The descriptive statistics for weekly quizzes for traditional direct and flipped-mastery instruction for each concept skill can be seen in Table 3and Table 4, respectively.

Table 3

Descriptive Statistics for Traditional Instruction Weekly Quiz Scores on Linear Functions Unit

	Quiz 1 Linear functions and Transformations	Quiz 2 Parent Functions and Transformations	Quiz 3 Modeling Linear Functions	Quiz 4 Solving Systems with 3 Variables
N	21	21	21	21
Mean	8.4524	8.2619	8.7857	7.5714
Median	9.5000	8.5000	9.0000	8.0000
Mode	10.00	8.50	9.00	8.00
Std. Deviation	2.06703	1.07957	1.27055	2.29829
Variance	4.273	1.165	1.614	5.282
Range	7.00	4.00	5.00	9.50

Table 4

Descriptive Statistics for Flipped-Mastery Weekly Quiz Scores on Quadratic Functions Unit

	Quiz 1 Transformations of Quadratic Functions	Quiz 2 Characteristics of Quadratic Functions	Quiz 3 Focus of Parabola	Quiz 4 Modeling Quadratic Functions
N	21	21	21	21
Mean	8.2857	7.0238	7.7619	8.2619
Median	9.0000	7.0000	8.5000	9.5000
Mode	10.00	10.00	8.00[a]	10.00
Std. Deviation	2.25594	2.74534	2.39071	2.81789
Variance	5.089	7.537	5.715	7.940
Range	10.00	10.00	9.00	10.00

a. Multiple modes exist. The smallest value is shown.

The weekly quizzes are mastery-based, providing multiple attempts until a deeper understanding of the concept skill is achieved (Bergman and Sams, 2013). Each quiz is based on a ten-point scale. Comparing the means from Tables 3 and 4, quizzes one, two, and three had higher means for traditional instruction. Quiz four had a higher mean for flipped-mastery (M= 8.2619, SD= 2.819) compared to traditional (M=7.5714, SD=2.29829). The results compared the four quizzes administered weekly for each intervention, shown in descriptive statistics Table 5. All mean quiz scores were higher on the traditional face to face teaching method except for one. Also, student learning is evident throughout the study, with a total mean quiz score of M= 8.0506, SD=0.52603.

Table 5

Group Descriptive Statistics

	Teaching Methods							
	Traditional face to face				Flipped Mastery			
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean
Quiz 1	21	8.4524	2.06703	.45106	21	8.2857	2.25594	.49229
Quiz 2	21	8.2619	1.07957	.23558	21	7.0238	2.74534	.59908
Quiz 3	21	8.7857	1.27055	.27726	21	7.7619	2.39071	.52169
Quiz 4	21	7.5714	2.29829	.50153	21	8.2619	2.817 89	.61491

The means were compared to determine a statistically significant difference between each quiz from both teaching methods, using an independent-samples two-tailed *t* test. The results are shown in Table 6.

Table 6

Comparison of Means for Each Quiz Scores for Traditional and Flipped Mastery

		Statistics								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Dependent variables	Assumptions	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Quiz 1	Equal variances assumed	.044	.834	.250	40	.804	.1667	.6677	-1.1828	1.5161
	Equal variances not assumed			.250	39.6	.804	.1667	.6677	-1.1831	1.5164

Quiz 2	Equal variances assumed	10.075	.003	1.92	40	.062	1.2381	.6437	-.0629	2.5391
	Equal variances not assumed			1.92	26.0	.065	1.2381	.6437	-.0850	2.5612
Quiz 3	Equal variances assumed	5.331	.026	1.73	40	.091	1.0238	.5908	-.1702	2.2178
	Equal variances not assumed			1.73	30.4	.093	1.0238	.5908	-.1820	2.2296
Quiz 4	Equal variances assumed	.116	.735	-.87	40	.389	-.6905	.7935	-2.2942	.9133
	Equal variances not assumed			-.87	38.4	.390	-.6905	.7935	-2.2962	.9153

Table 6 shows for each quiz that there was no significant differences in the scores for traditional and flipped teaching methods: quiz one (M=8.4524, SD= 2.06703) and flipped-mastery (M=8.2857, SD= 2.25584); t(40)=.250, p=.804; quiz two (M=8.2619, SD=1.07957) and flipped-mastery (M=7.0238, SD=2.74534) ; t(40)=1.92, p=.062; quiz three (M=8.7857, SD=1.27055) and flipped-mastery (M=7.7619, SD=2.39071) ; t(40)=1.73, p=.093; quiz four (M=7.5714, SD=2.29829) and flipped-mastery (M=8.2619, SD=2.817 89) ; t(40)=-.87, p=.390. Tables 7 shows the overall results of the total quiz mean for traditional and flipped mastery teaching methods.

Table 7

Total Quiz Mean Scores for Traditional and Flipped Mastery

	Total Quiz_scores	
	Teaching_Method	
	Traditional face to face	Flipped Mastery
N	21	21
Mean	8.2679	7.8333
Std. Deviation	1.42263	1.93259
Std. Error Mean	.31044	.42173

Comparison of Means for Total Quiz Scores for Traditional and Flipped Mastery

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Quiz Scores	Equal variances assumed	1.661	.205	.830	40	.412	.43452	.52367	-.6238	1.492
	Equal variances not assumed			.830	36.7	.412	.43452	.52367	-.6267	1.495

Therefore, from Table 7, there was no significant difference between the mean quiz scores for traditional (M=8.2679, SD= 1.42263) and flipped mastery (M= 7.8333, SD=1.93259; $t(40)=.830$, $p=.412$ ($p > 0.05$).

Finally, the quantitative results for the traditional and flipped-mastery posttests are presented in Table 8 using an independent samples *t* test with a significance level ($\alpha=0.05$).

Table 8

Group Descriptive Statistics

	Test_Scores	
	Teaching_Method	
	Traditional face to face	Flipped Mastery
N	21	21
Mean (%)	78.3810	72.3810
Std. Deviation	15.36384	24.92083
Std. Error Mean	3.35267	5.43817

Comparison of Means for Posttest Scores For Traditional and Flipped Mastery

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Posttest Scores	Equal variances assumed	3.703	.061	.939	40	.353	6.000	6.3885	-6.911	18.911
	Equal variances not assumed			.939	33.3	.354	6.000	6.3885	-6.993	18.993

The posttest reported in Table 8 identify the mean score higher in the traditional method of delivery (M= 78.3810, SD=15.36384) in comparison to the flipped mastery (M= 72.3810, SD=24.92083). However, there was no significant difference in the test scores for the traditional and flipped mastery teaching approaches t(40)=.939, p=.353 (i.e p>.05). The difference between achievement performance was insignificant between traditional and flipped-mastery teaching methods.

Research question two: Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method regarding students' engagement or active participation?

Qualitative data analysis measured student engagement by using observational data such as observational protocol form, field notes, and journal entries. The observational protocol form addressed student engagement in whole or small groups, activities, and working cooperatively or individually throughout the lesson. Finally, a Likert scale assessed the students' attentiveness and active participation in the learning process using a frequency scale of 1 (Never) to 4 (Always).

During the first four weeks of traditional teaching, the researcher recorded five field classroom observations. Using the observational protocol form and recording students' behaviors in a journal, the researcher noted limited interactions between the students and their peers/teacher were 80%, and 20% of the students were cooperatively working with their peers and teacher. When observed, the students engaged in the discussion as a whole group, 80% of the time, and 20% in small groups/pairs. Moreover, the students were primarily problem-solving/investigating, taking notes, or working collaboratively throughout the lesson, with occasional "head on the desk." Finally, Table 9 outlined the student engagement from the five field observations from the Likert scale data.

Table 9

Student Engagement Likert Scale Descriptive Statistics: 1 (Never) to 4 (Always) for Traditional Direct Instruction Method

	Students attentive in class	Students actively participating in the learning process	Students Engagement
N	5	5	10
Mean	2.4000	2.4000	2.4000
Median	2.0000	2.0000	2.0000
Mode	2.00	2.00	2.00
Std. Deviation	.54772	1.14018	.84327

The researcher's five observations were consistent in student attentiveness in class (M= 2.4, SD=.54772), students' active participation in the learning process (M= 2.4, SD= 1.14018), and overall student engagement (M= 2.4, SD=.84327). The mode was 2 for student engagement.

During the next four weeks of flipped-mastery intervention, the researcher continued with five classroom observations. The observational protocol form results reflected 60% of students were engaged in small groups/pairs, and 40% in the whole group. 40% of the students cooperatively worked with their peers and teacher, and 60% had limited interaction between the students and their peers/teacher. However, as supported by the researcher's journal notes, the teacher, also the researcher, spent less time in the front of the class teaching but instead circulated the room, assisting students with problems and activities. Students were engaged in think-pair-share discussions, as noted in field notes, such as matching quadratic function graphs. There were a large number of days in which the students were actively engaged in classroom activities.

Throughout the lesson, students were problem-solving/investigating, taking notes or reading mathematics (doing problems), and working collaboratively during a flipped-mastery intervention. Finally, the Likert scale observation data for student engagement can be shown in Table 10.

Table 10

Student Engagement Likert Scale Descriptive Statistics: 1 (Never) to 4 (Always) for Flipped Mastery Method

	students attentive in class	Students actively participating in the learning process	Student Engagement
N	5	5	10
Mean	2.6000	2.6000	2.6000
Median	3.0000	3.0000	3.0000
Mode	3.00	3.00	3.00
Std. Deviation	.54772	.54772	.51640

The researcher's flipped-mastery five observations were consistent in student attentiveness in class (M= 2.6, SD=.54772), students active participation in the learning process (M= 2.6, SD= .54772), and overall student engagement (M= 2.6, SD=.51640). The mode was 3 for student engagement. The data shown indicate that student engagement is more likely to take place in a flipped-mastery classroom.

To determine the statistical significance of the means for student engagement between traditional and flipped-mastery based on these observations, the independent-samples *t* test was used, as shown in Table 11.

Table 11

Descriptive Statistics for Student Engagement for Teaching Methods

	Student engagement For teachinng_methods	
	Traditional	Flipped-mastery
N	10	10
Mean	2.4000	2.6000
Std. Deviation	.84327	.51640
Std. Error Mean	.26667	.16330

Comparison of Student Engagement Means for Teaching Methods

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
students engagement	Equal variances assumed	1.923	.182	-.64	18	.530	-.2000	.31269	-.8569	.4569
	Equal variances not assumed			-.64	14.91	.532	-.2000	.31269	-.8668	.4661

Although the student engagement mean for flipped mastery (M= 2.6, SD= .1640) is higher than the traditional (M= 2.4, SD=.51640), there is no statistically significant difference t(18)=-.64, p=.532 ($p > 0.05$) between traditional and flipped mastery for student engagement.

However, from student interviews on flipped mastery, several themes emerged, such as “increased student engagement,” focus,” “one-on-one interaction with the teacher,” “quality instruction,” and “collaboration.” For example, Participant N noted that learning in class was more challenging and staying focused was difficult sometimes. They would “space out” during teacher lectures when traditional methods were employed. Participant D commented that they learned better at home. So the flipped mastery approach allowed Participant D to learn better at home by watching the videos because they were tired in the mornings during class and learned better in the afternoon. Thus, the participants’ interviews revealed that students were more engaged with the teacher and their friends during the flipped mastery intervention. Qualitative data collection through interviews and researcher observations, and documented journal notes indicated increased student engagement for the flipped mastery model.

Research question three: Is there a significant difference between the flipped mastery model and the traditional face-to-face learning method regarding students’ satisfaction levels?

Quantitative and qualitative data collection addressed the flipped mastery model’s satisfaction levels and the traditional face-to-face learning method. To measure student satisfaction, students completed a Likert scale survey used in previous studies to examine the efficacy of traditional and flipped-mastery teaching methods. The adapted Student Perception of Instruction Questionnaire (SPIQ) surveys were used to determine student satisfaction in the teaching methods. After finishing four weeks of the traditional instruction, the students completed the SPIQ pre-survey, followed by the SPIQ post-survey after completing four weeks of the flipped-mastery model.

The participants responded to twelve Likert-type survey items on a five-point scale, a score ranging from 1-5, with higher scores strongly agreeing to the statements. The Likert scale is an interval: 1 to 1.8, strongly disagree; 1.81 to 2.60, disagree; 2.61 to 3.40, not agree or disagree (neutral); 3.41 to 4.20, agree; and 4.21 to 5, strongly agree. Moreover, the surveys included a multiple responses question on improving learning experiences and open-ended responses to improving the class and student learning and meeting course expectations. Tables 12 and 13 in Appendix L and M summarize the pre-survey and post-survey descriptive statistics results indicating satisfactory student satisfaction with traditional and flipped classrooms.

From the SPIQ pre-post survey, question 4, "I have learned a lot in this course so far," question 6, "the availability of course materials, communication, and assessment tools helped me improve my learning," question 11, "I would choose to take another course like this one," and question 12, "I like the daily routine in this class" were used to determine student satisfaction. The results are shown in Table 14, comparing their means and determining the means' statistical significance using the independent-samples *t* test.

Table 14

Student Satisfaction Mean Scores for Traditional and Flipped Mastery

	Satisfaction	
	Teaching Methods	
	Traditional face to face	Flipped Mastery
N	20	21
Mean	13.2500	13.0000
Std. Deviation	2.35919	3.34664
Std. Error Mean	.52753	.73030

Table 14 (continued)

Comparison of the Satisfaction Means for Traditional and Flipped Mastery

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Satisfaction	Equal variances assumed	.816	.372	.275	39	.785	.25000	.90851	-1.587	2.087
	Equal variances not assumed			.277	36.0	.783	.25000	.90090	-1.577	2.077

Although the student satisfaction mean for traditional (M= 13.2500, SD= 2.359) is slightly higher than the flipped mastery (M= 13.0000, SD=3.34664), there is no statistically significant difference t(39)=-.275, p=.785 ($p > 0.05$) between traditional and flipped mastery for student satisfaction. Both methods had positive student satisfaction.

Item thirteen on the surveys outlined some of the ways the students' learning experiences improved, such as availability and accessibility to online content and course materials, group collaborations, in-class group discussion, and ease of use of the Web environment. The responses to the open-ended questions on the pre-post surveys addressed ways to improve traditional and flipped courses. Some of the traditional reactions included: for the class to be more organized, slower pace of lessons, and more in-class problems. For flipped mastery, shorter videos and sooner posting of the videos on Google Classroom, and slower pace were noted.

Item sixteen asked whether the flipped mastery or traditional instruction met the student's expectations and if they liked the opportunity. Most of the students responded positively to the teaching methods meeting their expectations. However, there were mixed responses to whether the students liked the opportunity for flipped mastery, such as "I liked flip wayyy better," to "I didn't like it because I don't learn well at home."

Qualitative data included student interviews in determining student satisfaction. Three students were randomly interviewed upon availability due to Covid quarantines. With consent from parents and students, the interviews were videotaped and later transcribed for coding. Several themes emerged "self-paced," "responsibility," and " satisfaction." The participants continually mentioned taking responsibility for watching the videos. The self-paced theme was evident as Participant N stated that the videos could be watched repeatedly until the content is understood. All three participants also emphasized self-paced learning by rewinding the video, taking notes, and going back to the lesson areas not well understood.

Furthermore, satisfaction for flipped mastery emerged from the interviews. For example, one participant's response to the interview question, "If you had to sum up your flipped classroom experience in one word, what would it be?": "It was exciting and helped me so much." And participants response to continuing with the flipped mastery question, " Happy about it!" "I liked it," and "I would be happy." However, there were challenges voiced in the interviews, such as "forgetting to watch the videos," "procrastinating in watching the videos," and "sooner posting of the videos."

Discussion and Summary

The study fills the gaps in limited research on flipped mastery in secondary mathematics. The study purports to add to previous studies on flipped mastery. The findings summary can be grouped according to the three research questions posed in the study to determine the flipped mastery model's effects on student satisfaction, engagement, and learning achievement.

The results for research question one indicated student learning and growth took place during the traditional mode of teaching on the Linear Functions Unit and the flipped mastery model on the Quadratic Functions Unit. There was a statistically significant difference between the means for both teaching methods with p=0.005. Hence, student learning occurred from the beginning of the unit lesson to the end.

However, there were no significant differences between the weekly quizzes and the unit tests for traditional and flipped: mean quiz scores for traditional (M=8.2679, SD= 1.42263) and flipped mastery (M= 7.8333, SD=1.93259; t(40)=.830, p=.412 (p > 0.05). The unit posttest scores for the traditional and flipped mastery teaching approaches t(40)=.939, p=.353 (i.e p>.05). Hence, the study failed to reject the null hypothesis H_0 (Null): Therefore, there are no significant differences between flipped-mastery and traditional direct instruction in students' learning achievement.

Contrary to previous studies from Bhagat and et al. (2016), Talan and Gulsecen (2019), and Orhan (2019), there were no positive effects on students' learning achievements using the flipped mastery model. The study results support Vang (2017) and Clark (2015) studies indicating no statistical difference regarding academic results between flipped and traditional teaching methods.

Research question two summarizes student engagement between the flipped mastery model and the traditional learning method. The results from the qualitative analysis include student observations and interviews, and researcher journal entries. From the observational protocol form, student engagement mean for flipped mastery (M= 2.6, SD= .1640) is higher than the traditional (M= 2.4, SD=.51640). However, there is no statistically significant difference t(18)=-.64, p=.532 (p > 0.05) between traditional and flipped mastery for student engagement.

On the contrary, the student interviews and recorded journal entries indicated more student engagement with the flipped mastery teaching method. As documented in the researcher's journal, the teacher circulated more in the classroom and spoke to every student to assess their content understanding. Moreover, the teacher integrated more hands-on activities rather than lecturing in front of the class to enhance student learning. Furthermore, from student interviews, themes of "increased student engagement," "quality instruction," "one-to-one interaction with the teacher," and "collaboration" emerged. However, due to Covid-19, class group activities were limited; thus, more data collection is needed to verify the significant difference between traditional and flipped mastery for student engagement.

Finally, the research question three results indicated from the SPIQ pre-post survey, though the student satisfaction mean for traditional (M= 13.2500, SD= 2.359) is slightly higher than the flipped mastery (M= 13.0000, SD=3.34664), comparison of the mean differences was t(39)=-.275, p=.785 (p > 0.05). Hence, failing to reject the null hypothesis H_0 (Null): There are no significant differences between flipped-mastery and traditional direct instruction in students' satisfaction. Both methods had positive student satisfaction.

From student interviews, themes of "satisfaction," "self-paced," "student responsibility" emerged. Overall, the interview participants were satisfied with the flipped classroom. They preferred flipped mastery over traditional teaching methods. One reason is more focused at home, learning new math content, and rewinding the videos to understand. The participants repeatedly stated that "forgetting to watch the flipped videos" was a challenge. It was the student's responsibility to watch the videos to prepare for class the following day. Thus, when the students came into class, the video's content was reinforced by class activity and problem-solving questions, improved quality instruction, and better-used class time as reflected in Clark's (2015) study of 42 ninth-graders enrolled in Algebra 1 course.

There appears to be a contradiction of quantitative and qualitative data analysis to determine student satisfaction for the flipped mastery method. One element that could have attributed to the skewness of irregularity in the teaching methods is the Covid-19 factor. For instance, by the second week of flipped mastery teaching intervention (sixth week of being at school), many students in the class had been intermittently in and out of the virtual classroom due to Covid-19. Some students voiced fatigue from online distance learning; thus, watching flipped videos wasn't easy or palatable. Therefore, as Zhai, Gu, Liu, Liang, & Tsai (2017) suggested from their study that the learners' prior learning experience is a far more significant indicator for predicting their satisfaction and favorable perceptions.

Limitations and Transferability

One of the limitations was the duration of the study. It was limited to eight weeks. Future studies should extend periods on teaching methods for more concrete and substantial data collection, such as a semester for traditional and flipped mastery. Another critical area is the study had a small sample size of twenty-one students due to the teacher's regular Algebra II class schedule. To reduce sampling error, the larger the sample size, the more the participants will be representative of the entire population, providing generalizability (Creswell & Gutetterman, 2019). Thus, the study's small sample size affected the study's conclusion to determine the effects of the flipped mastery model on student satisfaction, engagement, and learning achievement for other secondary mathematics classrooms. Therefore, generalizability couldn't be made from this study.

Furthermore, students experiencing the flipped-mastery model were fatigued from online distance learning due to Covid-19 quarantines. Therefore, the participants' responses could have been affected by the SPIQ pre-post surveys. Also, participants were not consistently in class for the flipped mastery intervention due to Covid-19. Therefore, data collection and student interviews were intermittent and not as extensive due to a lack of research time imposed by Covid-19. Moreover, the researcher was a participant-observer, which impacted the observational protocol and student interviews. During the interviews, the researcher had to inform the students that the interviewer was not the teacher but the researcher trying to collect data on their perceptions of student satisfaction and engagement. The students interviewed were a little cautious in their responses not to provide negative feedback or offend the teacher. Furthermore, during observations, playing dual roles as a researcher and the teacher, student engagement and satisfaction observations were limited while simultaneously teaching and observing. Finally, the small number of interviews limited comprehensive data collection, thus impacting this study's conclusion's transferability to the secondary mathematics classroom.

Implications and Recommendations

With the rapid advancement of technology and educators wanting alternative strategies and teaching methods to empower students effectively to engage in the teaching-learning process (Talan & Gulsecen, 2019), the results and findings of this mixed-methods study have multiple implications. This study's research implications include teacher and professionals' practices for the future of mathematics education.

From this study's interview and observation results, teacher practices are affected by increased student engagement and satisfaction, thus emphasizing differentiated instruction. For example, student interviews revealed that the students felt that they could better focus on new math concepts at home than at school during the flipped-mastery approach. The students had ownership of their learning. Moreover, the students shared they had accessibility to the math material at the convenience of the student. They could repeatedly rewind the flipped videos for content understanding. The interview participants expressed positive attitudes toward the flipped mastery model because it was self-paced and differentiated learning attending to their individual learning needs. Echoing Bergman (2017), "flipped-mastery learning is a way to manage a true mastery system and provide individual feedback for students, give them the challenges they need, differentiate for each student, and provide appropriate feedback for all students" (p. 45).

The study's results on the implications for professionals' practice endorsed the National Council of Teachers of Mathematics (NTCM) student-centered mathematics instruction environment. In this study, from extensive researcher journal entries, the teacher indicated that student engagement increased; thus, highlighting the benefits of hands-on activities and collaborated problem-based learning (CPBL). Aforementioned, the nation's current performance and achievement in mathematics are ranked 30th out of 64th industrialized countries, possibly attributed to passive learning experiences in the classroom; thus, effective mathematics instruction emphasizes student-centered learning strategies (Clark, 2015).

Finally, the lack of significant changes may be due to Covid-19, a small sample size, student interviews, and a single teacher who is the researcher as well. Potential action research implementation would be to expand the sample size, increase the number of student interviews, include focus group interviews, and interview teachers' perceptions of student engagement and teacher satisfaction. Moreover, the teacher's experience with the flipped mastery approach would be considered in future studies to improve the flipped mastery delivery with shorter flipped videos and restructured hands-on activity to accommodate Covid-19. “The flipped classroom is most effective when used on particular topics and can be used at all times, but the delivery method does not provide significantly different results at all times” (Schwankle, 2013, p. 53). Future implementations would expand and explore more secondary mathematics classrooms with different school settings and community among students with various academic abilities to determine the effects of flipped mastery on student engagement, satisfaction, and learning achievements.

Conclusion

Although there are many studies on the flipped classroom, they are currently gaps and limited research conducted on flipped-mastery models and few mixed-methods studies to determine the effects on student satisfaction, engagement, and learning achievement in the secondary mathematics classroom. This study addressed the research questions using pre-posttests, quizzes, pre-post survey (SPIQ), student interviews, and student engagement observations throughout the eight-week study.

The study showed student learning and growth for traditional and flipped mastery methods, as evidenced with siginifcance difference in the pre-posttest unit tests for the Linear Functions Unit and Quadratic Functions Unit. Contrary to previous studies on the flipped method, when comparing the posttest unit tests for traditional and flipped-mastery, there was no significant difference between the flipped mastery model and the traditional face-to-face learning method in students’ academic achievement scores. The lack of significant difference may be due to Covid-19, a small sample size (N=21), and a single classroom with a single teacher.

This mixed-method study explored improvements in student engagement and satisfaction. Through pre-post surveys (SPIQ) to determine the effects of flipped on student engagement, the frequency for student engagement for flipped mastery was higher than the traditional, indicating student engagement is more likely to take place in a flipped mastery classroom. However, comparing the difference of the means, using the independent-sample *t* test, there was no significant difference in student engagement and student satisfaction. Student engagement and satisfaction were seen more in the flipped-mastery from student interviews and comprehensive researcher journal entries than the traditional method. Therefore, the lack of significance of results may be influenced by Covid-19, the small sample size, and the study duration of eight weeks.

This study opened for further explorations into teacher satisfaction and other secondary mathematics classrooms with various academic abilities to determine the effects of flipped-mastery on engagement and satisfaction. Future implementations of the study to increase sample size and student interviews and include teachers' interviews and focus group interviews would prove useful. Therefore, the flipped mastery model in the secondary mathematics classroom can be effective on student satisfaction, engagement, and learning achievement.

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APPENDICES

Appendix A

Student Perception of Instruction Questionnaire (SPIQ) – Pre-Survey (Traditional Method)

Statements **In my Algebra II class…**		Strongly Agree	Agree	Not Agree or Disagree	Disagree	Strongly Disagree
Q1	During this last unit, I communicated a lot with other students.					
Q2	During the last unit, I talked with my teacher.	Every class	3x a week	2x a week	1x a week	Never
Q3	During the last unit, I have had to work hard in this course.					
Q4	I have learned a lot in this course so far.					
Q5	The assignments and projects I have worked on in this course deal with real-life applications and information.					
Q6	The availability of course materials, communication, and assessment tools helped me improve my learning.					
Q7	During the last unit, I have applied my out-of-class experiences and learned from practical applications.					
Q8	During the last unit, I have explored my strategies for learning.					
Q9	During the last unit, I have needed technical assistance for this class.					
Q10	During the last unit, availability and access to technical support and resources have helped me improve my learning.					
Q11	I would choose to take another course like this one.					
Q12	I like the daily routine in this class.					
Q13	Which of the following has helped you improve your learning experience during the last unit? (you may pick more than one) __a. Availability and access to online content and course materials __b. Enhanced communication using email, online discussion, assignment Google Classroom __c. Online testing and evaluation __d. Evaluation, feedback using the quiz, and grade tools. __e. Ease of use of the Web environment __f. In-class group discussion __g. Group collaboration __h. Working on the assignments and classwork by myself					
Q14	What other aspects of this course have helped improve your learning for the past four weeks?					
Q15	Please provide suggestions for how to improve this course or any other general comments about the course.					
Q16	Did the traditional classroom meet your expectations? Why or why not? What could be changed to make it better?					

Note. Pending permission and Adapted from Araño-Ocuaman, J. (2010). *Differences in student knowledge and perception of learning experiences among non-traditional students in blended and face-to-face classroom delivery*.

Note: Numerous attempts via emails and phone calls to Dean of Graduate Studies at the University of Missouri-St. Louis

Appendix B

Student Perception of Instruction Questionnaire (SPIQ) – Post-Survey (Flipped-Mastery Model)

Statements **In my Algebra II class…**		Strongly Agree	Agree	Not Agree or Disagree	Disagree	Strongly Disagree
Q1	During this last unit, I communicated a lot with other students.					
Q2	During the last unit, I talked with my teacher.	Every class	3x a week	2x a week	1x a week	Never
Q3	During the last unit, I have had to work hard in this course.					
Q4	I have learned a lot in this course so far.					
Q5	The assignments and projects I have worked on in this course deal with real-life applications and information.					
Q6	The availability of course materials, communication, and assessment tools helped me improve my learning.					
Q7	During the last unit, I have applied my out-of-class experiences and learned from practical applications.					
Q8	During the last unit, I have explored my strategies for learning.					
Q9	During the last unit, I have needed technical assistance for this class.					
Q10	During the last unit, availability and access to technical support and resources have helped me improve my learning.					
Q11	I would choose to take another course like this one.					
Q12	I like the daily routine in this class.					
Q13	Which of the following has helped you improve your learning experience during the last unit? (you may pick more than one) __a. Availability and access to online content and course materials __b. Enhanced communication using email, online discussion, assignment Google Classroom __c. Online testing and evaluation __d. Evaluation, feedback using the quiz, and grade tools. __e. Ease of use of the Web environment __f. In-class group discussion __g. Group collaboration __h. Working on the assignments and classwork by myself					
Q14	What other aspects of this course have helped improve your learning for the past four weeks?					
Q15	Please provide suggestions for how to improve this course or any other general comments about the course.					
Q16	Did the Flipped-Mastery classroom meet your expectations? If so, did you like the opportunity? Why or why not? What could be changed to make it better?					

Note. Pending permission and Adapted from Araño-Ocuaman, J. (2010). *Differences in student knowledge and perception of learning experiences among non-traditional students in blended and face-to-face classroom delivery*.

Note: Numerous attempts via emails and phone calls to Dean of Graduate Studies at the University of Missouri-St. Louis

Appendix C

Student Interview Protocol

1. What do you feel are the benefits of learning in a flipped math classroom?

2. What, if any, are the challenges you face from learning in a flipped classroom?

3. What are some of the activities you do in the classroom?

4. If I was a friend of yours taking this course next year, what would you tell me to expect from the class in general?

5. How do feel you are supported in a flipped classroom if you don’t understand your work?

6. What do you do when you are having a hard time understanding a concept?

7. How do you feel about the videos you watch at home?

8. What do you do with the notes you created while watching the flipped videos at home?

9. How do you take responsibility for your learning in a flipped classroom model?

10. Compared to traditional math classes, do you find the learning in the classroom less challenging, more challenging, or about the same? Why?

11. What were your thoughts when you first herad about the flipped classroom?

12. Did you experience any problems with the flipped classroom?

13. How would you describe your role as a student in the flipped classroom?

14. What did you like most about the flipped classroom? Least?

15. How did the flipped classroom impact your learning?

16. Do you have any suggestions for improvements?

17. If you learned that your teacher decided to continue the flipped classroom, what would your reaction be?

18. If you had to sum up your flipped classroom experience in one word, what would it be?

19. Have you had a flipped classroom prior to this research study?

20. If you had a choice between the traditional classroom and flipped classroom, which one do you prefer?

Note: Adapted with permission from Walton, D. F. (2019). *The flipped-mastery learning phenomenon: A case study of a sixth-grade mathematics classroom*, and Clark, K.R. (2015). The effects of the flipped model of instruction on student engagement and performance in the secondary mathematics classroom. *The Journal of Educators Online, 12*(1)

Appendix D

Observation Protocol

1. When observed, how were the students engaged in the discussion?

- [ ] A. Small groups/pairs
- [ ] B. Whole group

---

2. When observed, how were the students engaged throughout the lesson? Select all that apply.

- [ ] A. Problem-solving/investigating
- [ ] B. Taking Notes or reading mathematics
- [ ] C. Working with manipulatives
- [ ] D. Working collaboratively
- [ ] E. Playing a game to review skills
- [ ] F. Crafting an activity
- [ ] G. Using technology to practice concepts
- [ ] H. Communicating justifications

---

3. When observed, how were the students interacting with their peers and teacher?

- [ ] A. The students were cooperatively working with their peers and teacher
- [ ] B. There was limited interaction between the students and their peers/teacher

---

4. When observed, how well were the students attentive in class?

Never			Always
1	2	3	4

---

5. When observed, how well were the students actively participating in the learning process?

Never			Always
1	2	3	4

Note: Adapted with permission from Walton, D. F. (2019). *The flipped-mastery learning phenomenon: A case study of a sixth-grade mathematics classroom*.

Appendix E

Consent Form

Introduction:
My name is Ziniah Beasley. I am a graduate student at Southern Adventist University. I am conducting a research study on the effects of the flipped-mastery teaching model on student satisfaction, engagement, and learning achievement (academic performance). The study is to provide better teaching practices in the classroom for students to reach optimal learning. I am completing this research as part of my master's program. Your participation is entirely voluntary. I am seeking your consent to involve you and your information in this study. Reasons you might ***not*** want to participate in the study include trying new methods and the effect on your grade. Reasons you might want to participate in the study include possible improvement in learning and retaining information and increasing your academic performance. An alternative to this study is simply not participating. I am here to address your questions or concerns during the informed consent process.

PRIVATE INFORMATION
Certain private information may be collected about you in this study. I will make the following effort to protect your private information, including assigning numbers to each participant of the study to ensure confidentiality and privacy. All documents collected via audio-tape or videotape, journal, and observational notes will be secured in a safe place. Even with this effort, there is a chance that your private information may be accidentally released. The chance is small but does exist. You should consider this when deciding whether to participate.

Activities:
If you participate in this research, you will be asked to:

1. Take pre-post questionnaire surveys at the beginning and end of the eight-week study.
2. Take pre-post unit tests, and mastery concept quizzes for both traditional teaching method and flipped mastery method.
3. Take part in-class activities and lessons planned for the entire study.

Eligibility:
You are eligible to participate in this research if you:
1. enrolled in Algebra II class with Mrs. Beasley at Collegedale Academy 2020-21

You are not eligible to participate in this research if you:
1. not enrolled in Algebra II class with Mrs. Beasley at Collegedale Academy 2020-21

I hope to include 75-80 people in this research.

Risks:
There are minimal risks in this study. Some possible risks include anxiety from trying new teaching methods.
To decrease the impact of these risks, you can: skip any question and or stop participation at any time.

Benefits:
If you decide to participate, there are no direct benefits to you.

The potential benefits to others are: in the field of mathematics to improve teaching practices.
Confidentiality:
The information you provide will be kept confidential to the extent allowable by law. Some steps I will take to keep your identity confidential are: number to identify you
The people who will have access to your information are: myself, my master's program chair or advisor. The Institutional Review Board may also review my research and view your information.
I will secure your information with these steps: lock all information in a filing cabinet, and/or locking the computer file with a password
I will keep your data for seven years. Then, I will delete the electronic data and destroy paper data.
Contact Information:
If you have questions for me, you can contact me at: ziniahb@southern.edu, 423-598-8392. My master's program research study chair's name is Bonnie Eder. She works at Southern Adventist University and is supervising me on the research. You can contact at: beder@southern.edu, phone # : 423-236-2759
If you contact us you will be giving us information like your phone number or email address. This information will not be linked to your responses if the study is anonymous.
If you have questions about your rights in the research, or if a problem has occurred, or if you are injured during your participation, please contact the Institutional Review Board at: irb@southern.edu or 423-236-2285.

Voluntary Participation:
Your participation is voluntary. If you decide not to participate, or if you stop participation after you start, there will be no penalty to you. You will not lose any benefit to which you are otherwise entitled.
Future Research
Any information or specimens collected from you during this research may **not** be used for other research in the future, even if identifying information is removed.
Dual Role:
This research is being conducted in my role as a Southern Adventist University master's student but I also hold a role as a teacher at Collegedale Academy.
Audiotaping:
I would like to use a voice recorder to record your responses. You can still participate if you do not wish to be recorded.
Please sign here if I can record you: ______________________
Videotaping:
I would like to use a video camera to record your actions. Because this tape will show who you are, these extra steps will be taken: tapes on Zoom or videotaped will be secured in filing cabinets or protected on computer by locked password files.
You can still participate if you do not wish to be recorded.
Please sign here if you will allow me to videotape you: ______________________
Experimental Intervention or Treatment:
This treatment or intervention has not been tested before. The purpose of this study is to test it. You should know that there are other treatments or available to you that have been tested before. Some benefits to these are: possible increase in student satisfaction and engagement.

If you are interested in these interventions or treatments instead, please let me know.
Mandated Reporting:
I am required to report suspicion of child or elderly abuse to: Tennessee Department of Children's Services or Adult Protective Services.
If I am concerned you might hurt yourself, I must get help for you. I will: call suicide hotline, police, and family member.
If I am concerned you might hurt someone else, I will: contact police

Additional Costs:
There are no anticipated financial costs to you.
Termination of Participation:
I may stop your participation, even if you did not ask me to if signs of distress that would lead researcher to stop participation
If you decide to stop participation, you may do so by: notifying me of your intent. If so, I will not use the information I gathered from you. Your removal from the study, if it does occur, may not be immediate. Sometimes there could be harmful consequences. If this is the case, I will help you to safely leave the study. It will be important for you to follow my instructions.
New Findings:
Sometimes during a study we learn new information. This information may come from our research or from other researchers. If new information might relate to your willingness to participate, I will give you that information as soon as possible.

Signature:
A signature indicates your understanding of this consent form. You will be given a copy of the form for your information.

Participant Signature	Printed Name	Date
______________________	______________________	____________
Parent/Guardian Signature	Printed Name	Date
______________________	______________________	____________
Minors Assent Signature (when appropriate)	Printed Name	Date
______________________	______________________	____________
Researcher Signature	Printed Name	Date
______________________	______________________	____________

Note: Adapted from Southern Adventist University consent form

Appendix F

Informed Assent form

You are invited to participate in this research study (project). The study is about the flipped-mastery classroom teaching method and its effect on student satisfaction, engagement, and learning performance (academic achievement). A permission letter has been sent to your parents/guardians detailing the study. If you have further questions or concerns about this study, please inform the researcher or teacher. The study is voluntary, so you can choose to take part in the research or not.

If you want to take part in this study, please complete the form:

I,________________________________, have volunteered to be part of this study (projejct).

I am aware that my parents/guardians have permitted me to participate in this study about using the flipped-mastery classroom teaching method under the direction of Ziniah Beasley, a graduate student at Southern Adventist University. Since this study is voluntary, I may stop my participation in this research at any time. If I choose not to participate or withdraw from the study, it will not, in any manner, affect my grade in the class.

________________________________ __________________

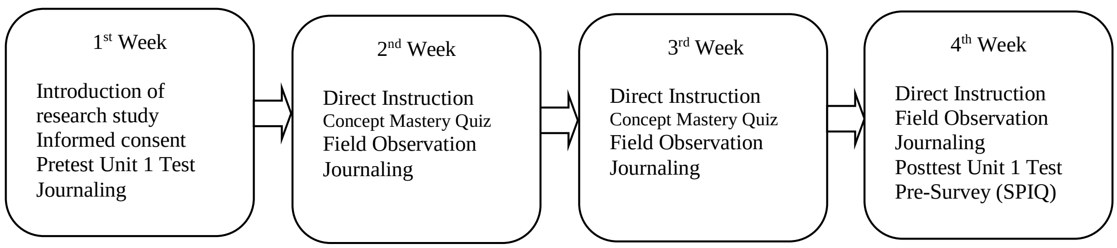
Signature Date

Note: Adapted with permission from Walton, D. F. (2019). *The flipped-mastery learning phenomenon: A case study of a sixth-grade mathematics classroom*.

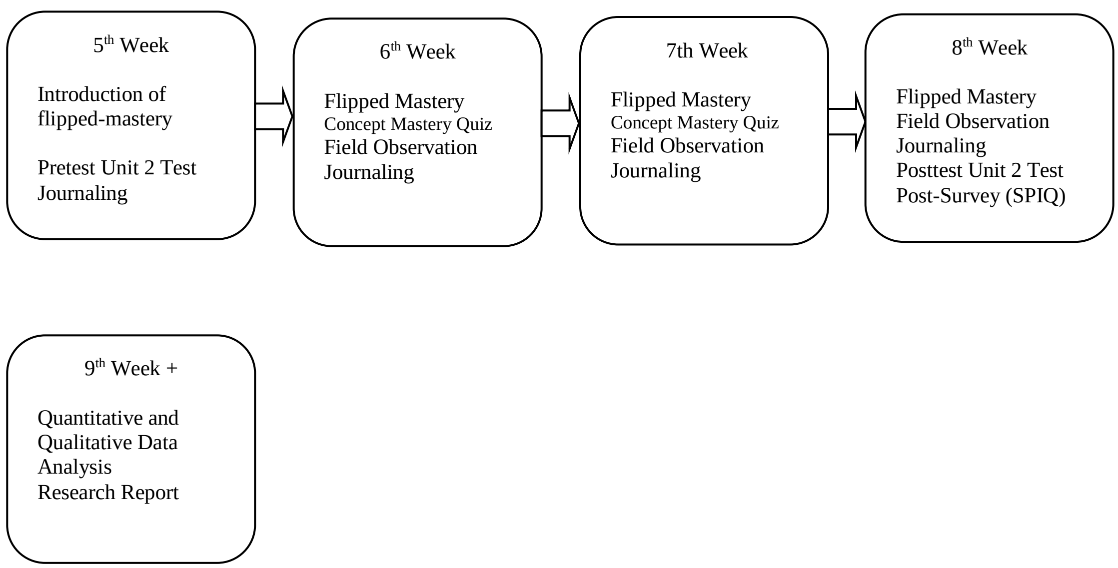
Appendix G

Research Study Timeline

Traditional Direct Instruction Method (1st 4 weeks): August 11, 2020 - September 4, 2020



Flipped-Mastery Model Method (2nd 4 weeks): September 7, 2020 – October 5, 2020



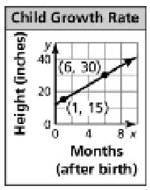
Appendix H

Pretests and Posttests Unit Test for Traditional Instruction Linear Function Unit

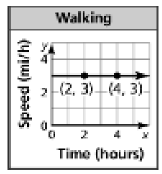
Name____ Date__________

Chapter 1 **Test A**

Write an equation of the line and interpret the slope.

1.


2.


3.


Solve the system. Check your solution, if possible.

4. $3x - 3y + z = 10$
$3x + 2y - 3z = -2$
$-3x + z = -2$

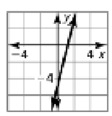
5. $3x + 5y + 4z = 13$
$5x + 2y + 3z = -9$
$6x + 3y + 4z = -8$

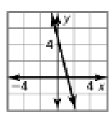
6. $-x - y - 2z = 9$
$-2x + 2y - 2z = -8$
$x - y + z = 5$

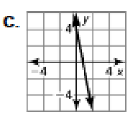
7. $x + y + z = 9$
$2x - 3y + 4z = 7$
$x - 4y + 3z = -2$

Match the transformation of $f(x) = x$ with its graph. Then write a rule for g.

8. $g(x) = -4f(x) + 5$ **9.** $g(x) = 4f(x) - 5$ **10.** $g(x) = -5f(x) + 4$

A.


B.


C.


11. A local grocery store makes a 9-pound mixture of trail mix. The trail mix contains raisins, sunflower seeds, and chocolate-covered peanuts. The raisins cost $2 per pound, the sunflower seeds cost $1 per pound, and the chocolate-covered peanuts cost $1.50 per pound. The mixture calls for twice as many raisins as sunflower seeds. The total cost of the mixture is $14.50. How much of each ingredient did the store use?

Answers

1. ____________

2. ____________

3. ____________

4. ____________

5. ____________

6. ____________

7. ____________

8. ____________

9. ____________

10. ____________

11. ____________

Appendix I

Pretests and Posttests Unit Test for Flipped Mastery Instruction Quadratic Function Unit

Name____ Date__________

Chapter 2 **Test A**

1. A parabola has an axis of symmetry $x = -2$ and passes through the point $(-5, 6)$. Find another point that lies on the graph of the parabola.

2. Let the graph of g be a vertical stretch by a factor of 4 and a reflection in the x-axis of the graph of $f(x) = x^2 - 3$. Write a rule for g.

3. Let the graph of g be a translation 1 unit down and 3 units left of the graph of $f(x) = |x - 4| + 2$. Write a rule for g.

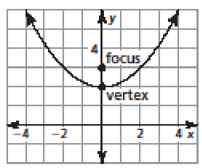
4. Identify the focus, directrix, and axis of symmetry of $f(x) = \frac{1}{16}x^2$.

5. Explain why a quadratic function models the data. Then use a linear system to find the model.

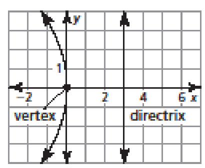
x	1	2	3	4	5
$f(x)$	−2	2	10	22	38

Write the equation of the parabola.

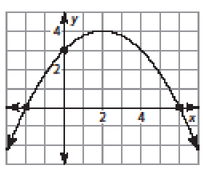
6.



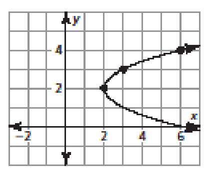
7.



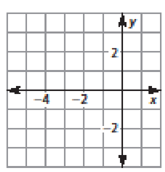
8.



9.



10. Identify the focus, directrix, and axis of symmetry of $x = -\frac{1}{2}y^2$. Then graph the equation.



Answers

1. ____________
2. ____________
3. ____________
4. ____________
____
____
5. ____________
____
____
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
____
____
See left.

Appendix J

Weekly Quiz sample for Traditional Direct Instruction Linear Function Unit

Name: ____________________ **Class:** ________________ **Date:** ________ **ID: A**

Algebra 2 Sec Concept Skills 1 -4 (secs 1.1-1.4) practice

Short Answer

Skill 4 (sec 1.4)
Solve the system.

1. $x - 6y + 4z = -12$
   $x + y - 4z = 12$
   $2x + 2y + 5z = -15$

2. $5r - 5s + 4t = 15$
   $3r + 5s - 6t = 7$
   $-r + 5s - 5t = 20$

3. $4r - 8s + 4t = 5$
   $-6r + 6s - 8t = 1$
   $3r + 3s + 6t = -9$

Skill 3 (sec 1.3) Modeling Linear Equations

4. The table shows how many miles y you are from home after x hours. What type of function models the situation the best? Estimate how many miles you are from home after 5.5 hours. Justify your solution.

Time (hours), x	Distance (miles), y
1	55
2	100
3	145
4	190
5	145
6	100

a) graph
b) type of function (linear, quadratic, absolute value, etc)

c) write an equation if it is linear

d) How many miles in hours from home?

Appendix K

Weekly Quiz sample for Flipped Mastery Instruction Quadratic Function Unit

Name: ______________________ **Class:** _________________ **Date:** _________ **ID: A**

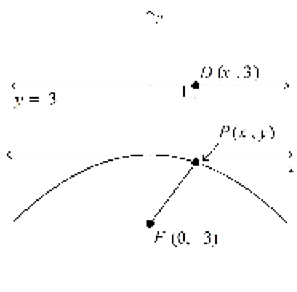
Concept Qquiz Algebra 2 Skill 5-8, (secs 2.0-2.3) USE SEPARATE PAPER TO SHOW WORK!

Short Answer

Skill 8 Focus of Parabola (sec 2.3)

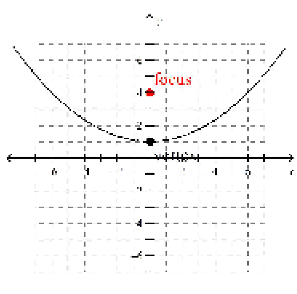
Use the Distance Formula to write an equation of the parabola.

1.



 # 2- 5 Write an equation of the parabola shown. Do <u>not</u> use distance formula

2.



Appendix L

Table 12

SPIQ Pre-Survey Results for Questions one – twelve for Traditional Method

	N					Std.
	Valid	Missing	Mean	Median	Mode	Deviation
1. During this last unit, I communicated a lot with other students	20	1	3.85	4.00	4[a]	1.182
2. During the last unit, I talked with my teacher	19	2	2.89	3.00	2	1.197
3. During the last unit, I have had to work hard in this course	19	2	4.11	4.00	4	.658
4. I have learned a lot in this course so far	20	1	3.90	4.00	4	.912
5. The assignments and projects I have worked on in this course deal with real life applications and information	20	1	2.85	3.00	3	.933
6. The availability of course materials, communications, and assessment tools helped me improve my learning	20	1	3.55	4.00	4	.826
7. During the last unit, I have applied my out-of-class experiences and learned from practical applications	20	1	2.70	3.00	3	1.081

8. During the last unit, I have explored my own strategies for learning	19	2	3.68	4.00	4	.671
9. During the last unit, I have needed technical assistance for this class	20	1	3.25	3.50	4	1.164
10. During the last unit, availability and access to technical support and resources has helped me improve my learning	20	1	3.45	3.00	3	.887
11. I would choose to take another course like this one	20	1	2.45	2.50	3	.999
12. I like the daily routine in this class	20	1	3.35	3.00	3	.875

Appendix M

Table 13

SPIQ Post-Survey Results for Questions one – twelve for Flipped-Mastery Method

	N					Std.
	Valid	Missing	Mean	Median	Mode	Deviation
1. During this last unit, I communicated a lot with other students	20	22	3.95	4.00	5	1.099
2. During the last unit, I talked with my teacher	20	22	3.20	3.00	4	1.152
3. During the last unit, I have had to work hard in this course	21	21	4.33	4.00	4	.658
4. I have learned a lot in this course so far	21	21	3.33	3.00	4	1.017
5. The assignments and projects I have worked on in this course deal with real life applications and information	21	21	2.81	3.00	3	1.030
6. The availability of course materials, communications, and assessment tools helped me improve my learning	21	21	3.43	4.00	4	.926

7. During the last unit, I have applied my out-of-class experiences and learned from practical applications	21	21	2.38	2.00	2	.973
8. During the last unit, I have explored my own strategies for learning	20	22	3.40	4.00	4	1.353
9. During the last unit, I have needed technical assistance for this class	21	21	3.29	3.00	2	1.189
10. During the last unit, availability and access to technical support and resources has helped me improve my learning	21	21	3.33	3.00	3	.856
11. I would choose to take another course like this one	21	21	2.90	3.00	3	1.411
12. I like the daily routine in this class	21	21	3.33	3.00	3	.966