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Benefits of the Modern Classroom Project in High School Mathematics

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Benefits of the Modern Classroom Project in High School Mathematics

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DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Education
at the University of Kentucky

By
Micah Josiah Smith
Lexington, Kentucky

Director: Dr. Molly Fisher, Professor of STEM Education
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2022

ABSTRACT OF DISSERTATION

Benefits of the Modern Classroom Project in High School Mathematics

Previous research has shown that mathematical self-efficacy is positively correlated with mathematical achievement. However, in a high school classroom setting, teachers' effectiveness varies based on experience, education, and how they incorporate certain pedagogical practices. The Modern Classroom Project was designed to have teachers integrate self-paced learning, mastery-based learning, metacognition, and blended instructions all within one classroom; with an emphasis placed on allowing students the opportunity to understand a particular skill before attempting the next skill. Discovering what components of the Modern Classroom Project enhances student's self-efficacy score, and mathematical achievement was the focus of the study.

This explanatory sequential mixed-methods design was conducted in a high school geometry course with the research participants being in 8^{th} grade. There were two stages of research for this study. The first phase was assessing students' self-efficacy and mathematical achievement skills. Upon reviewing those scores phase two consisted of interviewing students who fell into one of the four categories high performance/high self-efficacy (High P/High SE), low performance/low self-efficacy (Low P/Low SE), high performance/low self-efficacy (High P/Low SE), or low performance/high self-efficacy (Low P/High SE). Upon the completion of the interviews, they were analyzed by the researcher and codes were established to determine what factors could contribute to a higher self-efficacy and mathematical achievement score. Those aspects included self-paced learning, collaboration, academic feedback, and goal setting. This quantitative and qualitative study found that there was an increase in students' mathematical achievement and self-efficacy scores for students who participated in the Modern Classroom Project. The implications of these results could help high school teachers identify practices that allow students to enhance their learning and feel more confident in their ability.
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KEYWORDS: Modern Classroom Project, Social Cognitive Theory, Metacognition, Self-paced learning, mastery-based learning, and blended instructions

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09/27/22

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Benefits of the Modern Classroom Project in High School Mathematics

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DEDICATION

I dedicate this work to my wife Katie who helped me accomplish this feat by encouraging me and supporting this process. Her patience and understanding of the time commitment made this task worth it. I also dedicate this work to the students who helped me understand this pedagogical practice. Thank you for participating and I hope it helped you know more about how you learn.

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CHAPTER I: INTRODUCTION

In today's school system, teachers are challenged to effectively teach a wide variety of students, some of whom come from backgrounds that are culturally and linguistically diverse or in which parental expectations and community norms may be at odds with the expectations of schools. In fact, Yamamoto and Holloway (2010) found in their study that minority groups or low-SES parents distrust teachers' feedback when evaluating their children's academic performance. In particular, they found that parents' sense of self-efficacy in supporting their children's schooling is conditioned by available resources and sources of support. Their main argument is that parental expectations, especially among the Latino population, do not necessarily translate to academic achievement. The main reason provided is the language barrier with the study suggesting that ethnical background and immigrant status can diminish parental expectations. Teachers also have an increasing number of students who need to develop technical as well as soft skills to be prepared for higher education or the work force. Dharmarajan et al. (2012) demonstrate that soft skills are essential for students because they provide them the opportunity to advocate for themselves and communicate in an efficient manner. They also advocate that teachers need to emphasize that every student needs to acquire adequate skills beyond academic or technical knowledge; with their main argument being that a school that emphasizes the development of soft skills provides the student with a new understanding of the relationship between education, academic curriculum, and employment. Even though this might seem daunting to most educators, teachers do have the opportunity to engage students in a wide variety of pedagogical practices to improve students' mastery of content and development of soft skills. Some suggestions could be blended learning, independent projects, interest centers or interest groups, tiered assignments, flexible grouping,

learning centers, varying questions, mentorships, anchoring activities, and learning contracts. While these concepts are not new to educators the method in which they are delivered varies based on a teachers' outlook and knowledge. Leinwand (2014) and the National Council of Teachers of Mathematics (2000) argue that there are eight practices that describe how a mathematics teacher can create a learning environment that is effective in promoting acquisition of knowledge and they are as follows.

1. Establishing mathematics goals to focus learning.
2. Implementing tasks that promote reasoning and problem solving.
3. Using and connecting mathematical representations.
4. Facilitating meaningful mathematical discourse.
5. Posing purposeful questions.
6. Building procedural fluency from conceptual understanding.
7. Supporting productive struggle in learning mathematics.
8. Eliciting and using evidence of student thinking.

Leinwand (2014) continues with his discussion that teachers often focus on the teaching and learning of procedures without any connection to meaning, understanding, or the applications of those procedures. His core belief is that the following five concepts: access and equity, curriculum, tools and technology, assessment, and professionalism can guide teachers to construct lessons that are engaging and relevant. Finally, he concludes that educators need to develop effective teaching strategies that ensure that all students learn mathematics at high levels while also taking into consideration the eight mathematical practices.

Nuri (2019) reinforces the idea that the National Mathematics Teachers Council (NCTM) made a conscience effort to reform mathematical practices to improve student achievement in mathematics. But he goes a step further and suggests that teachers need to provide students with the opportunity to explore and practice mathematics at a deeper understanding by developing effective blended learning techniques. Nuri also advocates that this process is important because "conceptual understanding cannot be transferred by the teacher to students, but must be built and formed by students under the guidance of the teacher, and on the basis of prior knowledge and experience" (p.1). In terms of how to create this learning atmosphere the author provides the following proposition:

1. Expand the space and opportunities available for learning.

2. Supporting course management activities (e.g. communication, assessment of submission, marking, and feedback).

3. Support the provision of information and resources for students.

4. Involve and motivate students through interactivity and collaboration.

The author recommends that through these four practices blended learning begins to operate on the premise that students will learn concepts by being provided multiple methods in which to learn. Finally, he demonstrates that blending learning if successfully implemented not only impacts students' achievement but also improves their attitude towards learning.

Another organization that offers insights into how a mathematical classroom should be organized so that students receive a high-quality of education is the Common Core. The Common Core State Standards for Mathematics (CCSSM) demonstrate that a teacher should

utilize the following practices to help students develop the necessary skills to master mathematical concepts.

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Jones and Texas (2013) argue that these standards ultimately allow the students to engage in mathematical content by helping them develop procedural fluency and conceptual understanding. They also discuss that for students to master these eight practices, the teacher must understand that students learn differently and not in the same time frame. Therefore, they suggest that teachers need to create lessons that allow students the opportunity to explore these practices in real world situations while also allowing them the time to reflect on their learning.

With these concepts in mind, the issue that mathematics educators face is how to develop a classroom that utilizes these diverse practices while also teaching self-efficacy and mastery of content. Marzano et al. (2001) argue that metacognitive approaches to teaching strive to improve students' general knowledge of cognition as well as their awareness of their own thought processes. Their main argument is that certain teaching practices that emphasize

metacognition will have a variety of important impacts in enhancing student learning. In particular, the authors demonstrate that modeling, scaffolding, coaching, cooperative learning, and whole-class and small-group discussion can all be used effectively in teaching students' metacognitive skills. Furthermore, Marzano (2007) provides three frameworks that he believes indicate that a school or teacher is effective in enhancing student's conceptual understanding and mastery of content. He argues that the following three components ultimately develop an effective pedagogical classroom:

1. Use of effective instructional strategies.

2. Use of effective classroom management strategies.

3. Effective classroom curriculum design.

He continues with his discussion that each element will play a unique role in establishing a wide array of instructional practices to help teachers run an efficient classroom.

Now that there is a better understanding of the situation, the critical question that needs to be addressed is how a teacher develops the necessary skills to meet the above demands. This study intends to address certain aspects of that question, in particular, research will be conducted on the Modern Classroom Project (MCP) and how it affects students' mastery of mathematical concepts and student's self-efficacy, with the main focus around the idea that the Modern Classroom Project is designed to help students' master content and learn self-worth by utilizing best practices for implementing mastery-based learning, blended-learning, self-paced learning, and metacognitive approaches to instruction.

Statement of the Problem

In their study, Nye et al. (2004) state that it is widely known that teachers differ in their effectiveness. In fact, they found that the discrepancy in achievement between a 25th percentile teacher versus a 75th percentile teacher was half a standard deviation in math scores. Furthermore, the average teacher in the 50th percentile when compared to a teacher in the 90th percentile has a standard derivation of .46 in mathematical achievement. The authors continue with this data to argue that interventions need to be in place to help teachers improve their instructional practices or schools need to have a more efficient training program. Their main suggestion is that teachers need the opportunity to have more of a say in the instructional outcomes of the school. In particular, they need the opportunity to support each other and decide how to improve their instructional practices. Finally, they suggest that instead of trying to reform the schools that are struggling with ineffective teachers, the leadership team should instead provide high yield strategies that will not hinder those unproductive teachers.

Aronson, (2018) states that there is an increased use of technology for the delivery of educational content, and researchers need to take a deeper look into how to structure classrooms to efficiently integrate these new tools. She argues that historically mathematical education has relied heavily on direct instructions because the teacher can monitor student growth and provide immediate feedback. Another benefit to this structure is collaboration among the students and in-depth discussions about how mathematics can apply to the real world. However, a weakness stated in the article is that students who need extra help or already understand the topic do not receive differentiated instructions. A particular response to this situation has been the implementation of online learning which allows students to master materials at their own pace. However, some draw backs to asynchronous learning is that a teacher cannot provide immediate

feedback, and it is nearly impossible to monitor students individual work. Furthermore, students who are not intrinsically motivated can struggle with this learning format. Aronson, (2018) then suggests that blended learning has the unique opportunity of providing students with benefits of in person instruction along with asynchronous learning. The main argument is that through this process students can engage in cooperative learning with the teacher serving as the facilitator. This concept also allows students to progress at their own pace and work on their individual learning needs.

Tok, (2013) argues that mathematical instructors commonly focus on the procedures and mathematical literacy but neglect the role of metacognition in problem solving. In fact, he believes that many students have become passive learners since their teacher has not required them to reflect on their learning. However, he discusses that teachers who emphasize that students must understand monitoring strategy will ultimately improve their knowledge of mathematical content. He continues with his argument that through the process of metacognitive learning a student will acquire strategies that facilitates deeper understanding. His main dispute is that through this process students will develop the ability to transfer these skills to less familiar problems.

The above arguments demonstrate that the manner in which students receive instructions drastically affects their mathematical understanding. As the studies demonstrated, it can be extremely challenging for teachers to understand what practices are deemed worthy to meet the needs of the students. Therefore, the issue arises that a teacher must decide the manner in which to deliver instructions by ultimately taking into consideration best pedagogical practices. Mathematics educators need a method in which the classroom will begin to operate on the premise that students learn best when they find the material engaging, relevant, and interesting.

In particular, educators must determine which tactic or strategies can contribute to a teacher becoming a catalyst for learning, one in which they use their skills to ignite interest in students and help them be more effective and efficient in their quest for learning. However, learning has to happen within the student. Therefore, teachers must create an environment that promotes the translation of meaningful content into experiences and sequences that connect with students, ensuring that students know the teacher believes in them and becomes their champion in learning, guiding students to draw on the best that is in them as they learn, ensuring a classroom community that supports the risk of learning, and so on. The student is key in the process and wise teachers draw heavily on student interest, curiosity, and energy to craft their teaching and to respond to the students they teach.

Justification of the Study

The purpose of this study was to evaluate the impact of the Modern Classroom Project on student's mastery of mathematical concepts and self-efficacy. In particular, the study hopes to address that the Modern Classroom Project takes into consideration the above needs of the students and instills in teachers "best practices" that they can use when implementing many of those diverse methods of teaching. Currently, there are no empirical articles on how the Modern Classroom Project affects students' mastery of content. However, the Modern Classroom Project requires teachers to implement mastery-based learning, self-paced learning, blended instructions and metacognitive approaches to instruction all of which have been found to have a huge impact on students understanding of content.

In fact, that National Research Council (2000) found that students who use metacognition along with student-centered instructions can establish the following set of skills. Firstly, students learn how to predict their performances on various tasks, monitor their use of strategies, and

scrutinize their levels of mastery and understanding of the content being taught. Secondly, students require the necessary skills to transfer their learning to new settings and situations without the need for explicit prompting. And lastly, these practices provide students with a direct outlet to practice and develop skills in self-regulating their own learning.

In terms of mastery-based learning, Bangert-Drowns et al. (1991), found that when teachers utilize this practice students normally state that they are more satisfied with the instruction they receive because they have the opportunity to establish a better understanding of how concepts tie into other aspects of their learning. Furthermore, their study showed that students have more positive attitudes towards the content they are taught compared to students attending more conventional classes. Finally, they demonstrated that mastery-based instructions substantially enhances students' ability to retain the materials over a longer period of time versus traditional learning.

Research Questions

With these ideas in mind the purpose of this dissertation was to conduct a mixed method study to address the following questions:

1. How does the Modern Classroom Project affect students' self-efficacy?

2. In what ways does the Modern Classroom Project impact students' mastery of mathematical concepts?

Theoretical Framework

Two major theories provide the framework for this study: social cognitive theory and self-efficacy theory which is a sub-category of social cognition. Social cognitive theory is based

on the idea that individuals acquire knowledge through social interactions and that learning occurs between the dynamic and reciprocal interaction of the person, environment, and behavior (Bandura, 1977) see figure 1.1. Furthermore, Bandura demonstrates that people are often perceived as self-organizing, proactive, self-reflecting, and self-regulating, and that through these perceptions, humans have the ability to control their thought processes, motivations, and actions. However, these developments are influenced not only by the environment, but also personal knowledge held by that person. In the most general sense, social cognitive theory argues that human nature is fashioned not only from observational experience but also through external and internal social reinforcement.

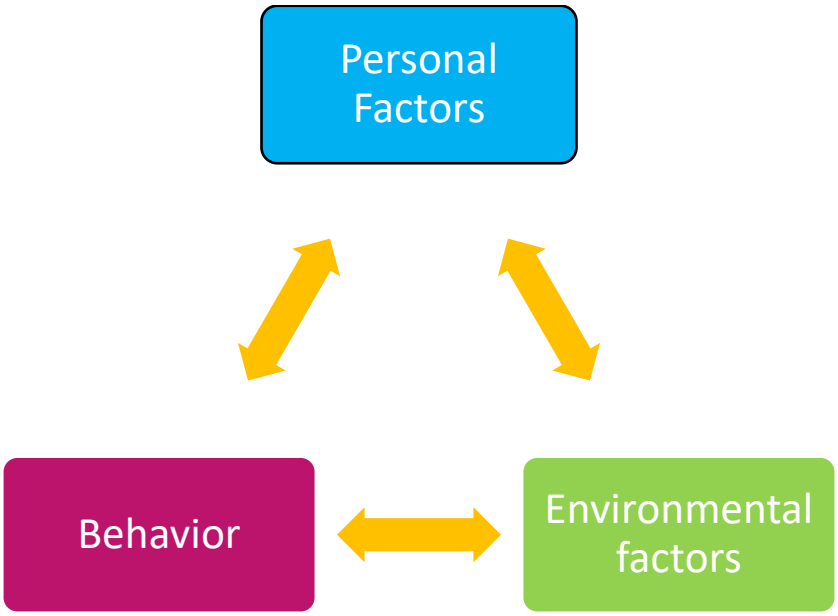


Figure 1.1: Social Cognitive Theory

LaMorte (2019) demonstrates that there are five major components of social cognitive theory: reciprocal determinism, behavioral capabilities, observational learning, reinforcements, and expectations. He argues that reciprocal determinism is the central component of social

learning theory and that the interaction between the person, environment and behavior all work hand-in-hand to help individuals understand difficult concepts. Through those social interactions human beings use their own learned experiences to achieve particular goals by collaborating and observing others. In terms of behavioral capability, LaMorte demonstrates that individuals learn how their behavior can affect the environment in which they live. In particular, he exhibits that a person's actual ability to perform a certain behavior are a product of their essential knowledge and skills. These skills often allow a person to understand their dynamic role in their social environment and help them establish guidelines for how to react in different situations. When discussing observational learning he asserts “that people must witness and observe a behavior conducted by others, and then reproduce those actions. This is often exhibited through "modeling" of behaviors. If individuals see successful demonstration of a behavior, they can also complete the behavior successfully” (p.2). When referring to reinforcements, Lemorte provides that a person’s behavior is often a product of either internal or external responses and that they can be either positive or negative. Furthermore, he suggests that reinforcements can be self-initiated or a by-product of the learning environment and that through reciprocal relationships students can develop a better understanding of ideal behaviors that result in positive reinforcements. Finally, when discussion expectations he believes that an anticipated consequences influence the manner in which someone will behave. His main argument is that when people are about to act they first anticipate the consequences of their actions before engaging in the behavior, and these anticipated consequences influence the behavior either positively or negatively. Finally, he concludes that expectations largely derive from previous experience within the social setting. These previous experiences often allow individuals to focus on the desired outcome and are subjective to that person’s personal expectations. Overall,

LeMorte (2019), along with Bandura (1977) demonstrate that humans have the unique ability to symbolize, plan alternative strategies, learn through vicarious experience, self-regulate, and self-reflect when encountering new knowledge. This ability to symbolize and understand the environment is essential for personal growth. This growth is normally represented by the development of cognitive models on how the world works and allows people to develop meaning and understanding from their personal environment.

Self-efficacy, according to the research conducted by Bandura (1977), refers to an individual's belief in his or her capacity to execute behaviors necessary to yield results that obtain a higher level of mastery. Furthermore, he demonstrates that self-efficacy is a reflection of the students' confidence in their ability to exert control over one's own motivation, behavior, and social environment. He continues with his discussion by providing that the manner in which students obtain self-efficacy stems from four main components: *performance accomplishments, vicarious experience, verbal persuasion,* and *emotional arousal.* In terms of performance accomplishments, Bandura shows that successes and failures students encounter in their pursuit of knowledge impact their self-motivation. In particular, if students are more successful in learning new materials that experience can build their confidence and allow them to apply those skills into new situations. When reflecting on vicarious experiences, Bandura suggests that when individuals see other students struggling with a concept and overcoming that hardship, they will increase their efforts in learning that material. When contemplating verbal persuasion, Bandura states: "people who are socially persuaded that they possess the capabilities to master difficult situations and are provided with provisional aids for effective action are likely to mobilize greater effort than those who receive only the performance aids" (p. 198). And finally, he expresses that emotional arousal affects student's sense of self-efficacy when they encounter

situations that cause anxiety. In particular, if a student feels discouraged about their understanding of a topic they could shut down because they do not see the benefits of persevering.

In terms of how self-efficacy effects students' mastery of content Kim et al. (2014) found in their study that students who have a thorough understanding of the above four concepts excel academically. In particular, they found that student's self-efficacy determines their level of perseverance, including the amount of time and effort they will give, when they encounter a challenging academic task. This effort impacts their academic performance by providing them with the knowledge that being lazy will negatively impact their grade. While persevering and seeking help will improve their mastery of the topic.

This study looked at how the Modern Classroom Project utilized these two theoretical practices to not only improve students' self-efficacy but also how students can improve their mathematical understanding. As the above scholars demonstrated, if students know how they actively construct knowledge, and have a thorough understanding of their individual strengths they can engage in activities that ultimately enhance their self-worth and educational achievements.

Significance of the Study

As stated, before the Modern Classroom Project has zero published work. Therefore, the main impact of this study was to determine if this project is worthy of teachers, administrators, and other educational stakeholders' attention. Particularly, should teachers study this approach and start implementing the four main principals into their classroom. While there is no research on how the Modern Classroom Project affects students' mastery of the content there is a

momentous amount of research on self-paced learning, mastery-based learning, metacognitive learning, and blending learning.

Anderson (1994), in her literature review of mastery-based learning, found that students are often more satisfied with the instruction they receive and have more positive attitudes towards the content they are taught compared to students attending more conventional classes. Furthermore, she demonstrates that this approach has also been found to improve students' academic self-concept. In particular, her research shows that there are copious positive affective outcomes for students, such as, student attendance and time-on-task increases while variance and time for remediation decreases over time.

In terms of self-paced learning, Tullis, and Benjamin (2011) found that giving learners more control over their study habits resulted in better memory performance. They also established that self-pacing yields improvements in metacognitive functions by allowing students the opportunity to reflect on their behaviors that might distract them from their learning. Finally, they conclude that self-paced learning allows students the opportunity to customize their learning environment to fit their individual needs. Their main argument is that through this process students develop confidence in their ability to actively construct their own knowledge while getting customized feedback from the teacher.

When reviewing blended learning Eryilmaz (2015) found in his study that this process had a positive effect on student achievement. His main point of emphasis was that this procedure, if utilized correctly, can provide students with the opportunity to acquire existing knowledge from their peers and actively create new knowledge by integrating cooperative learning. He goes further to demonstrate that this method also allows teachers to deliver instruction in different ways, thereby eliminating monotony and boosting students' interest. And

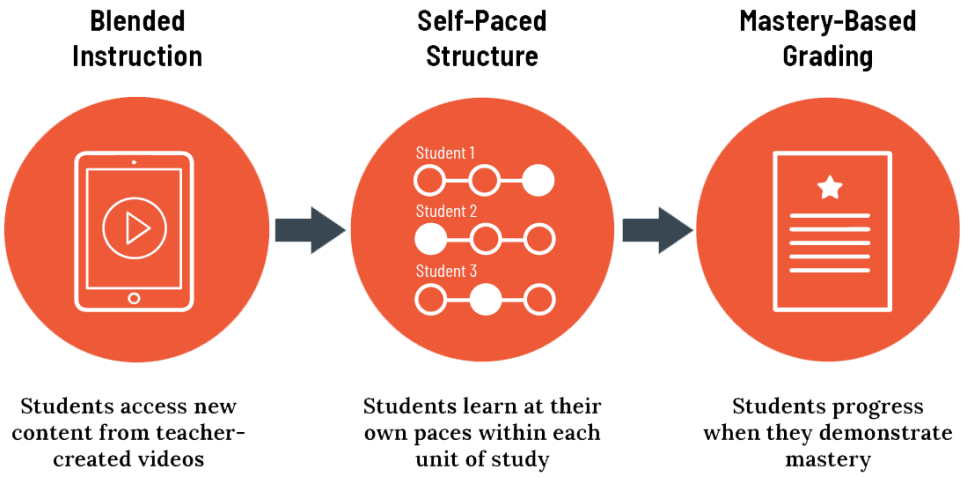
when there is an increase in students' interest, they are more likely to retain the content of the class.

In using this above information, this dissertation becomes significant by demonstrating that these combined resources will provide teachers with the opportunity to engage students in authentic learning while also meeting their diverse needs. Based on the above studies the students will have higher achievement in the classroom, since the teacher decided to actively meet the needs of each individual learner. Furthermore, since students have lessons that target their personal needs, they are more likely to engage in the process of learning, thus generating their own unique ideas about the materials. Students who are also actively engaged will most likely be able to retain and recall factual information and apply it to classroom situations and then evaluate that information and apply to real world situations.

Definition of Terms

To help facilitate this discussion there needs to be a working definition of the Modern Classroom Project; Figure 1.2 Fareh (2021) provides an overview of this instructional process.

Figure 1.2 Instructional practices for the Modern Classroom



Note. Modern project classroom design from https://www.modernclassrooms.org/

Blended instruction can be defined as an educational practice where students learn through a combination of in person and online instruction with the teacher providing collaborative work groups. In fact, Yorganci (2020) argues that blended learning creates an environment where students have the opportunities to increase their communication skills, develop a sense of community, participate in collaborative tasks, receive adequate feedback in a timely fashion, and have active participation.

Self-paced approaches to learning are those where students are provided learning tasks that they complete at a speed that is customized to their personal levels of mastery. In these learning environments, students can progress through the material based on their learning needs. They can take longer with material they might struggle with, skip topics that cover material they already know, or repeat topics as needed.

Mastery-based learning refers to an instructional approach where students have to exhibit a certain threshold of competence with a task before moving on to the next. In contrast with more traditional forms of instruction where all students are provided the same amount of time to achieve competence with a given skill before the teacher moves to the next topic, in mastery-based approaches, each student continues to spend time on a skill until they achieve proficiency.

Metacognition in its most basic definition is thinking about thinking. However, Livingston (2003) provides the following definition that will be used for this paper: "metacognition consists of both metacognitive knowledge and metacognitive experiences or regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes, knowledge that can be used to control cognitive processes. While metacognitive knowledge is

divided into three categories: knowledge of person variables, task variables and strategy variables". (p. 2).

Organization of the Study

This study is organized into five chapters. Chapter 1 provides the introduction to the study along with the problem statement, the purpose of the study, and the significance of the research; additionally, the research questions and definition of terms are also discussed. Chapter 2 provides a review of literature relevant to the study along with best practices for each pedagogical concept. Chapter 3 offers a description of the research design and the methodology for conducting the research. Chapter 4 provides the data analysis and the impact the modern classroom had on students' self-efficacy and mathematical achievement. Lastly, chapter 5 provides a discussion on the implications of this study. Chapter 5 also provides suggestions for future studies and limitations of this study.

CHAPTER II: LITERATURE REVIEW

The Modern Classroom Project is composed of four key elements: blended instructions, self- paced learning, mastery based learning, and metacognitive practices. One of the organizations' main objectives is to provide educators with methods in which to implement a research-backed instructional model that leverages technology to improve educator effectiveness and learners understanding. Therefore, a thorough investigation of each pedagogical practice was conducted to identify the importance of each component. Furthermore, suggestions for how to implement each component were found through numerous articles and they are provided below. However, there are three important themes that are evident in the Modern Classroom Project. Firstly, the Modern Classroom Project is a student-based method. Secondly, the effectiveness of

each concept depends on four guiding principles that teachers need to practice, which are: a focus on essential ideas and skills in each content area; a responsiveness to individual student differences; the integration of assessment and instruction; and the ongoing adjustment of content, process, and products to meet individual students' levels of prior knowledge, critical thinking, and expression styles. The third theme, and probably the most important, is how to implement each instructional practice in a classroom setting based on the students' and teachers' unique skills.

Self-Paced Learning

Self-paced learning is a method in which students are provided learning tasks that they complete at a speed that has been customized to their individual learning style. Furthermore, a students' personal level of mastery will vary, and teachers must plan according. However, Bray and McClaskey (2010) suggest that students can take longer with material they might struggle with, skip topics that cover material they already know, or repeat topics as needed with the ultimate goal that students are taking responsibility for their learning. Based on their research there are three benefits for this progression. First, students enjoy this learning atmosphere because it provides them with the necessary tools to set their own goals, track their progress, and monitor their thought process. Second, these methods can be extremely motivating to the student by providing them with the opportunity to focus on materials they may struggle with. And finally, this sequence can increase students' interest in the subject, which in turn can amplify their understanding of the content.

When reflecting on increasing students' interest in a subject Balentyne and Varga (2016); and Edwards and Rule (2013) demonstrate that self-paced learning provides students with the unique opportunity to explore materials that they are unfamiliar with. In particular, they reveal

that certain class concepts often build upon each other. So, students must master one topic before moving on to the next to fully grasp the meaning of that skill. Furthermore, their studies showed that self-paced learning of mathematics is a solution to boredom and lack of motivation by providing students with the prospect of feeling empowered in their pursuit of knowledge. Their main argument is that a well-executed self-paced learning technique, often a cornerstone feature of student-centered instructional programs, has a highly beneficial impact on motivating students. This motivation stems from the fact that students can progress through the materials at their own pace before being required to complete a performance assessment.

Lambert et al. (2016); and Tullis, and Benjamin (2011) agree that self-paced learning can increase the motivation of the student. However, they demonstrate that a boost in curiosity can also help motivate the students to tackle more challenging concepts. In particular, their studies found that if teachers utilize particular strategies, such as having students monitor their work ethic, there was an increase in students' performance and engagement. This higher achievement rate was contributed to students taking on more roles, like self-pacing, than in a traditional classroom. Cho and Heron (2015) go more in depth with this idea by demonstrating that the students who are more engaged in the process will also enhance their self-efficacy. This boost in confidence will also reduce students' negative emotion in a mathematics course which is a crucial variable in increasing their engagement and confidence. They argue that through this process students will find the class to be more enjoyable and will try harder to master the materials. And if a student is more engaged in their learning, they are going to perceive the class as beneficial.

Svenningsen et al. (2018); and Kizilcec et al. (2017) agree that self-paced learning environments are perceived by students as sensible and insightful. However, they demonstrated

that self-paced learning situations provide students with a direct outlet to practice and develop skills in self-regulating their own learning. These strong self-regulated learning skills along with forms of expertise in planning, managing, and controlling the learning process, have been shown to correlate with faster learning and higher achievement. Their main argument is that a personalized learning skill ultimately provides students with the method to acquire higher order and critical thinking skills. Kizilcec et al. (2017) actually provide a more thorough investigation of this idea and demonstrate that when students engage in these metacognitive strategies, they are more likely to achieve their individual goals and engaged more deeply with course topics.

Given these viewpoints, it is perhaps not surprising that self-paced instructional approaches, those that value and attend to students' individual learning needs, have been shown to have numerous benefits over more traditional forms of teaching. However, the best way to implement self-paced learning has yet to be discussed. Following is a breakdown of three important skills: goal setting, feedback, and formative assessment. These practices are vital, and teachers must utilize them when implementing this pedagogical practice. It should not be noted that self-paced learning can easily be mistaken for self-regulated learning which includes the cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning. In fact, Butler (2002), demonstrates that self-regulated integrates the following components: goal setting, self-monitoring, self-instruction, and self-reinforcement. While they do share commonalities the key difference lies in the idea that students are choosing the time frame in which to learn and are provided resources by the teacher.

Set Goals

Goal setting has been well established in the field of education as a practical application to help foster students' academic achievement. In fact, Marzano (2010) found that goal setting

can increase student learning between 18 and 41 percentile points. His main argument is that this structure provides students with the opportunity to create learning objectives. These learning objectives will need to be effectively communicated with the teacher to help establish an understanding of how they will approach their independent learning. In helping students set goals, Marzano et al. (2001), argue that the teacher should provide guidance to assist students in identifying goals that are challenging but achievable. They continue with their discussion by stating that when setting overarching "classroom learning goals", that teachers should err on the side of less specificity and aim for goals that are fairly broad. Though somewhat contradictory to the conventional wisdom on goal setting, their research found that highly specific goals often narrow the focus of student learning, and can actually deter learning in areas not directly aligned with the goal itself. In other words, exceedingly specific goals have a tendency to narrow the instructional focus to the extent that teachers can wind up simply teaching to the test. By contrast, slightly broader goals seem to foster a wider scope of learning and allow space for students to adapt and personalize the goals to match their individualized learning plans.

Schunk and Gaa (1981) demonstrate that "through the process of setting goals, students become more likely to engage in specific appropriate activities, attend to instructional processes, persist at the tasks, and expend greater effort toward goal accomplishment. These motivational effects lead to more on-task behavior and more rapid learning. Further, how students' perceptions of their accomplishments compare to their goals signals information about performance capability" (p.1). Saphier et al. (2008) took this a step further and demonstrated the importance of contractual goals. In particular, having students engage in academic goal setting and personal goals will help foster active involvement. This involvement is normally created as an individualized learning plan. This learning arrangement has been shown to be highly

beneficial with students as they use self-paced learning. Mainly since the students are not only setting goals but signing a contract with the teacher agreeing that achieving the goal will result in a particular grade.

In terms of how to implement this procedure in a classroom setting, Usher and Kober (2012) argue that there are four key components teachers must consider. First, the teacher must provide the students with the opportunity to build proficiency. This competence can take on many different forms and must be made to fit the need of the students individual learning plans. But the objective is to empower the student to reflect on their current struggles. Second, students need the autonomy to establish their own goal with help from the teacher. This will make them more active in their learning and can enhance their conceptual understanding. Third, this goal or goals needs to cultivate the students' interest in the learning process. In particular, students should consider their level of development, and the skill level they have of the topic. And finally, the students need a tangible measurement so that they can actively see how this goal setting is affecting their abilities.

Formative Assessment

In terms of assessment, particularly ongoing formative types of assessment, Lee (2014) found three benefits: "it helps thoroughly evaluate whether students have reached a high enough level of mastery on the current topic to move on; it identifies specific learning needs; and it allows tracking of individual progress towards learning goal" (p. 15). She argues further that ideally, assessments should be criterion- as opposed to norm-referenced and should be tied to student learning goals and based on well communicated performance standards. Saphier, Haley-Speca, and Gower, (2008) go a step further, and discuss that assessments need to be leveraged in a way that fosters feedback and helps modify student learning. Frequent error analysis on behalf

of the teacher, as well as self-analysis of errors on behalf of the student, are important components of assessment particularly so for self-paced learning.

White (2019) also provides three benefits for using formative assessment. First, teachers have the ability to make instructional decisions by collecting and applying evidence of learning during classroom time. This in turn will allow them to differentiate the materials to help meet the needs of the students. Second, through the process of providing students quick checks this practice could boost student achievement. This accomplishment can result in the student taking ownership of their learning and could encourage students to collaborate on the assignments. And lastly, if students are given immediate feedback, they can see a measureable difference in their understanding. She argues that this can allow them to adjust their mindset and develop self-regulation skills like perseverance, critical thinking, and problem solving.

Quality Feedback

The feedback that students receive as a result of formative assessment is arguably the most important predictor driving the success of students as they engage in self-paced learning. In fact, Bellon et al. (1997) and Dean et al. (2012) suggests that academic feedback is a crucial skill that teachers must implement to raise student achievement and understanding of materials. Furthermore, they argue that the more feedback students receive the more likely they are going to become aware of their learning style. This in turn makes it easier for the students to recognize their mistakes and develop strategies for overcoming those obstacles. However, the manner in which students receive this feedback is extremely vital and teachers need to integrate strategies that have proven to be successful.

Kulik et al. (1990); Saphier et al. (2008); and Marzano et al. (2001) provide ample research on the how to provide effective feedback. First, teachers need to be specific and precise in their feedback. In particular, educators must provide students with not only what was accomplished correctly but they also need to highlight mistakes that were made so students can see the correlation between the two. Second, the feedback must be matched to the learning objective and mastery threshold. This will allow students to comprehend the deficiencies in their work. Third, feedback must be corrective in nature. This should be personal to the student and provide them with the opportunity to correct their mistakes. Marzano, Pickering, and Pollack, (2001) suggest "The best feedback appears to involve an explanation as to what is accurate and what is inaccurate in terms of student response" (p. 98). Fourth, students should generate feedback not only for themselves but also their classmates. This idea of students self-reflecting allows them to develop metacognitive skills that in turns helps them master the materials. Furthermore, having students evaluate other works can provide them with alternative ways of thinking about the problem. And lastly, feedback must be given in a timely fashion. This helps shape student learning and increases the likelihood that students will be able to modify their learning behavior in ways that are impactful.

Mastery Based Learning

Mastery based learning refers to an instructional approach where students have to show that they understand a particular learning objective before moving onto the next topic. Dick and Reiser (1989) demonstrate that each student must continue to spend time on a skill until they have demonstrated that they are proficient for that skill. However, they caution that students must comprehend what is considered mastery before the unit is started. They also suggest that the goal of this approach is to allow students to develop automaticity with basic sub-skills. With

the teacher intending for those basic skills to be applied to more complicated class requirements. Finally, they present that mastery-based learning will significantly enhance students' ability to retain their learning since the practice requires them to completely understand a topic before moving on.

In terms of the benefits of mastery-based learning, Anderson (1994); Kulik et al. (1990); Guskey and Pigot, (1988); and Duby (1981) found three positive impacts this practice has on student achievement. First, they established that students who are engaged in this process commonly state that they are more satisfied with the instruction they receive and have more positive attitudes towards the content they are taught. Second, this method will improve students' academic self-worth by providing them with ample time in which to learn the materials. This in turn will help with retention and understanding. And lastly mastery-based learning makes students develop a growth mindset. In particular, the studies demonstrated that there was a direct correlation between student achievement and the amount of time spent practicing the skills.

Given these perspectives, it is perhaps not surprising that mastery based instructional approaches, where all students are provided the same amount of time to achieve competence with a given skill before the teacher moves to the next topic, have been shown to have numerous benefits on student achievement. However, the manner in which teachers effectively execute these practices will ultimately decide how beneficial mastery learning will be for the students. What follows is a breakdown of three important skills, chunking, practice, and remediation, which teachers should utilize when implementing this pedagogical concept.

Chunking

If mastery-based learning was to be broken down into components, then students would first be presented with a complex task. That task when then be broken down into smaller, more easily managed pieces that students will master one at a time. This is commonly referred to as chunking. In terms of research Marzano (2007) provides the following guidelines.

> "First, organize the content you want to address by creating topics or steps. If presenting the content visually, give each topic a heading to help students understand how to categorize the information in relation to the other topics. Second, move from broad or foundational concepts to more complex and detailed concepts. Design your chunks so that each chunk builds on the previous chunk. And lastly give students the opportunity to ask questions about each chunk. Use different techniques to gauge how well students understand the content" (p.5).

While this helps teachers understand how to break down the materials it does not demonstrate the impact this has on student achievement.

So, when contemplating how this practice will benefit students, Zhang et al. (2012); and Attardi, and Dell'Orletta, (2008) demonstrated that this process affects students in two ways. Not only does it allow the teacher to address students who have learning disabilities by providing them with accommodations that meet their individual needs but it also supplies more manageable tasks for all students. This in turn will allow students to not feel overwhelmed when completing their course requirements. The other beneficial aspect found in these studies was that if this practice is used efficiently, it can facilitate comprehension and retrieval of information

Practice

Anderson, (1995); Marzano et al. (2001); and Newell and Rosenbloom, (1981) demonstrate that teachers need to be aware that when students are acquiring new skills that they need ample time to practice applying them to different situations. Furthermore, for students to actually master the content the teacher must design problems that focus on specific elements of that complex skill. Marzano et al. (2001) summarize this idea by stating that "Learning new content, does not happen quickly. It requires practice spread over time. The results of such practice will be increments in learning that start out rather large but gradually get small and smaller as students' fine tune their knowledge and skill." (p. 69).

When contemplating this suggestion as it pertains to the classroom Saphier et al. (2008) suggest that student practice sessions should be frequent and collaborative. However, they suggest that over time as students develop competency, the teacher should reduce the amount of practice time. Their main argument is that this allows students the opportunity to gain independence and set their own pace. They also state that instructional scaffolding should be utilized when introducing a new skill. This method according to their research will allow students the opportunity to freely ask questions, provide feedback and support their peers in learning new material. This quote summarizes this belief "The smallest unit of new information that retains meaning should be practiced at any one session and worked on for the shortest unit of time to allow the students to feel they have accomplished something. After they have achieved proficiency, they should practice learned items two or three more times to make the learning more permanent. Unlike athletics and motor skills, where practice makes perfect and the more the better (up to a point), long practice sessions with academic skills quickly reach a point of diminishing returns." (p. 232)

Corrective Feedback and Remediation

As previously mentioned Bellon et al. (1997) demonstrated that frequent use of formative assessment and providing students with robust corrective feedback is crucial to the success of learners. Furthermore, Saphier et al. (2008) provided the idea that teachers should make the formative assessments correlate to the learning objective and that these assessments should be tied directly to the students learning and reflective of the summative performance. Based on the research by Dick and Reiser, (1989), they found that in mastery learning, teachers must demonstrate to students how to utilize corrective feedback. In particular, they discuss that teachers need to show students how to take feedback and correct their mistakes. This remediation process can provide the students with the opportunity to acquire information about their existing achievement which in turn will help them to improve. Finally, they suggest that teachers should not penalize students' grades based on these practice assessments as the objective is to allow students to grow and learn from their mistakes.

A key component of determining when to provide remediation is that a teacher must clearly define to the students what is considered mastery. This could be through a rubric or another established method. But students must thoroughly understand how they will be graded before they can begin the process of remediation which is a significant component of mastery-based learning. In fact, Bangert-Drowns et al. (1991), found that having students attain higher levels of mastery can make learning more meaningful and can also increase student achievement relative to lower standards. Dick and Reiser (1989) actually take that a step further and suggest that teachers should "find that the best way to identify a mastery level of performance is to identify the level of performance of students" (p. 104). Setting assessment performance at this level may be a useful starting point for teachers new to using this technique.

Finally, Lysakowski and Wallberg (1982) discuss that this process of providing students with corrective feedback and giving them ample time to complete the remediation process is vital to mastery-based learning. Their argument is that students need to be aware of how their performance on various assessments affects their level of competence. This is turn will hopefully elicit from the students a productive struggle with the teacher serving as mentor. The overall task of this method is to ultimately help the students determine if they need to move onto the next topic or pursue alternative types of learning to master the current topic they are studying.

Metacognitive Reflection

Saphier et al. (2008) and Hacker (1998) demonstrate that *metacognitive* approaches to teaching help improve students' general knowledge of cognition as well as their awareness of their own thought processes. Or in other words, students learn to think about how they learn materials and ultimately reflect on that process. In the context of education, students use metacognition to predict their performances on various tasks, monitor their use of strategies, and monitor their levels of mastery and understanding of the content being taught. Through this method Marzano et al. (2001); Wang et al. (1993); and Davidson and Sternberg, (1998) found four benefits. First, students become more aware of their own thoughts concerning the topic at hand. Second, this procedure increases student's problem-solving abilities. Third, students often have an increase in motivation since they feel that they have more control in their individual learning. And lastly, metacognitive practices increase students' ability to transfer acquired skills to new situations without being promoted. In fact, the National Research Council, (2000); and Schoenfeld (1991) demonstrate that when teachers effectively make their classrooms utilize metacognitve practices, the classroom will focus on helping students make meaning of content; finding personal relevance in ideas; transferring the knowledge, skill, and understanding from the

teacher into the world beyond the classroom; and helping students use reason to become better at problem solving.

Given these perspectives, it is perhaps not surprising that metacognitive instructional approaches, where the intention of making learning an experience that is engaging, relevant, and interesting, have been shown to have numerous benefits on student achievement. However, the manner in which teachers effectively execute these practices will ultimately decide how beneficial metacognitive will be for the students. The National Research Council (2000) state that "because metacognition often takes the form of an internal dialogue, many students may be unaware of its importance unless the processes are shown explicitly by teachers. An emphasis on metacognition needs to accompany instruction in each of the disciplines, because the type of monitoring required will vary" (p. 21). What follows is a list of pedagogical practice teachers should incorporate to make metacognitive instruction successful.

Make Students Thinking Visible

Research suggests that if a teacher would like to foster students' metacognitive thinking skills, they must provide them with amply time in which to reflect on their learning. In particular, students need to ask themselves "what am I doing right now". Furthermore, the teacher needs to cultivate methods in which students can make their thinking visible. In fact, Saphier et al. (2008); and Schoenfeld, (1985) demonstrate that a very effective tool for teaching metacognitive skills is to allow students to think aloud. In particular, they suggest that teachers should ask the students to conduct the following questions: "What do I see?", "What do I think about that?", and "What does it make me wonder?" They suggest that through this process students will gradually become accustomed to reflecting on their internal thinking. This in turn

will create a habit where students become aware of, monitor, and as needed, modify their thought processes.

Winne, and Hadwin (1998) demonstrate that teachers need to help students complete the following tasks to make their thinking visible. First students need to define their task and enact a plan to accomplish that task. Upon creating the plan, they need to create a goal and demonstrate how they will monitor that goal. Next, the student needs to adapt that plan as they develop a better understanding of their thought process. Winne and Hadwin argue that through this method the students will become more aware of, monitor, and as needed, modify their thoughts about the topic at hand. This in turn can allow students to "monitor other attributes that describe studying, such as actual time taken, effort spent, and strength of the judgment of learning contrasts this profile of meta-level standards to attributes that describe the product created by using the tactic" (p. 149). If utilized correctly these cognitive modifications should help students solve problems and learn content more effectively. In particular, as students define the tasks, set goals, enact study tactics and strategies, and metacognitively think about the above suggestions they are engaging in think aloud strategies.

Metacognitive Development

The National Research Council, (2000) demonstrate that modeling, scaffolding, coaching, cooperative learning, and whole-class and small-group discussion can all be used effectively in teaching students metacognitive skills. However, the Modern Classroom Project encourages teachers to use the following skill set: scaffolding, think aloud, and reciprocal teaching to foster academic growth.

Scaffolding

Scaffolding of math instruction is targeted support for students as they transition from the initial acquisition of a math concept or skill to independent mastery. Teachers incorporate immediate feedback, model a correct approach, and answer questions students might have. As students show mastery, intervention decreases, and the teacher strategically ask students to complete more challenging problems to expend their existing knowledge. Geert, and Steenbeek, (2005) argues "that the scaffold function or process exists, that it is effective in that it advances learning and that it has different forms, i.e. that it differs among individuals and contexts." (p. 117). When teachers effectively scaffold their materials, classroom instructions will focus on helping students make meaning of content; find personal relevance in ideas; transfer the knowledge, skill, and understanding from the teacher into the world beyond the classroom; and help students use reason to become better at problem solving.

Think-aloud

While there are various methods in which a teacher can implement think aloud strategies, Anderson, and Freiberg, (1995) provide a guideline for "self-talk" strategies.

1. Identify the problem: "What am I about to do? How can I find out?"

2. Choose a plan or strategy: "How can I do it? What are some plans?"

3. Self-monitoring questions: "Am I using my plan?"

4. Self-evaluation questions: "Is my plan working? How did I do? Do I need a new plan?"

They recommend that teachers should have students use these four steps when they are engaging in new materials or solving new problems. They reveal that through these approaches students

have the opportunity to significantly improve their problem solving behavior especially in understanding the problem. In particular, this process benefits the students by having them verbalize their inner speech, and a great teacher models how expert thinkers solve the problem by providing students with concrete examples. This is normally accomplished with the teacher reflecting on their own learning processes, and then discussing with students how they will approach the situation. In fact, Kani, and Shahrill, (2015) found in their study that think aloud strategies helped students become aware of their individual thinking process which improved their problem-solving skills. In their study they showed that as students think out loud with teachers and with one another, they gradually internalize that dialogue, which in turn can become their inner speech. They argue that this process will allow students to direct their own behaviors and problem-solving abilities. The National Council of Teachers of Mathematics (2000) confirms this practice by demonstrating that when teachers use assessment techniques such as observations, conversations and interviews with students, or interactive journals, students are likely to learn through the process of articulating their ideas and answering the teacher's questions.

Reciprocal Teaching

Reciprocal teaching is an educational practice where teachers utilize cooperative learning by assigning a team leader for each group. After a teacher creates a group, they then provide students with the necessary materials to understand the topic. In fact, Palinscar and Brown, (1985) provide the following six steps to help facilitate discussion between the group members.

1. The teacher selects for the students a passage or example to read that presents new content or materials.

2. Once the students have completed the initial task, the "student leader' verbally summarizes the new content for the group.
3. The student leader then engages the group in a discussion where the other students take turns making additions to the summary.
4. The student leader then poses questions to the group concerning the key material covered with the students in the group take turns responding.
5. The student leader then asks the group to point out confusing aspects of the summary, and the group discusses how to clarify the misconceptions.
6. The student leader then directs the group to make further observations and if possible, they could try another example.

When utilizing this practice Marzano, (2007) and Marzano et al. (2001) suggest that the teacher can provide cues and prompts to the group as needed, but generally they should allow the students to take ownership of their work. However, they should still address common misconceptions and provide feedback to groups upon completion of the work.

Blended Instructions

Blended learning is a relative new concept in the field of education and does not have a universal definition. However, Nuri (2019); Palloff, and Pratt (2013); Balentyne, and Varga, (2016); and Aronson (2018) agree that blended instructions is an educational practice where teachers effectively integrate a combination of technology and face to face instructions. Furthermore, they present that the teacher must construct a learning atmosphere where the students are subjected to different models of teaching and various styles of learning that integrate a strategic and systematic approach that addresses the benefits of online instructions with in-person instructions. In particular, Nuri (2019) demonstrates that teachers should utilize the

following four methods to create an effective classroom. "1. a mixture of Web-based technologies; 2. a mixture of various pedagogical approaches (eg. Constructivism, behaviorism, cognitivism); 3. a combination of all forms of technology teaching with face-to-instructor-led conditions; or 4. a combination of instructional technology and actual work tasks to form a mixture of effective and working learning" (p. 2). Through these practices Smith and Brame, (2018) demonstrate that there are two major benefits for the students. First, students will see an increase in conceptual understanding and perform better on varies assessments. And secondly, if teachers correctly integrate metacognitive practices and cooperative learning into the classroom, students' self-regulation and self-efficacy skills will improve.

When reviewing the literature on how blended learning increases student achievement and self-efficacy Nuri (2019) provides the following four justifications. "(1) Blended learning allows teachers to expand the space and opportunities available for learning; (2) support course management activities (e.g, communication, assessment of submission, marking, and feedback); (3) support the provision of information and resources for students; and (4) involve and motivate students through interactivity and collaboration" (p. 2). She than provides that through these four concepts students will see an increase in their academic achievement and there will be an impact on students' attitudes towards learning. Dickfos et al. (2014), also provide justification on the benefits of using blended learning, which include: quality improvements in learning and teaching, widening student participation, and meeting student expectations. They demonstrated that these findings also had an impact on student achievement as well as engaged them in metacognitive practices. In particular, their research had students reflect and evaluate the videos they made for class. During this process, the students provided that this application allowed for them to identify different aspects of their oral communications skills, and through reflection they

were able to improve and clarify misconceptions they had about communication skills. Palloff and Pratt (2013) summarize these findings by suggestion that "The online classroom is a potentially powerful teaching and learning arena in which new practices and new relationships can make significant contributions to learning. In order to harness the power this creates in education; instructors must be trained not only to use technology but also to shift the ways in which they organize and deliver material. Making this shift can increase the potential for learners to take charge of their own learning process and facilitate the development of a sense of community among them" (p.30). In conclusion, Smith and Brame (2018) and Yorganci (2020) present that blended instruction allow students to participate in student centered instructions, collaborative and interactive learning, metacognitive awareness, increased flexibility, immediate feedback, and multimodel content. They demonstrate that each one of these aspects will allow students to master the content while also increases their self-efficacy.

Provided these perspectives, it is not surprising that blended learning instructional approaches, where students are provided the opportunity to explore and practice more deeply a concept, supports student conceptual understanding and mastery of content. Furthermore, blended learning has been shown to have numerous benefits on student learning by requiring them to participate in collaborative activities to foster communication and problem-solving skills. However, the manner in which teachers effectively execute these practices will ultimately decide how beneficial blending learning will be for the students. What follows is a breakdown of three important skills, collaboration, communication, and gamification that teachers should utilize when implementing this pedagogical concept.

Collaboration

Collaborative learning has been shown to not only develop higher-level thinking skills in students but boost their confidence and self-esteem as well. In fact, Marzano (2007) demonstrated that students who are regularly exposed to cooperative learning gain 23 percentile points on achievement tests. Furthermore, Okita et al. (2008) and Gillies (2016) demonstrate that when teachers utilize certain strategies that involve students discussing and sharing ideas, working together toward a common goal, or strategically socializing in ways that enhance learning are advantageous for learning new content. In particular, they present that through the use of group assignments, student team competitions, jigsaws, group learning simulations, and class discussions not only does blended learning become less isolating for students, but engagement and learning increase by a significant margin. Palloff and Pratt (2013) expand on this idea by stating: "collaborative learning processes help students achieve deeper levels of knowledge generation through the creation of shared goals, shared exploration, and a shared process of meaning making. In addition, collaborative activity can help to reduce the feelings of isolation." (p. 39).

When contemplating how to integrate this practice into the classroom Marzano (2007), and Kagan (1989) suggests that teachers should design group work around the core components of cooperative learning: positive interdependence, group processing, appropriate use of social skills, face-to-face interaction, and individual and group accountability. According to Kagan (1989) a teacher knows their classroom is utilizing this practice when the following four basic components are met.

1. Positive interdependence occurs when gains of individuals or teams are positively correlated. In particular, the group is making sure all participants have a thorough understanding of the topic and demonstrate that understanding.

2. Individual accountability happens when all students in a group are held accountable for doing a share of the work and displaying mastery of the material learned. This can be accomplished through varies methods like group rating or a target check.
3. Equal participation must be established before the groups begin their work and every member of the group has to provide equal responsibilities and input.
4. Simultaneous interaction occurs when class time is designed to allow many student interactions during the period.

Through these four steps students have the opportunity to increase their understanding of difficult content by relying on each other instead of just the teacher. This creates a more positive learning atmosphere because students are actively constructing their own knowledge.

Communicate

According to the research conducted by Smith and Brame, (2018) blended learning environments can provide a learning advantage when compared to purely face-to-face instruction. In particular, they demonstrate that when students are participating in blended learning, teachers must adapt their pedagogical practices to not only engage students during in-person instructions but also create a strong online presence. Their main argument is that teachers need to create meaningful communication between the students that effectively provides feedback in a timely fashion. They also suggest that teachers should use online tests and quizzes because they can be constructed with an automatic grading capability that provides immediate feedback. Reilly (2020) actually provides four concrete guidelines to help teachers create effective communication for blended learning. First, he suggests that student emails and messages should be answered within 24 hours. This provides the students with immediate

feedback in which to complete their work while also allowing them to fix any mistakes they might have made. Second, weekly progress checks should be conducted with the students. During this progress check the student and teacher have the opportunity to communicate about the instructional materials and create a positive relationship. Third, monthly conferences should be conducted one-on-one with students. During this conference the teacher should have suggestions for how the student can improve their work. Furthermore, teachers should have the students engage in metacognitive practices to reflect on their learning. And finally, for teachers to be effective in their communication they need to actual listen to what the students have to say about the instructional tools being used in the classroom. This could provide the teacher with the opportunity to differentiate their instructions. In particular, they can get feedback about their interactive presentations, videos, images, or graphic organizer and adjust them to meet the needs of their students.

Gamification

One aspect that students enjoy about blended instructions is that it provides them with the opportunity to utilize either a computer or tablet to learn the content. Furthermore, teachers have the unique opportunity to engage students in a wide variety of online educational platforms like mobymath, khan academy, ALEKS, and explore learning to name just a few. Makers of these digital curricula are learning to effectively balance sound teaching with engaging game-like features. In fact, Hamari et al., (2016) in their research found that educational video games can be an effective means of increasing engagement in learning, can facilitate deep immersion or "flow states" in engaging with an instructional activity, and can enhance both long-term interest and learning outcomes. Hamari et al. (2016) continue with this train of thought by suggesting that many of the features of effective games overlap with the features of effective lessons:

> "In an ideal educational game setting, students learn how to solve complex problems. The problems within a game typically start off easy and then progressively become more difficult as players' skills develop. Players are motivated to learn, in part because learning is situated and occurs through a process of hypothesizing, probing, and reflecting upon the simulated world within the game. In addition, the goals are clear, and information becomes available to players at just the time that it is needed to reach each goal. Making sense of that information becomes a goal intrinsic to gameplay." (p. 170)

Other researchers Budhai and Skipwith, (2017) also advocate that game-based learning can indirectly cultivate skills such as problem-solving, lateral thinking, and concentration. Given this growing body of research, strategically selecting and providing students with instructional games can be an effective means of leveraging online teaching in a way that enhances both engagement and learning.

Conclusions

There are three underlying principles of the Modern Classroom Project that are important to remember. First, the Modern Classroom Project is student centered with the intention of making learning an experience that is engaging, relevant, and interesting. Students must take some responsibility for their own growth, develop a sense of pride in their accomplishments (no matter how small), and be active in making and evaluating decisions based on learning. Second, students and teachers are learners together. Teachers will know more about the subject matter, but they must continuously learn about how each one of their students learn. Teachers must make blended learning steeped in educational practices by combining sources of professional intuitions and knowledge base to each learner, developing a classroom where the learner actively participates in a blend of whole-class, group, and individual instructions. And third, the Modern

Classroom Project is rooted in mastery-based learning with assessment being a key component. The teacher must effectively assess his or her students throughout the entire lesson plan, to determine the particular need of each of their students. This, then, will allow the teacher to design lessons based on their students' understanding. After reviewing this literature, this author conducted a mixed method research study to understand the significance of this issue more completely.

CHAPTER III: METHODOLOGY

The purpose of this mixed method study was to examine how the Modern Classroom Project (MCP) affects students' mathematical achievement and self-efficacy. In particular, the structure of the study was modeled after the work of Creswell and Plano-Clark, (2011) in which their mixed methods research design begins with a quantitative data collection and analysis, followed by qualitative data collection and analysis which is commonly referred to as explanatory sequential. The quantitative phase of the study focused on examining the impact – positive, negative, or nonexistent – the Modern Classroom Project had on students' conceptual understanding of mathematical practices and state standards. Furthermore, the quantitative data was also used to evaluate students' self-efficacy by administrating two different surveys. The purpose of these surveys was to determine how the Modern Classroom Project shapes students' perception of their individual mathematical abilities. In terms of the qualitative segment, open-ended questions were utilized to investigate students' beliefs on how this educational practice influences their mastery of content and their self-efficacy. This chapter describes the research methodology used in this mixed methods study. The chapter also presents the research questions, mixed methods design, location, participants, instruments, procedures, and data analysis.

Wolf et al. (2020) demonstrated that teachers who participated in the MCP found this pedagogical practice to help engage students in authentic learning by providing differentiation, skill development, and effective classroom practices such as self-pace and blended instructions. With this increase in student engagement, the teachers in their study believed there was higher achievement in the classroom, especially when teachers decide to actively meet the needs of each individual learner. The main argument was the idea that if students have lessons that target their personal needs; they are more likely to engage in the process of learning, thus generating their own unique ideas about the materials. Students who are also actively engaged will most likely be able to retain and recall factional information and apply it to classroom situations and then evaluate that information and apply to real world situations. Therefore, if the quantitative results do not show an increase in students' mathematical achievement this study could still provide this researcher with a better understanding on students' perception on how they acquire mathematical thinking skills.

Research Questions

This mixed methods study addressed the following research questions:

RQ1. How does the Modern Classroom Project affect students' self-efficacy?

RQ2. In what ways does the Modern Classroom impact students' mastery of mathematical concepts?

Mixed Methods

Shorten and Smith (2017) define mixed methods research as an approach were the researcher collects and analyzes both quantitative and qualitative data within the same study. Furthermore, they argue that this approach has the potential of allowing individuals to explore

diverse perspectives by understanding the intricate nature of the relationship between different data points. Additionally, Shorten, and Smith (2017) demonstrate that there are three advantages to using a mixed method approach. First, they demonstrate that this method allows researchers to explore research questions that neither quantitative nor qualitative methods could answer alone but instead provide a more complete picture of the intricate nature. Secondly, they suggest that this method truly reflects participants' point of view by providing them a voice in the study while also ensuring that the study's findings are grounded in participants' experiences. And lastly, mixed methods emulate the way individuals naturally collect information from real world experiences.

Creswell, and Plano-Clark (2011) elaborated on these advantages by providing a more in-depth list and they are as follows:

- "Comparing different perspectives drawn from quantitative and qualitative data.
- Explaining quantitative results with a qualitative follow-up data collection and analysis.
- Developing better measurement instruments by first collecting and analyzing qualitative data and then administrating the instruments to a sample.
- Understanding experimental results by incorporating the perspectives of individuals.
- Developing a more complete understanding of changes needed for a marginalized group through the combination of qualitative and quantitative data.
- Having a better understanding the need for and impact of an intervention program through collecting both quantitative and qualitative data over time" (p. 267)

These six bullet points along with the advantages provided by Shorten and Smith are the core reason mixed methods was utilized in this study.

Research Design

An explanatory sequential mixed method was used for this study (See Figure 3.1).

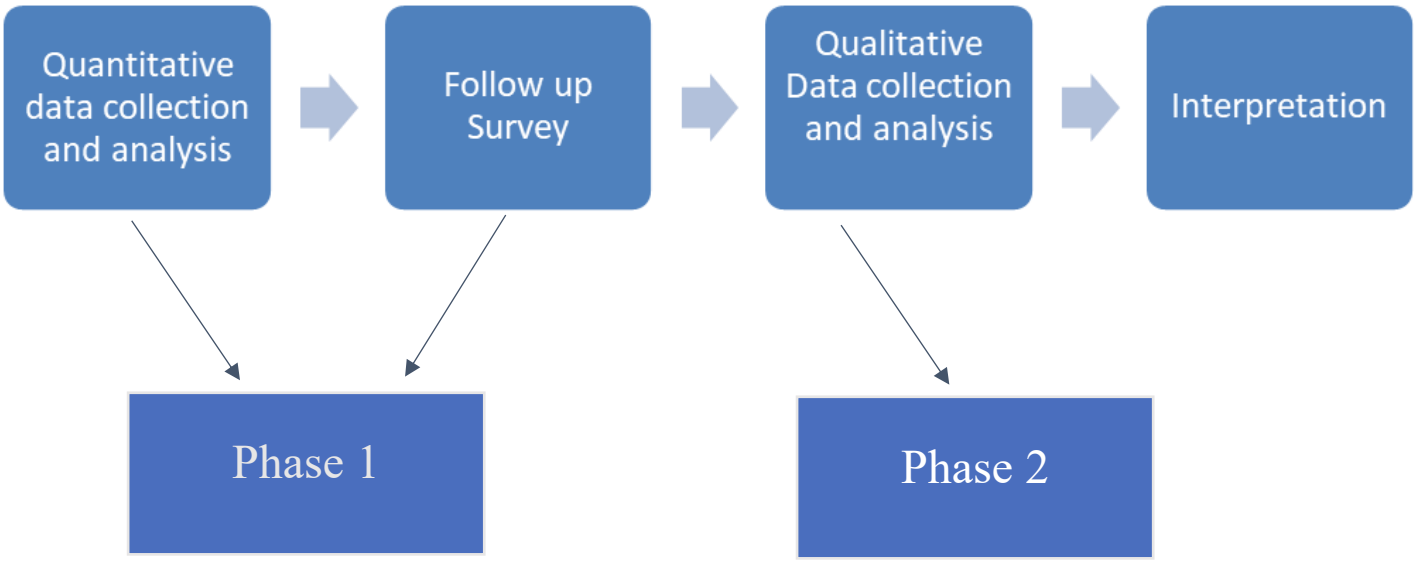


Figure 3.1 Visual model of sequential explanatory mixed methods.

This design was utilized as the researcher could use both quantitative and qualitative methods to obtain information about the MCP. This design normally consists of two phases. In Phase I, quantitative data is collected and evaluated for extreme or outlier cases. In particular, this research identified specific quantitative results that need further explanation. The qualitative aspect will then enhance what was learned from the quantitative results. This is then followed up

with Phase II, with the intention of refining, extending, or explaining those findings through an in-depth qualitative exploration. Furthermore, the qualitative data is used for interpretation and clarification of the results from the quantitative data analysis. During this phase the two points of data are integrated thus creating mixed methods research; with the researcher combining the results to determine what aspects enhanced the research questions. In summary, through this explanatory mixed methods design, the researcher used quantitative data in Phase I to identify outlier cases. These outlier cases were students who did not fit the typical mathematics performance/self-efficacy predisposition. And then during Phase II qualitative data was incorporated through student interviews in order to refine, extend, or explain the outlier cases.

For Phase I, both of the research questions required quantitative data analysis using data collected from the district assessment and surveys. The district assessment was used to answer the second research question while the surveys focused on the first research question. This assessment was conducted during class time and students' responses were recorded for analysis. Once the data for the survey and district assessment was collected and evaluated, an comparison was made between the pretest and posttests to determine statistical significance. Furthermore, the data was used to identify the outlier students in which their self-efficacy did not align with their mathematical achievement. In particular, the quantitative data scores from the district assessment were grouped with the quartile scores from the self-efficacy survey. Students were then chosen to participate in individual interviews based on their self-efficacy scores and district assessment results (Phase II).

During Phase II, this research employed a set of open-ended interview questions conducted after the survey and district assessment. This aligns with the concept of sequential explanatory since the research was using the responses to determine the effect the quantitative

data has on self-efficacy and mastery of mathematical concepts. In particular, the qualitative results were used to explain the quantitative results and together the two provided a better understanding of the significance of the Modern Classroom Project. Once the quantitative data were recorded, the performance rating and self-efficacy rating were placed side by side and analyzed for all of the participants in the treatment group. This data analysis placed students into different groups (i.e., high self-efficacy/high achievement, low self-efficacy/low achievement, low self-efficacy/high achievement, and high self-efficacy/ low achievement). Any students with an average rating in either performance or self-efficacy were not considered for the interviews. When these groups were established, each student from the last two groups (high self-efficacy/low achievement or low self-efficacy/high achievement) was interviewed. In terms of the qualitative data, responses were coded to determine what aspect of the MCP affected students' mastery of mathematic concepts and self-efficacy. Seidman (2006) argues that the purpose of open-ended questions is to understand the experiences lived by individuals. So, to determine how effective the MCP is for changing student's perception of self-efficacy this study used a set of open-ended questions in a semi-structured format to flush out those incidents. In particular, the participants answered a set of questions and if they stated a concept that pertained to the research, that response will be coded based on the research question. To help establish a coding procedure this field study followed the guidelines provided by Emerson et al. (2011). Notably, this project used their suggestion of naming, distinguishing, and identifying the conceptual importance and significance of each response. Furthermore, this study integrated their ideas on data analysis by interpreting, and clarifying the questions being presented to the contributors. Table 3.1 shows an overview of the research questions, data sources used to answer the research questions, and the methods of analysis.

Table 3.1

Data Analysis overview

Phase	Research Question	Instrument/Data source	Data Analysis
1	In what ways does the Modern Classroom impact students' mastery of mathematical concepts?	District Assessment	Comparison
1	How does the Modern Classroom Project affect students' self-efficacy?	Self-Efficacy Survey Modern Classroom Survey	Comparison
2	In what ways does the Modern Classroom impact students' mastery of mathematical concepts? How Does the Modern Classroom Project affect students' self-efficacy	Student Interviews	Constant Comparative

After analyzing both the quantitative and qualitative data, the four analyses were brought together to compare and relate to one another to provide stronger information about the influences the MCP has on student mastery of content and self-efficacy.

Location

The research site for this field study was North Town High (pseudonym) located in Lexington, Kentucky. North Town High school is currently composed of 1,640 students and 115 teachers. North Town High School is a Title-One School with 70% of the students qualifying for free and reduced lunch. In terms of demographics the school is composed of 623 White, 574 African Americans, 385 LatinXs, and 58 mixed races. The school is also unique by utilizing an academy model to help students prepare for their future, including a medical, engineering, leadership, Station Arts, and information technology pathways. In terms of the structure of the building there are two stories and two wings. The building is further broken down by hallways where students participate in classes that integrate their academic pathway.

Participants

The participants in this study were students all in 8th grade (N=62) and enrolled in Advanced Geometry at North Town High School. Students were between 13-14 years old. These students were chosen based on their MAP scores and attended high school to receive their geometry credit. The gender of the students consisted of 41 females and 21 males. Race proportions were as follows: Black (19%), Mixed-Race (2%), White (53%) and LatinX (26%). Five students had an individualized education program (IEP) or 504 and had learning adaptations planned to target their learning objectives. One teacher taught a group of 30 students using practices such as direct instructions and blended learning otherwise known as business-as-usual. The treatment teacher had 32 students and used the methods outlined by the MCP. Both courses followed the same district curriculum that was created based on the Kentucky state standards in collaboration with Pearson's instructional materials. The students enrolled in these courses were required to sign an assent form and their parents all signed a consent form. This form was

obtained by the district math specialist, who also conducted the interviews. 60 students were enrolled in the Spanish immersion program and received extra services for acquisition of Spanish. This included the majority of their courses being taught in Spanish, with English being used for clarification. However, the geometry course did not require this type of immersion.

Instrumentation

District assessment

The quantitative data was collected by implementing the self-efficacy survey and the district assessment. The district assessment (Appendix C) was created by specialist from Pearson's in collaboration with the county's math specialist and data director. The Cronbach's Alpha for this instrument was .786. This item was utilized for two reasons. First all students must complete this assessment to determine how effective the teachers are between each school. And secondly, a lot of the items are questions similar to the national tests the students complete at the end of the junior year. All questions were pulled from Pearson's national math testing data base and were aligned to Kentucky State Standards. The assessment was designed to cover four topics: foundations of geometry; parallel and perpendicular lines, transformations, and triangle congruence. The Kentucky standards that the students encountered were as follows.

- KY.HS.G.1 Know and apply precise definitions of the language of Geometry: a. Understand properties of line segments, angles, and circles. b. Understand properties of and differences between perpendicular and parallel lines.
- KY.HS.G.22 Justify and apply the slope criteria for parallel and perpendicular lines and use them to solve geometric problems.

- KY.HS.G.4 Understand the effects of transformations of geometric figures. a. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure. b. Specify a sequence of transformations that will carry a given figure onto another. c. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure. Given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
- KY.HS.G.5 Know and apply the concepts of triangle congruence: a. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. b. Explain how the criteria for triangle congruence (ASA, SAS and SSS) follow from the definition of congruence in terms of rigid motions.

In terms of the common core the district assessment utilized the following standards from the National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010) and they are as follows.

- "CCSS.MATH.CONTENT.HSG.SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
- CCSS.MATH.CONTENT.HSG.CO.A.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
- *CCSS.MATH.CONTENT.HSG.GPE.B.5* Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point);

- CCSS.MATH.CONTENT.HSG.CO.B.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions;
- CCSS.MATH.CONTENT.7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure".

Self-efficacy

The survey utilized to address student's self-efficacy score was a mathematics self-efficacy questionnaire (Appendix A) created by Umay (2001). This particular instrument has been used in two different studies; in those studies, Umay (2001) calculated the Cronbach's alpha value of the questionnaire as 0.88. Yorganci (2020) found the Cronbach's alpha value to be .80 and for this research, it was determined as 0.82. The Mathematics Self- Efficacy Scale was given as a pre- and post-questionnaire to both the control group and the treatment group. This Likert-type survey had students answering, always, mostly, sometimes, rarely, and never i.e *I feel competent in solving problems in mathematics*. Student's responses were scored for each item and then an average score was calculated to obtain the student's overall mathematics self-efficacy. On a scale of 1-5, an average score of 1 indicated a low self-efficacy, 2, or 3 demonstrated an average self-efficacy score, and a 4 or 5 was considered a high self-efficacy score.

Interviews

The study utilized two sets of qualitative data. The first was a set of open-ended semi-structured interview questions created by Mantilla (2015) (Appendix D). The students were

asked the same set of questions, but those questions were also intended to have a degree of freedom and adaptability. In particular, if more information is needed or if clarification to a student's response was required the interviewer had the opportunity to ask additional questions. Those additional questions were recorded along with the student's response.

This instrument was used for two reasons. First the interviews would allow the researcher to analyze the interviews according to the guidelines outlined by Bogdan and Biklen (1997) and Emerson et al. (2011). In particular, the data could be interpreted by using the constant comparative method created by Glaser and Strauss (1967). Secondly, that set of questions according to Mantialla (2015) were based on the four sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and physiological states.

MCP survey

The second aspect of the qualitative data was created by the MCP research team (Wolf et al., 2020) with the intention of determining students' perception of the research and to allow them to have an input on their personal education (Appendix B). The MCP survey includes items relating to:

- Engagement in the course (i.e *I use class time effectively*)
- Skills development (i.e. *I can teach myself new academic content and skills*)
- Self-efficacy (i.e. *I am responsible for my own learning*)
- Beliefs about teacher efficacy (i.e. *My teacher challenges me to learn as much as I can*)

The MCP survey also utilized a likert-scale with the students completing a strongly agree, agree, neutral, disagree, or strongly disagree with an area provided to further describe their

choice. However, those particular questions did not pertain to the two research questions but were instead utilized for personal relevance by the teachers to adjust their educational practices. In particular, the survey was intended to assess students understanding of how the MCP could help them improve their mathematical skills. However, for this study and to address the two research questions, the open-ended questions were used to strengthen the quantitative results. The survey also asked students to provide personal interpretations of different settings and situations to help understand the impact the modern classroom had on their quantitative results.

Data Collection

The research took place over a period of eight weeks through two units of mathematical focus. For the quantitative data there were three main sources: the self-efficacy survey pre and post, the MCP Survey pre and post, and the district assessment administrated as a pretest and posttest. Students completed the pretest one week before the unit with the teacher evaluating the students' scores followed by a posttest at the end of the two units. The pretest was constructed from the posttest that the district requires all students to complete. This is a critical point of the research, either the MCP served as an advantage to increase students understanding of mathematical concepts, or it had no effect on their learning ability which will be perceived as a disadvantage. In terms of the collection there were two different teachers from North Town High School acquiring the data from the students. The first set of students was the business-as-usual (BAU) group and their teacher utilized practices currently implemented in her classroom. Those practices included the following key educational concepts. First, the teacher did incorporate some blended instructions with the teacher making videos for the students to watch independently. Furthermore, upon getting the results of the preassessment the teacher integrated examples like that assessment to meet the needs of the students. And finally, the teacher taught

the same standards by through direct instructions, and group projects. The second group of students was the treatment group, and their classroom integrated the four main practices of the MCP. Upon completing the district pretests, the student responses were scrutinized to find common misconceptions and trends within students' mathematical knowledge. The teacher both the business-as-usual and the treatment teacher developed instructions strategies based on the pretest. Once the groups of common misconceptions were established the MCP teacher could then developed instructional techniques by using a range of strategies such as scaffolding, workshop model, and tiered activities to name just a few. Then upon implementing those different practices the students took the posttest. The process of this experiment design was as follows. The business-as-usual group pursued the following configuration (see Figure 3.2).

Figure 3.2 Method of learning for business-as-usual group

The treatment group integrated the best practices defined in the literature review (see figure 3.3).

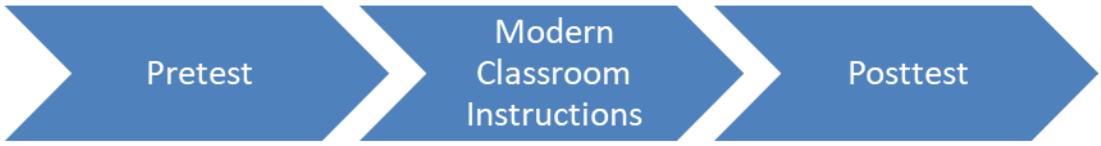


Figure 3.3 Method of learning for treatment group

The scores from these assessments were then assigned to students' individual anonymous numbers. Each exam was compared and contrasted using an analysis not only between control

and treatment group but also from the pretest to the posttest controlling for Gender, Race, and Socioeconomic status. This was conducted to determine if there were any differences between the control and treatment group.

The second point of data for this field study was the self-efficacy survey (Appendix A) that each participant completed at the beginning of the units and at the conclusion of the units. The purpose of this data point was to help the researcher determine students' perception of the MCP versus the methods used in a more traditional setting. This questionnaire also allowed the participants the opportunity to reflect on their individual perception of self-efficacy. This survey also provided the students with the opportunity to add their personal experiences about their classroom. The main focus of the questionnaire was to assess students understanding of how their instructional practices could help students improve their communication, technology and dependability scores. This survey was given during classroom instructions. Since the survey focused on students' perceptions and personal relevance of the research, a comparison between the pre-survey and post-survey was used to help answer both of the research questions. The percentage of students in the class responding Always, Mostly, Sometimes, Rarely, and Never to certain survey questions was calculated and compared to see what, if any, changes occurred in students' perceptions towards mathematical learning.

The next point of data for this research was the survey (Appendix B) created by the Modern Classroom Project. This survey had students answering Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree to five main topics. Those topics include: students thoughts, their teacher, skill development, and opinions and beliefs. This survey was given during classroom instructions, once during the start of the study, and then again at the conclusion of the study. Students completed this survey after Unit 2 and then again at the conclusion of the Unit

four. This data was also evaluated for what method of teaching the students preferred, with the reviewer looking for tendencies for or against the modern classroom project.

The final point of data for this research was the interview questions (Appendix D). This was conducted at the conclusion of the research. To remove biases the math specialist from the district conducted these interviews and she interviewed students based on their self-efficacy and mathematical achievement scores. In particular, if a student was in the category of high self-efficacy/high achievement, low self-efficacy/low achievement, low self-efficacy/high achievement, and high self-efficacy/ low achievement they were asked to partake in the interview. Table 3.2 demonstrates the number of students in each category. The students who agreed participated in about a 15 minute interview that was recorded and transcribed. This was conducted in a designated room at the field site with a computer recording the student's responses.

Table 3.2 (students interviewed)

	Low Math Achievement	High Math Achievement
Low Self-Efficacy	N=2	N=3
High Self-Efficacy	N=3	N=5

Data Analysis

For this research to determine the affect the Modern Classroom Project has on students' mathematical achievement and self-efficacy, the scores for both the pretest and posttest were evaluated and compared between the control group and the treatment group. In particular, the R-

squared values were utilized as statistical measurement of fit to indicate how much variation between the dependent variables is explained by the independent variable in a regression model. For Phase I, there were two stages of data analysis to determine which students would be considered outliners. First, the scores for the district assessment were compared between the treatment group and the business-as-usual group with students scoring low on the district assessment or high set into two categories. Secondly, students who had a high or low mean average on the self-efficacy survey were also separated into two categories.

Upon establishing the outlining students' descriptive statistics was conducted on the district assessment (RQ2) to provide basic information about the variables in the dataset and to highlight potential relationships between those variables see table 3.3. Since the absolute value of the skewness and kurtosis was less than one and the skewness and kurtosis was plus or minus two standard errors the data was considered normally distributed. Upon reviewing the descriptive statistic an analysis was utilized to determine if there was a statistical significance between the business-as-usual group and the treatment group for the district assessment controlling for Gender, Race, and Socioeconomic status. The results of this analysis demonstrated that there was no significant difference between groups. So, to test the growth (or lack thereof) in mathematical knowledge a multiple regression was performed to model the relationship between the variables. The data was subjected to a linear regression model constructed in SPSS to determine what factors contribute to student achievement. In particular, this researcher used the change between the pretest and posttest of the mathematical unit being compared to determine the effect the modern classroom on mastery. A finding was considered significant if the exams had a positive correlation to students' academic performance. The following formula was utilized: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Gender) +$

$\beta_4(SES) + \beta_5(Ethnicity) + Error$. . Upon completing the analysis, the data was checked for normality, linearity, homogeneity of variances, and homogeneity of regression slopes.

Table 3.3 Descriptive statistics for Mathematical Achievement

	Mean	SD	Variance	Skewness	Kurtosis
Pre Assessment BAU	9.83	3.152	9.937	-.367	-.802
Post Assessment BAU	13.83	3.217	10.351	-.864	.586
Pre Assessment Treatment	8.97	3.587	12.870	.014	-.998
Post Assessment Treatment	16.22	3.329	11.080	-.596	-.707

In terms of the self-efficacy (RQ1) this research used a survey developed by Umay (2001). The questionnaire he created (Appendix A) contains 14 items using a 5-point Likert scale ranging from 1 to 5. As mentioned previously Umay (2001) calculated the Cronbach's alpha value of the questionnaire as 0.88. The Mathematics Self- Efficacy Scale was given as a pre- and post-questionnaire to both the control group and the treatment group. Student's responses were scored for each item and then an average score was calculated to obtain the student's overall mathematics self-efficacy. On a scale of 1-5, an average score of 1 indicated a low self-efficacy, 2, or 3 demonstrated an average self-efficacy score, and a 4 or 5 was considered a high self-efficacy score. To determine if the data was normally distributed descriptive statistics was conducted on the self-efficacy (RQ1) to provide basic information about the variables in the dataset and to highlight potential relationships between those variables see Table 3.4. Given that the absolute value of the skewness and kurtosis was less than one and the skewness and kurtosis was plus or minus two standard errors the data was considered normally distributed. In terms of

analysis an of variance was performed on the Mathematics Self-Efficacy Scale pre-test scores to determine whether the different groups of students had similar self-efficacy controlling for Gender, Race, and Socioeconomic status. Since there was no significant difference between the two groups a regression was conducted in SPSS to determine what factors contributed to students' self-efficacy score. The following equations was utilized: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Gender) + \beta_4(SES) + \beta_5(Race) + Error$. Based on those results the regression model was used to determine the impact the Modern Classroom did or did not have on students' self-efficacy. Upon completing the analysis, the data was checked for normality, linearity, homogeneity of variances, and homogeneity of regression slopes.

Table 3.4 Descriptive statistics for Self-Efficacy

	Mean	SD	Variance	Skewness	Kurtosis
Pre survey BAU	42.33	4.536	20.575	-.216	-.674
Post survey BAU	42.33	3.975	18.161	-.047	-.770
Pre survey Treatment	40.41	3.975	15.797	-.555	.242
Post survey Treatment	43.78	4.133	17.080	-.542	-.269

The second set of surveys (Appendix B) was to help determine students' attitudes about the Modern Classroom Project. Since the other survey focused on students' self-efficacy this one measured their perceptions and personal relevance to the research. A comparison between the pre-survey and post-survey was conducted to determine if there was any statistical significance between the two groups. Descriptive statistics was conducted to provide basic information about the variables in the dataset and to highlight potential relationships between those variables see table 3.5. For the business-as-usual group and the treatment group the data was normally

distributed. The percentage of students in the class responding Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree to certain survey questions were calculated and compared to see what, if any, changes occurred in students' perceptions towards mathematical learning. This data was also evaluated for what method of teaching the students preferred, with the reviewer looking for tendencies for or against the Modern Classroom Project. In particular, the treatment group and control group both received the pre-survey and the post survey with the intention of having the students evaluate which method of learning they believed benefited their personal educational gains. The pre-survey was administrated at the beginning of the research and the post-survey will be given to the students at the conclusion of the research. The second type of analysis will be similar to the study conducted by Wolf et al. (2020). In particular, they examined changes in survey responses over time, from the midpoint to the end of the year. Their analysis showed to what extent students improved their survey scores over time and after participating in the Modern Classroom's model. Survey responses were recoded to combine "strongly agree" with "agree" responses, and the other responses (e.g., neutral, disagree, or strongly disagree) were coded as lack of agreement. Furthermore, in their study they also explored patterns in pre and mid-year survey responses by grade level. The responses from both surveys were compared and evaluated based on students' feelings and personal interpretations.

Table 3.5 Descriptive statistics for MCP

	Mean	SD	Variance	Skewness	Kurtosis
Pre Assessment BAU	77.07	9.490	90.064	-.254	.443
Post Assessment BAU	77.97	9.416	88.654	.554	1.006
Pre Assessment Treatment	84.53	10.333	106.773	-.632	-.337
Post Assessment Treatment	87.37	9.761	95.274	-.922	2.712

For the qualitative data (Phase II) this research analyzed the interviews according to the guidelines outlined by Bogdan and Biklen (1997) and Emerson et al. (2011) and used the constant comparative method created by Glaser and Strauss (1967). In particular, this researcher used their strategies on how to name, distinguish, and identify the conceptual importance and significance of each response. First, using the transcribed interviews, the researcher makes notes of themes that are emerging, patterns that were present, and connections between those pieces of data. Then those common themes are identified and sorted into different categories with codes being assigned based on the aspect of the research. Upon establishing the codes, the data was further analyzed by the guidelines provided by Kolb (2012). He suggests that the researcher integrates the following four stages: "(1) compare incidents applicable to each category, (2) integrate categories and their properties, (3) delimit the theory, and (4) write the theory" (p. 1). Furthermore, he suggests that if a response has three of the code words, then that section of the interview should be deemed important to the research. Upon coding the interviews, a comparison was conducted between the data with the reviewer looking for contradictions, expansion to students' self-efficacy claims, or other supports towards that phase one data.

Research Biases

When reflecting over the intentions of this study it is imperative that particular biases be addressed for this research. The first major bias that is prominent in this study is that North Town High (pseudonym) was having teachers pilot the Modern Classroom Project to determine if the school will adopt this method of learning. This concept has required this researcher to evaluate how the Modern Classroom Project fits into their academic model. This means some aspects have been adjusted to meet that demand along with the unique grading policy that the school practices. This includes using standards-based grading while incorporating mastery-based

grading. Furthermore, self-efficacy at the school is normally evaluated based on the students' dependability points this required the students to shift their mindset from their normal method of receiving feedback from the teacher.

Additionally, this researcher has been working at North Town High for the past six years and 32 of the participants were students within my own classroom. To help address these issues, Katherine Ridner (pseudonym) the district math specialist conducted the interviews and obtained the consent and assent forms. Furthermore, some of the participants were students who already understood my methods of teaching from older siblings. This could affect their self-efficacy score, since they already comprehend that I expect for them to advocate for their own learning while also meeting high expectations for students within the Spanish immersion program.

In terms of the qualitative results, to eliminate biases an individual from the district interviewed the students. This was conducted at the field site and had students participating in a 15–20-minute interview in an independent room from their actual classroom. However, a bias could arise from the coding of the interviews. The researcher was the only one reviewing the interviews and the study could have benefited from others also looking at the qualitative data. In particular, the district specialist or the individual teaching the control group could have highlighted the different themes and codes that enhanced the quantitative aspects of the study. Furthermore, the students could have been asked if the codes created by the researcher pertained to their beliefs. This could possibly enhance the results by providing a deeper understanding of their responses.

CHAPTER IV: RESEARCH FINDINGS

The purpose of this explanatory sequential mixed methods study was to examine the impact– positive, negative, or nonexistent- the Modern Classroom Project had on students' self-efficacy and mathematical achievement. To determine the significance of this pedagogical practice this researcher utilized an analysis of variance to check if the means of the district assessment and self-efficacy were significantly different from each other. Upon finding that there were no differences, a regression was utilized to determine the statistical impact the Modern Classroom had on self-efficacy and mathematical understanding. To explain why the Modern Classroom Project had this impact – positive, negative, or nonexistent – interview data was coded and analyzed utilizing the constant comparative method. Glaser and Strauss (1967) demonstrate this method allows researchers to name, distinguish, and identify the conceptual importance and significance of each response.

Results

4.1 First Research Question. *How does the Modern Classroom Project affect students' self-efficacy?*

4.1.1 First regression

Students in the treatment group utilized the best practices outlined in the literature review while the students in the business-as-usual group received instructions that their teacher deemed appropriate based off their pre-assessments. As previously stated, R-squared was used to demonstrate the statistical measurement between the proportion of the variance for the dependent variable (post assessment) that's explained by the independent variables-pre-assessment, and treatment. In particular, the correlation explains the strength of the relationship between the

independent and dependent variables. R-squared also explains to what extent the variance of one variable explains the variance of the second variable.

SPSS was used to determine if there were any significant differences between the business-as-usual group and treatment group on the self-efficacy survey. Multiple regression was conducted to determine if the treatment group had a statistically significant difference in self-efficacy when compared to the BAU group. That difference was found to be statistically significant ($F = 21.483$, $p<.001$). Additionally, the R square value was .421 indicating that 42.1% of the variance in posttest scores was accounted for by pretest scores and treatment group.

Upon completing the comparison of means and F test , this researcher utilized the following regression to determine what coefficients affected the results of the post survey table 4.1: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + Error$. Based on the results (see table 4.1), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. In particular, there was evidence that the MCP contributes considerable information for the prediction of the post survey. On average, the mean score for the self-efficacy survey was 2.665 higher for the treatment group than the mean score of the business-as-usual group.

Table 4.1 Multiple regression

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	15.816	4.239		3.731	<.001
	Pre	.626	.099	.642	6.319	<.001
	Treatment	2.655	.852	.317	3.116	.003

a. Dependent Variable: Post

Since the study had other factors such as race, socioeconomic status, and gender that might effect the results of the post suvery mutliple regressions were then computed to determine the effect those independent variables would have on the outcome of the post survey. VanderWeele and Robinson, (2014) demonstrated in their study that researchers need to account for socioeconomic status, race, and gender when evaluating results. Therefore, this researcher decided to control for gender, race, and socioeconomic status because they are variables that are not of interest for this study but they could influence the outcome of the self-efficacy survey. It should be noted that only one lurking variable was used at a time because the sample size was so small, therefore, each regression only adds one inpdenedent factor. Furthermore, control variables should enhance the validity of a study by limiting the influence of confounding and other extraneous variables. This in turn establishes a relationship of correlation between the variables of interest.

4.1.2 Second regression

The researcher conducted a second R-squared test, F test and regression to determine if there were any statistically significant differences on post survey scores controlling for SES. The difference was found to be statistically significant ($F = 14.515$, $p<.001$). Additionally, the R square value was .429 indicating that 42.9% of the variance in posttest scores was accounted for by pretest scores, treatment group and SES. Upon completing the comparison of means and F test, this researcher utilized the following regression to determine what coefficients affected the results of the post survey table 4.2. $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(SES) + Error$. Based on the results of the second regression (see table 4.2), students in the treatment

group versus the business-as-usual group had a statistically significant higher score. On average, the mean score for the self-efficacy survey was 2.665 higher for the treatment group than the mean score of the business-as-usual group controlling SES.

Table 4.2 regression

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	15.252	4.297		3.549	<.001
	Pre	.621	.100	.637	6.240	<.001
	Treatment	2.665	.854	.318	3.120	.003
	SES	.947	1.091	.086	.868	.389

a. Dependent Variable: Post

4.1.3 Third regression

The researcher conducted a third R squared test and F test to determine if there were any statistically significant differences on post survey scores controlling for gender. The difference was found to be statistically significant (F = 14.502, p<.001). Additionally, the R square value was .429 indicating that 42.9% of the variance in posttest scores was accounted for by pretest scores, treatment group and gender. Upon completing the comparison of means and F test, this researcher utilized the following regression to determine what coefficients affected the results of the post survey $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Gender) + Error$. Based on the results (see table 4.3), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. There was evidence that the MCP contributes considerable information for the prediction of the post survey. On average, the mean score for

the self-efficacy survey was 2.679 higher for the treatment group than the mean score of the business-as-usual group controlling for gender.

Table 4.3 Multiple regression

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	16.042	4.257		3.769	<.001
	Pre	.607	.102	.623	5.964	<.001
	Treatment	2.679	.854	.320	3.136	.003
	Gender	.794	.928	.087	.856	.396

a. Dependent Variable: Post

4.1.4 Fourth regression

The researcher conducted a fourth R squared test and F test to determine if there were any statistically significant differences on post test scores controlling for race. The difference was found to be statistically significant (F = 14.502, p<.001). Additionally, the R square value was .463 indicating that 46.3% of the variance in posttest scores was accounted for by pretest scores, treatment group and race. Upon completing the comparison of means and F test, this researcher utilized the following regression to determine what coefficients affected the results of the post survey: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Race) + Error$. Based on the results (see table 4.8), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. There was evidence that the MCP contributes considerable information for the prediction of the post survey. On average, the mean score for the self-efficacy survey was 2.564 higher for the treatment group than the mean score of the business-as-usual group controlling for race.

Table 4.4 Multiple regression

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	14.606	4.159		3.512	<.001
Pre	.635	.096	.651	6.583	<.001
Treatment	2.564	.829	.306	3.092	.003
Race	1.711	.811	.204	2.111	.039

a. Dependent Variable: Post

Through these analyses, an argument can be made that the Modern Classroom Project had a positive impact on the students' self-efficacy scores no matter what independent variable was used to calculate the slopes. However, since the study only had 62 participants the confounding variables were deemed insignificant and the following regression equation was used: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + Error$. Furthermore, the effect size (Cohen's D) was calculated by using the following equation. $Cohen's\ d = \frac{(42.33-43.78)}{4.05477} = .357604$. This suggest that there is a weak/medium relationship between the treatment and business-as-usual group post assessment scores. According to the students interviewed, there were three major factors contributing to this outcome. The first was the intentional group and partner work with 7 of the 13 students being interviewed suggesting this outcome. The main aspect, based on the students' responses, was that through this process of partner work they got to strengthen their math skills because they were required to demonstrate their own ideas about the difficult problems. In fact, Jonathan summarized this finding:

> "I probably like working with a partner, because I like that I can hear their ideas and it kind of helps me come up with an answer. Instead of as a group because there is little bit

too many people. I feel like it's always like we're all talking and and the like, okay, but like there's one problem. It's all trying to get it as different ways and with a partner. I feel it's more like, you know, they give me their idea. I give them my idea and then we can kind of like work together and solve that problem".

Furthermore, through this partner work, students got to practice their self-efficacy by presenting their point of view. Not only were they required to demonstrate their unique understanding, but they were also supposed to listen to their partners explanation and determine the best approach when solving challenging problems. This in turn, at least according to the students, allowed them to have a better understanding on different ways to approach problems when solving them.

The second aspect that helped students score well on self-efficacy was goal setting. As mentioned in the literature review, Marzano et al. (2001), suggest that through the process of goal setting, students can evaluate their own skill set and reflect on their learning. In terms of this study, four of the thirteen students who were interviewed thought that through the process of reflecting and sharing their goals they demonstrated their individual understanding while also reinforcing their peers' knowledge. Molly summarized this belief with the following quote:

"You look more self-reliant. You're like, oh, I think I did good on this, but and then you start comparing yourself to other people saying, oh they did this. I got better than that. And now it's both but you can't be really don't compare yourself to people because, you know, they're on their own level. There may be doing better because they're learning a different way and stuff".

While the students did share and discuss their goals, the above quote demonstrates that the students understood that a unique goal was tailored to what they hoped to accomplish.

Furthermore, students were aware that not stressing about others understanding allowed them to have more confidence in their own ability.

Lastly, the students believed that through the process of receiving feedback on the projects associated with each unit of study they felt more confident in advocating for themselves. These projects were meant to reinforce student knowledge while also summarizing the learning objects. In terms of the student, seven of the thirteen students interviewed argued that through the process of feedback they were able to see their mistakes and feel confident in asking questions. Henry summarizes this belief with the following quote.

> "I really like it, and I understand his feedback. And I'm not afraid to ask questions either because he doesn't make us feel like we can't ask questions. So I feel really comfortable asking questions for me too. But most of the time I feel really good about it, and I know what I'm doing regarding like the curriculum, like, Advanced geometry".

When effectively used, feedback provides students with accurate information about what they understand and can do, as well as areas where they still need to build proficiency. In terms of the Modern Classroom Project, the quality of the question is at the heart of effective feedback. When a teacher provides corrective feedback, students should use those comments to clarify their understanding, evaluate their work, find errors, make corrections, and apply their learning to different problems.

Based on the student responses these three attributes enhanced students' self-efficacy score by providing a learning atmosphere were ultimately the students could collaborate, provide feedback to each other and help each other learn. And through the process of presenting their point of view, the students realized that their ideas had merit to those within their groups.

Furthermore, the students interviewed demonstrated that feedback, collaboration, and goal setting provided them with new insights into the way they learn and present their unique understanding of difficult concepts.

4.2 Second Research Question. *In what ways does the Modern Classroom impact students' mastery of mathematical concepts?*

4.2.1 First regression

As previously stated, R-squared was used to demonstrate the statistical measurement between the proportion of the variance for the dependent variable (post assessment) that's explained by the independent variables-pre-assessment, and treatment. In particular, the correlation explains the strength of the relationship between the independent and dependent variables. R-squared also explains to what extent the variance of one variable explains the variance of the second variable.

SPSS was used to determine if there were any significant differences between the business-as-usual group and treatment group on the self-efficacy survey. Multiple regression was conducted to determine if the treatment group had a statistically significant difference in self-efficacy when compared to the BAU group. That difference was found to be statistically significant ($F = 24.992$, $p<.001$). Additionally, the R square value was .459 indicating that 45.9% of the variance in posttest scores was accounted for by pretest scores and treatment group. Based on the regression see table 4.5 there was evidence that the treatment group had a higher posttest score. On average, the mean score for the district assessment was 2.904 higher for the treatment group than the mean score of the business-as-usual group score.

Table 4.5 Multiple regression

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	7.932	1.081		7.337	<.001
	Treatment	2.904	.664	.422	4.374	<.001
	Pre	.600	.099	.586	6.071	<.001

a. Dependent Variable: Post

As previously mentioned there are other variables such as race, socioeconomic status, and gender that might effect the results of the posttest. Therefore, mutliple regressions where computed to determine the effect those independent variables could have on the outcome of the posttest. The reason this researcher decided to controll for gender, race, and socioeconomic status because they are variables that are not of interest for this study but they could influence the outcome of the posttest of the district assessment. Furthermore, control variables could possibly enhance the validity of this study by limiting the influence of confounding and other extraneous variables. This in turn establishes a relationship of correlation between the variables of interest.

4.2.2 Second regression

The researcher conducted a second R-squared test, F test and regression to determine if there were any statistically significant differences on post survey scores controlling for SES. That difference was found to be statistically significant ($F = 16.640$, $p<.001$). Additionally, the R square value was .463 indicating that 46.3% of the variance in posttest scores was accounted for by pretest scores, treatment group and SES. Upon completing the comparison of means and F test, this researcher utilized the following regression to determine what coefficients affected the

results of the post survey table $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(SES) + Error.$ Based on the results (see table 4.6), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. On average, the mean score for the district assessment was 2.913 higher for the treatment group than the mean score of the business-as-usual group, controlling for SES.

Table 4.6 Multiple Regression

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	7.494	1.278		5.863	<.001
	Treatment	2.913	.667	.424	4.365	<.001
	Pre	.597	.099	.583	6.001	<.001
	SES	.565	.867	.063	.651	.518

a. Dependent Variable: Post

4.2.3 Third regression

The researcher conducted a third R-squared test, F test and regression to determine if there were any statistically significant differences on post survey scores controlling for gender. That difference was found to be statistically significant (F = 17.215, p<.001). Additionally, the R square value was .471 indicating that 47.1% of the variance in posttest scores was accounted for by pretest scores, treatment group and gender. Based on the regression $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Gender) + Error$ (see table 4.7), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. On average, the mean score for the district assessment was 2.973 higher for the treatment group than the mean score of the business-as-usual group, controlling for gender.

Table 4.7 Mulitple regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	7.265	1.220		5.954	<.001
	Treatment	2.973	.665	.433	4.474	<.001
	Pre	.606	.099	.592	6.140	<.001
	Gender	.833	.715	.112	1.166	.249

a. Dependent Variable: Post

4.2.4 Fourth regression

The researcher conducted a fourth R-squared test, F test and regression to determine if there were any statistically significant differences on post survey scores controlling for race. That difference was found to be statistically significant (F = 16.381, p<.001). Additionally, the R square value was .459 indicating that 45.9% of the variance in posttest scores was accounted for by pretest scores, treatment group and gender. Based on the results $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + \beta_3(Race) + Error$ (see table 4.8), students in the treatment group had statistically significantly higher scores on the posttest than students in the control classes. On average, the mean score for the district assessment was 2.907 higher for the treatment group than the mean score of the business-as-usual group, controlling for race.

Table 4.8 Multiple Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
	(Constant)	7.956	1.149		6.926	<.001

	Treatment	2.907	.671	.423	4.333	<.001
	Pre	.600	.100	.586	6.016	<.001
	Race	-.044	.667	-.006	-.066	.948

a. Dependent Variable: Post

Through these analyses, an argument can be made that the Modern Classroom Project had a positive impact on the students' mathematical achievement scores no matter what independent variable was used to calculate the slopes. However, since the study only had 62 participants the confounding variables were deemed insignificant and the following regression equation was used: $Post = \beta_0 + \beta_1 Pre + \beta_2(Treatment) + Error$. Furthermore, the effect size (Cohen's D) was calculated by using the following equation. $Cohen's\ d = \frac{(13.83-16.22)}{3.273479} = .73011$. This suggest that there is a strong meaningful relationship between the treatment and business-as-usual group post assessment scores. According to the students interviewed there were two major factors that contributed to this outcome. First, all thirteen students believed that self-pacing allowed them to master the materials without concern for what their peers were currently working on. In fact, a student had this to say about the process.

> "I mean, I really like the self-paced class, like, it really works for me because like, it helps me get my work done, like at my own pace and do it when I want to do it. And it's like, it makes me even more self-motivated, because if I want to like, if, if I'm doing it when I want to do it, right? It makes it easier for me and less frustrating".

Furthermore, the students demonstrated that the self-pacing was their favorite aspect of the Modern Classroom Project. All thirteen students, in one form or another, discussed that through self-pacing they do not feel pressured when they initially do not understand a concept. They in fact argued that this process not only increased their confidence, but also helped them perform

better on the exams. Their main argument was that when they did not pass a mastery check they could receive additional help from either the teacher or their peer and then retake a new set of problems and pass it.

The second aspect that the students believed helped them master the content was the practice assignments. Ten of the thirteen students interviewed discussed that while working through the online software they could check their answer, and if they got the answer wrong, they could generate another problem and try again. The following quote from a student summarizes this belief.

> "I have a learning disability. So, it's sometimes like really hard for me like mental math and stuff like that. But when I do the math problems and I get them, right. I feel really like proud of myself that I could do it and I am smart, but sometimes, if I don't get the certain grade that I wanted, I feel really stupid or like I beat myself up too much. However, Mr. Smith will always help you if you need help. And yes, I normally do really well because of how the class is set up. There is just a video, then work and then like a small like quiz or whatever. So, it's mostly really easy especially cuz it's just like you can do a back-to-back to back problems until you get them right. So you learn it, you practice it and if you fail you can get a new quiz on it".

The students also demonstrated that through this process of completing extra problems until they got them right helped them master the materials. Their main argument was that they could identify their mistakes based on the feedback from their peers or teacher and then rectify those misconceptions by trying again.

Additional Findings

Nearly every student interviewed believed that they felt more engaged in the process of learning because they were allowed to master the materials before moving onto the next component of the unit. One of the key reasons, at least according to the students was the self-pacing aspect of the course. In fact, Maribelle had this to say about the process: “The freedom of not having due dates and being able to learn on my own time”. Furthermore, the students also believed that through self-paced learning they had an increase in their soft skill development such as goal setting, work ethic, and establishing a growth mindset. Their main argument was that collaboration combined with the self-pacing allowed them to help and encourage each other. This in turn established a routine that they could easily follow.

Since, the district assessment had common core standards and state standards, this researcher decided to look at the difference in the mean scores for the treatment group and the business-as-usual group. In particular, the questions were grouped according to their standards and then compared between the two groups, the results are as follows. For the standard “CCSS.MATH.CONTENT.7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure” the following data was obtained:

Table 4.9 means by standard

Group		Q1	Q2	Q3	Q4
BAU	Mean	.87	.87	.87	.93
	N	30	30	30	30
	Std. Deviation	.346	.346	.346	.254
Treatment	Mean	.97	.84	.94	1.00
	N	32	32	32	32
	Std. Deviation	.180	.374	.250	.000
Total	Mean	.92	.85	.90	.97

N	62	62	62	62
Std. Deviation	.277	.358	.300	.180

Based on this information the students in the treatment group had a higher average then the students in the business-as-usual group for questions 1, 3 and 4 but lower for question 2.

The means were then compared on the standard *CCSS.MATH.CONTENT.HSG.GPE.B.5* Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point. See table 4.10.

Table 4.10 means by standard

Question 5

Group	Mean	N	Std. Deviation
BAU	.07	30	.254
Treatmetn	.68	32	.475
Total	.38	62	.489

Based on this information the students in the treatment group had a higher average then the students in the business-as-usual group for questions 5.

The same report was then conducted on the standard "CCSS.MATH.CONTENT.HSG.CO.A.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments". See table 4.11.

Table 4.11 means by standard

Group		Q6	Q7	Q8	Q9
BAU	Mean	.77	.73	.87	.86
	N	30	30	30	30

	Std. Deviation	.430	.450	.346	.346
Treatment	Mean	.74	.77	.90	.87
	N	32	32	32	32
	Std. Deviation	.445	.425	.301	.341
Total	Mean	.75	.75	.89	.87
	N	62	62	62	62
	Std. Deviation	.434	.434	.321	.340

		Q10	Q11	Q12	Q13
BAU	Mean	.80	.47	.60	.67
	N	30	30	30	30
	Std. Deviation	.407	.507	.498	.479
Treatment	Mean	.68	.71	.87	.90
	N	32	32	32	32
	Std. Deviation	.475	.461	.341	.301
Total	Mean	.74	.59	.74	.79
	N	62	62	62	62
	Std. Deviation	.444	.496	.444	.413

Based on this information the students in the treatment group had a higher average then the students in the business-as-usual group for questions 7, 8,9, 11,12, and 13 but lower for question 26 and 10.

Another report was conducted for the standard:

“CCSS.MATH.CONTENT.HSG.SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures. See table 4.12

Table 4.12 means by standards

Group		Q14	Q15
BAU	Mean	.20	.80
	N	30	30
	Std. Deviation	.407	.407
Treatment	Mean	.81	.71
	N	32	32
	Std. Deviation	.402	.461
Total	Mean	.51	.75
	N	62	62
	Std. Deviation	.504	.434

Based on this information the students in the treatment group had a higher average then the students in the business-as-usual group for question 14 but lower for question 15.

Finally, the same report was performed on the standard: "CCSS.MATH.CONTENT.HSG.CO.B.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions" see table 4.13.

Table 4.13 means by standard

Group		16	17	18	19	20
BAU	Mean	.63	.70	.63	.57	.97
	N	30	30	30	30	30
	Std. Deviation	.490	.466	.490	.504	.183
Treatment	Mean	.68	.97	.58	.71	1.00
	N	31	31	31	31	31
	Std. Deviation	.475	.180	.502	.461	.000

Total	Mean	.66	.84	.61	.64	.98
	N	61	61	61	61	61
	Std. Deviation	.479	.373	.493	.484	.128

Based on this information the students in the treatment group had a higher average then the students in the business-as-usual group for questions 16,17,19, and 20 but lower for question 18.

The researcher was also interested in the students' perspective on the modern classroom project. A question from the MCP survey was "what do you like most about this class"? There were three major responses from the students. The first response, with 18 students suggesting that the best component of the modern classroom project was self-pacing. As mentioned above the students believed that self-pacing was helping them master the materials because it provided them with the freedom to establish their own pace of learning. Furthermore, when students finished the required materials, they had the opportunity to work on extra materials called aspire to do. These were designed to help the students connect what they were learning with the real world. And through that connect students had a better understanding of the materials. The second aspect that the students enjoyed about the modern classroom project was collaboration. Emma had this to say about the process: "I like that once students are done with their work, they can help others with theirs". This was a common occurrence in the classroom, many students were consistently providing feedback and suggestions on how to approach challenging problems. The final element that students enjoyed about the Modern Classroom Project was the ability to receive help, in particular small group tutoring or 1-1. Rachel had this to say about the process: "Whenever we start doing the work, it's fun for me. I think of it like a game. It's kind of, like, I'm trying to solve the puzzle and stuff and once I get it wrong, I don't really feel too mad about it because it's, you know, I if I need help, I'll ask him and he'll help me." Overall, the students in

the treatment group believed that the Modern Classroom Project provided them with ample time to master the materials and through that self-pacing aspect, students believed that were developing skills to work independently.

Summary of the results

The purpose of this sequential explanatory mixed methods study was to examine the impact Modern Classroom had on student's mathematical achievement and self-efficacy scores. In terms of how the data was analyzed there were two major phases. In Phase I the study wanted to address RQ1 and RQ2 by using the district assessment and the self-efficacy survey. In particular, the ratings to measure students' self-efficacy as well as performance in mathematics was calculated. Then based on those results the students were given ratings of high, average, or low, on the district assessment and self-efficacy survey. Those ratings were then used to place students into one of the four categories: students with low performance/high self-efficacy, low performance/low self-efficacy, high performance/low self-efficacy, and high performance/high self-efficacy. This study then focused on phase 2 with students in the high performance/low self-efficacy and low performance/high self-efficacy being interviewed. In Phase II, the students in these categories were interviewed in order to answer the two different research question. The responses from each student were recorded, coded, and categories were formed based on their responses. The interview questions were then organized and analyzed according to Bandura's (1995) sources of self-efficacy: mastery experiences, vicarious experiences, verbal persuasion, and physiological states. These responses were then combined with the results from the self-efficacy survey and the district assessment.

Students in the treatment class were found to have a statistically significant higher post test scores compared to the business-as-usual group. Furthermore, the treatment group had a

statistically significant higher self-efficacy score compared to the business-as-usual group. Based on the students' interviews, there were three main benefits of the Modern Classroom Project. First, students enjoy the self-paced aspect of the Modern Classroom Project. Many of them stressed, that through that process, they did not feel pressured to learn as quickly as some of the other students. Rachel in fact said: "The freedom of not having to turn in materials at the same time and being able to learn on my own time". Second, the structures in place, such as small group tutoring and collaboration, allowed students to take responsibility for their learning. One student said: "I like that once students are done with their current lesson, they can help others with theirs". And lastly, the Modern Classroom Project created a positive atmosphere where the students could ask detailed questions and receive individual tutoring. These results indicate the MCP if integrated correctly can help students' master mathematical concepts and increase their self-efficacy.

CHAPTER V: DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

Given that the Modern Classroom Project has only been around for a few years, it is imperative that teachers, parents, administration, and educational stake holders understand the impact this educational practice can have on students' mathematical achievement and self-efficacy. While the Modern Classroom Project does utilize four distinctive pedagogical practices, the need to recognize how and why those practices influence students' ability to learn should be addressed. Nye et al. (2004), demonstrate in their study, that teachers differ in their effectiveness based on their training. Furthermore, they suggest that instructional practices or schools need to have a more efficient training program that integrate "best" practices. Their main suggestion is that teachers need the opportunity to have more of a say in the instructional outcomes of the school. With this idea in mind, the purpose of this explanatory sequential mixed method was to

determine how the MCP could help teachers design a classroom to increase students' confidence and mathematical ability.

This study investigated how the MCP, when implemented in a high school mathematics course, can influence students conceptual understanding of mathematics while also promoting self-efficacy. The results of the study indicate that the use of blended instructions, metacognition, self-pacing, and mastery-based learning had a positive impact on students' self-efficacy and mathematical achievement scores. Students whose scores increased from the pretest to the posttest and from the pre-survey to the post survey, indicated that there were four major factors that contributed to their overall higher score. The first was self-pacing, with the students indicating that this aspect really promoted their understanding. The second characteristic was goal setting, with the students demonstrating that reflecting on their learning allowed them to identify common misconceptions in their work. The third was academic feedback, with the students arguing that through the process of receiving feedback they developed a better comprehension of their individual skills. And lastly, collaboration was a key component of mastering the materials because it allowed them the opportunity to work in groups to solve the problems presented to them. A discussion of the results, followed by the conclusions, limitations, and implications are provided in the subsequent sections.

5.1 Discussion of the Results

Overall impact. Upon controlling for each one separating race, gender, and socioeconomic status, the treatment classes had a statistically significantly higher posttest and post survey results than students in the business-as-usual group. The quantitative data showed that both the self-efficacy and mathematical achievement scores increased by a significant amount, with an average score of 2.904 higher on the district assessment and 2.655 higher on the

self-efficacy survey. During the qualitative phase of this study, the researcher used a set of open-ended questions to determine what aspects affected students' scores. Based on the students' responses there were four aspects related to these positive outcomes: (a) collaboration, (b) feedback, (c) self-pacing, and (d) goal setting. These four concepts are reinforced by the literature review and highlight how this educational practice could help teachers design instructions that ultimately allow students to take ownership of their learning. Furthermore, those four outcomes influenced self-efficacy and mathematical achievement by providing students the opportunity to participate in four educational practices that require them to find relevance in what they are learning.

5.1.1 Self-Efficacy

As previously mentioned, the theoretical framework for this study was the Social Cognitive Theory and self-efficacy. Bandura (1977) demonstrates that students ultimately acquire knowledge through social interactions, and that learning will occur when a student understands the reciprocal interaction of the person, environment, and behavior. LaMorte (2019) takes this concept a step further by demonstrating that a person's actual ability to perform a certain behavior are a product of their essential knowledge and skills. In terms of self-efficacy Bandura (1977), shows that it reflects the students' confidence in their ability to exert control over one's own motivation, behavior, and social environment. With these ideas in mind and based on this research, there were three major aspects that helped students increase their self-efficacy score and that was collaboration, goal setting, and feedback.

Based off the quantitative data, students in the treatment group scored 2.592 higher on the self-efficacy survey then the business-as-usual group. One of the main factors based on the qualitative results was collaboration. Rebecca summarizes this belief with the following quote: "I

like partner work, I get the most done because I don't have any distractions, but when I'm working with a partner, I can, we can like, collaborate on certain things, and it might be better for grades and stuff". This is reinforced by Nuri's (2019) argument that when a teacher involves and motivates students through interactivity and collaboration, they will have a higher self-efficacy. Smith and Brame- (2018) also provide justification on how collaboration will help students improve their self-efficacy, and they provide two major benefits for the students. First, students, when collaborating, will have an increase in conceptual understanding and perform better on different assessments. And secondly, when teachers correctly integrate cooperative learning into the classroom, students' self-regulation and self-efficacy skills will improve. Kim et al. (2014) also provide a rational on why students self-efficacy scores will increase. They argue that students who learn perseverance, including the amount of time and effort they will give, perform better on assessments, with their main argument being that effort impacts their academic performance by providing them with the necessary skills to self-regulate.

The second aspect on why students scored higher on the post-survey was goal setting. Every student was required to establish a goal at the beginning of the unit. This goal was always chosen by the student and had to reflect their current level of understanding. Many students would establish goals such as: "complete the work in a timely fashion", "complete all of the videos", or "get 4 of the 5 questions right on the mastery check". Marzano, et al. (2001) agree with this finding and establish that goal setting can increase student learning between 18 and 41 percentile points. Their main argument was that through this process of goal setting, students have the unique opportunities to create learning objectives. These learning objectives not only effectively communicate to the teacher what they would like to master, but it also allows them to participate in independent learning. Saphie et al. (2008) also demonstrated the importance of

contractual goals. Their argument is that when students engage in academic goal setting and personal goals this in turns fosters active involvement. This participation is highly beneficial to students because it allows them to focus on aspect of their learning that is meaningful to them.

The final aspect that influenced student's self-efficacy score was academic feedback. A quote from Joshua summarizes this belief: "My mind immediately tells me just to stop and I try not to, but I normally just ask Mr. Smith for help, and he'll help and he knows how I need help". Bellon et al. (1997) and Dean et al. (2012) confirm this finding by demonstrating that academic feedback is a crucial skill that teachers must implement to raise student achievement and understanding of materials. Furthermore, they argue that the more feedback students receive, the more likely they are going to become aware of their learning style. This in turn makes it easier for the students to recognize their mistakes and develop strategies for overcoming those obstacles. However, the manner in which students receive this feedback is extremely vital, and teachers need to integrate strategies that have proven to be successful. This includes demonstration of mistakes, feedback between the students, with individuals explaining their process, and opportunities to correct their mistakes. This concept is reinforced by Kulik et al. (1990); Saphier et al. (2008); and Marzano et al. (2001) where they provide ample research on how goal setting effects students' self-efficacy scores. They provide four concepts that help improve students' independent skills which include self-reflecting, timely feedback, collaborative feedback, and feedback that is matched to the learning objective.

Overall, these three concepts: collaboration, goal setting, and feedback had a positive impact on students' self-efficacy scores by providing them with the means in which to learn from their mistakes. This is crucial when implementing the requirements of the Modern Classroom

Project, since it allows the students to understand how and why they need to master the materials.

5.1.2 Mathematical achievement

Based off the quantitative data, students in the treatment group scored 2.993 higher on the post assessment then the business-as-usual group. When reviewing the qualitative data there were three aspects that contributed to this finding. Those concepts were self-paced learning, academic feedback, and formative assessments. Each component, if utilized correctly, had a distinct impact on students' mathematical achievement. While the study did not focus on which particular aspect contributed to a higher score, the students in the treatment group had to participate in all three of these components of the Modern Classroom Project.

The first concept that every student interviewed believed helped them do better on the district assessment was self-paced learning. Emery does a great job summarizes the students' beliefs:

> "I personally think that in this class, what I'm doing is a lot easier than like any other class I've done. Considering it's like a self-paced class and I like I can like tell myself when I need to do something. Like I have a specific due date, but it's like they give me plenty of time to like work because if I didn't, I would like rush myself and not really understand. Like what I'm learning to work again over the standard that day. I feel like with the self-paced, it's showing me a lot more, like, good opportunities to like myself and to like teach myself. Yes, get ready for like other things. Okay, so myself how to like prepare, and like self-pace and time things, good, do other things".

This is reinforced by Balentyne and Varga (2016); and Edwards and Rule (2013) where they demonstrate that self-paced learning provides students with opportunity to learn materials at a pace in which is conducive for their individual learning style. Furthermore, they argue that since certain class concepts often build upon each other, allowing a student to master a concept before moving unto the next skill gives them a better understanding of that specific standard. An argument is then made that through self-paced learning of mathematics teachers create an atmosphere where boredom and lack of motivation is eliminated since students are empowered in their pursuit of knowledge. And when students are motivated to learn the material at their own pace, they do better on performance assessments since they are not required to learn in the same manner as their classmates. Finally, through self-paced learning, students are provided the opportunity to customize their learning environment to fit their individual needs. This in turn should increase achievement scores by helping students engage in authentic learning.

The second aspect that not only improved students' self-efficacy but also increased mathematical achievement was corrective feedback. For students in the treatment group, the teacher would consistently work in the small groups providing feedback on the practice and assessment work. Furthermore, students could also provide feedback to each other and had guidelines on how to accomplish effective advice. A quote from Jonathan summarizes this concept: "First, I try to work through it, and then I try to get Mr. Smith for help, he's always helping other people and stuff. But if he can help me, then that like that because it's like one-on-one, but if not, then I'll just ask the person who sits next to me or, like another friend". This idea is reinforced by Kulik et al. (1990); Saphier et al. (2008); and Marzano et al. (2001) who provided the researcher with five strategies teachers need to utilize when implement feedback. In

their studies, they suggest that through the implication of feedback, students will start to develop metacognitive skills that in turns helps them master the materials. Furthermore, having students evaluate other works will provide them with alternative ways of thinking about the problem and will enhance their understanding. And finally, feedback that is given in a timely fashion allows students modify their learning behavior in ways that are impactful. This method of providing feedback in a timely fashion is reinforced by the arguments of Saphier et al. (2008). In their study, they demonstrated that assignments need to be constructed in such a way that feedback will happen naturally. During that process of corrective feedback, students have the opportunity to modify their learning by understanding their mistakes. Once they understand their mistakes, they should be then given the opportunity to fix those mistakes. During this process of error analyses, as well as self-analysis Saphier et al. (2008), argue this process is critical in constructing students understanding.

Bellon et al. (1997) and Dean et al. (2012) take this a step further and suggest that the feedback students receive on assessments is the most important predictor on student achievement. Their main argument is that the more feedback students receive the more likely they are going to become aware of their learning style. And when they are more familiar about the way they learn they can recognize their mistakes and develop strategies to eliminate those misconceptions. Overall, an argument could be made that the way students receive this feedback was extremely vital to improving students' mathematical achievement and teachers need to integrate strategies that have proven to be successful.

The final attribute that helped students in the treatment group score well on the district assessment was formative assessments. Every lesson, students had two forms of practice work, the video with questions built in, and the MATH XL sheet that reinforced the materials watched

in the video. In terms of why formative assessment was beneficial for helping students master the materials an argument from Lee (2014) provides three justifications. The first is that when students are having their work evaluated the teacher and student can determine if they have reached a high level of understanding before moving on. The second contribution is that the teacher can identify specific learning needs and plan future lessons that target deficiencies. And finally, students can track their individual process making sure they are reaching their established goal. Saphier et al. (2008) go a step further and discuss that assessments need to be leveraged in a way that fosters feedback and helps modify student learning this in turn will have an increase in their understanding. Furthermore, they argue that frequent error analysis on behalf of the teacher, as well as self-analysis of errors on behalf of the student, will increase their understanding.

White (2019) also provided three benefits on why formative assessments will increase student learning. First, teachers can differentiate the materials to help meet the needs of the students. This happened often in the classroom. The teacher would make instructional decisions by collecting and analyzing student work and then modify those assignments to help others. This in turn allowed the students to receive individualized problems. The second aspect that helped students master the content was mastery checks. Every student had to complete a five-question check at the end of each lesson. And through this process of providing students quick mastery checks, it boosted their self-confidence because they could see a correlation between what they practice with what they needed to understand. And from that understanding the students can start taking ownership of their learning and encourage students to collaborate on the assignments. And lastly, if students are given immediate feedback on assessments, they can see a measurable

difference in their understanding. This in turn allows students to adjust their mindset and develop self-regulation skills like perseverance, critical thinking, and problem solving.

The final concept on why formative assessment work helped students master materials was the pace in which they could complete those assignments. Since the students were allowed to self-pace, they could retake the MATH XL sheets as many times as needed to receive a score they believed was beneficial to their learning. This is reinforced by Anderson, (1995); Marzano et al. (2001); and Newell and Rosenbloom, (1981) where they demonstrate that teachers need to be aware that when students are acquiring new skills that they need ample time to practice applying them to different situations. Furthermore, for students to master the content, the teacher must design problems that focus on specific elements of that complex skill. Saphier et al. (2008) elaborate on those findings by demonstrating that formative assessments need to be frequent and collaborative. They also suggest that allowing students the opportunity to freely ask questions, provide feedback and support for their peers will create a classroom that promotes academic success.

Overall, these three concepts: self-paced learning, corrective feedback, and formative assessments had a positive impact on students' mathematical achievement scores by providing them with opportunity to mastery materials at their own pace. This is crucial when implementing the requirements of the Modern Classroom Project, since it allows the students to understand that not every student learns in the same manner. Furthermore, through these three educational practices, students got to see the benefits of preserving when encountering challenging problems. Through that diligence, the students ultimately scored better on the post assessment.

5.2 Conclusions

This research had two questions: *How does the Modern Classroom Project affect students' self-efficacy* and *in what ways does the Modern Classroom Project impact students' mastery of mathematical concepts?* After reviewing the results, the hypothesized questions have data that supports their claim. First, the Modern Classroom Project does increase students' self-efficacy, because students are more likely to have lesson that actively engage them in the learning process, thus, allowing them to develop their own ideas and concepts about the material. This in turn gives the students a greater appreciation for mathematical concepts and makes those concepts tangible. This fundamental concept is a common theme in the literature on the Modern Classroom Project. Second, the MCP, based off the findings from this study, did improve student's exam scores. This becomes apparent after reviewing the pretest, posttest, and summative assessments; the growth of the student scores were statistically significant. After reviewing the data, the increase in mathematical achievement coincides with what the literature has to say if teachers decided to dynamically carve apart the curricular, elements of content, process, and product, they have the opportunity to create a new product or lesson plan that targets students' deficits. Teachers also have the luxury of diversifying their lessons, so that they will incorporate instructional practices that effectively work in targeting numerous learners. These advantages include a higher level of engagement, fewer behavioral issues, and students perceiving those difficult mathematical concepts can be entertaining and challenging to learn.

This researcher believes that the Modern Classroom Project is a useful tool to help engage students and create a classroom that integrates best practices. This study did show a significant increase in students' mastery of mathematical materials and self-efficacy. And when a teacher uses the MCP model, the result should be higher achievement in the classroom,

especially when teachers decide to actively meet the needs of each individual learner. If students have lessons that target their personal needs, they are more likely to engage in the process of learning, thus generating their own unique ideas about the materials. Students who are also actively engaged will most likely be able to retain and recall factional information and apply it to classroom situations and then evaluate that information and apply to real world situations.

Overall, these results could be used to show that students are more likely to participate in activities and find instructional practices to be engaging if the teacher takes the time to actively change their classroom. If teachers understand that readjusting certain ways, they use materials and teaching methods, the outcome should be a more enjoyable experience for the students. This will then allow the student and teacher to work collaboratively towards the same goal-mastery of the desired content.

5.2.1 Limitations

When evaluating how the Modern Classroom Project impacted students' mathematical achievement and self-efficacy, it is imperative that this research also discusses the limitations of this study. Those limitations include, sample size, location, number of teachers, and composition of the classes. In terms of sample size, this research targeted two geometry classes with one class having 32 students and the second class 30 students. Both classes had students with learning disabilities such as attention deficit hyperactivity disorder, and difficulty with reading and language development. A limitation could arise when trying to create an environment that will correctly encompass these students without hindering their ability to learn. With this smaller number of participants, the results were easier to compare and contrast when conducting this

research; however, the study might have a better range of data if there was a larger group of participants and a variety of subject areas. More research is needed on a larger population to determine what significant impacts the Modern Classroom has on student's self-efficacy and mathematical achievement.

This research might also benefit from a larger group of teachers integrating metacognition, blended instructions, self-paced learning, and mastery-based learning into their classroom. With only having one teacher with the business-as-usual group and one teacher with the treatment group, the study did not take into account their individual teaching styles or the manner in which they present the materials. With just having two teachers the results could become misconstrued or interpreted in the wrong manner, thus making it difficult to extrapolate to the general population. Furthermore, with only two teachers this narrowed the focus on the study to just geometry. To have better results multiple subjects should be utilized to ultimately determine if the Modern Classroom Project has similar results in different subject areas and mathematical concepts like Algebra 1 and 2.

These classes were also located within the same school which could obstruct the results of the case study by not amply testing a diverse population. Ideally, multiply schools should be integrated into study with a diverse set of classes being utilized. This will not only make the sample size larger but also would eliminate teachers' individual effectiveness. If a study was conducted in multiple schools, this could also allow the researcher to not be a participant in the study.

Upon the conclusion of this research, the project intended to have students evaluate which method they preferred and discuss the significance of their choice, with student responses being evaluated for validity. Though this method allows the participants to have an actual say in

the study, the response could be more of personal interpretation instead of using an analytical approach. This could conflict with the actual results gleaned from the test results. Students may perceive a positive correlation between certain techniques when none exists. So, it is imperative that these results be separated when discussing the true effectiveness of the Modern Classroom Project. However, the survey did show an unforeseen conclusion that will allow further research of how teachers can tailor their instructional methods to help students become more engaged in the materials.

Finally, the time frame of this research, a total of eight weeks, was extremely narrow in scope, especially when trying to evaluate how the Modern Classroom Project affects students' mastery over a topic. An increase in the quantity of time might also indicate different results. The number of units tested is also extremely small. Rather than researching a limited small aspect, this project might have better results with an increased number of units and different areas of mathematics.

5.2.2 Future Implications

As previously mentioned, there are no publication on how the Modern Classroom Project effects student's mathematical achievement or self-efficacy. This makes it impossible to find studies that have incorporated the same technique on how metacognitive, self-paced learning, blended instructions, and mastery-based learning influence students understanding of challenging concepts and ideas. Furthermore, there is no ideal curriculum that helps students make meaning of the content, find personal relevance in its ideas, transfer the knowledge, skill, and understanding into the world beyond the classroom, and help them become better at reasoning and problem solving. Finally, there are a lot of methods to assess students' achievement, which makes it difficult to compare the findings of this study to another similar topic of choice.

Most studies found in the literature review suggests that self-paced learning, blended instructions, metacognition, and mastery-based learning improves students' achievements, however there is no study that demonstrates that the Modern Classroom Project, which utilizes those four educational practices, has an impact on student's self-efficacy and mathematical achievement. This researcher would recommend that this study be conducted over a larger pool of schools with multiple teachers. I would also advocate if this study was implemented again that the researcher only focuses on one of the concepts. This is important because the study might find a correlation that has not previously been shown.

This researcher also recommends that more work in the area of assessment and managing multiple activities is needed. Students who interacted in the diverse lesson plans did have a higher level of engagement, however, those lessons were from my limited experience of varied instructional concepts. Also, the Modern Classroom Project does not have one particular technique that encompasses every aspect, so it is imperative that when researching these methods to only use the four predetermined strategies. This could possibly narrow the scope of what the MCP efficiently enhances students' participation.

Appendices

Appendix A

Self-efficacy

Perception of self-efficacy with mathematics	Never(1)	Rarely (2)	Sometimes(3)	Mostly (4)	Always (5)
1. I think I can use mathematics effectively in my daily life.	1	2	3	4	5
2. I think mathematically while planning my day/time.	1	2	3	4	5
3. I don't think math is a suitable occupation for me.	1	2	3	4	5
4. I feel competent in solving problems in mathematics.	1	2	3	4	5
5. I can solve all kinds of math problems if I try hard enough.	1	2	3	4	5
6. I have a feeling that I am taking wrong steps while solving problems.	1	2	3	4	5
7. When I encounter an unexpected situation while solving a problem I get alarmed.	1	2	3	4	5
8. I can wander through mathematical structures and theorems and make new, small discoveries.	1	2	3	4	5
9. I know how to behave when faced with a new situation in mathematics.	1	2	3	4	5
10. I believe it is impossible for me to master mathematics as much as those around me.	1	2	3	4	5
11. Most of the time I spend solving problems I feel lost.	1	2	3	4	5
12. While studying mathematics, I notice that my confidence in myself decreases.	1	2	3	4	5
13. I can easily help those around me with their math-related problems.	1	2	3	4	5

14. I can propose solutions to all kinds of problems in life with a mathematical approach.	1	2	3	4	5

Appendix B

MCP Survey

Directions: Please answer all questions to the best of your ability. Put the answer in the area provided. Remember there are no right or wrong answers. Please be honest.

1. What is your gender?

Male Female Non-binary

2. What is your race?

3. What Grade and Class are you in?

4. Engagement

a. I use class time effectively.

Strongly Agree Agree Neutral Disagree Strongly Disagree

b. I behave well during class.

Strongly Agree Agree Neutral Disagree Strongly Disagree

c. I always have something challenging to do in class.

Strongly Agree Agree Neutral Disagree Strongly Disagree

d. I am learning things that are relevant to me.

Strongly Agree Agree Neutral Disagree Strongly Disagree

e. I care about what I am learning.

Strongly Agree Agree Neutral Disagree Strongly Disagree

5. Skill Development

a. I am learning how to use technology.

Strongly Agree Agree Neutral Disagree Strongly Disagree

b. I am developing good study habits.

Strongly Agree Agree Neutral Disagree Strongly Disagree

c. I can teach myself new academic content and skills.

Strongly Agree Agree Neutral Disagree Strongly Disagree

d. I can catch up if I miss class.

Strongly Agree Agree Neutral Disagree Strongly Disagree

e. I can complete challenging assignments without giving up.

Strongly Agree Agree Neutral Disagree Strongly Disagree

f. I learn from my peers during class time.

Strongly Agree Agree Neutral Disagree Strongly Disagree

6. Opinions and Beliefs

a. I am responsible for my own learning.

Strongly Agree Agree Neutral Disagree Strongly Disagree

b. I really understand what I'm learning.

Strongly Agree Agree Neutral Disagree Strongly Disagree

c. I enjoy learning.

Strongly Agree Agree Neutral Disagree Strongly Disagree

d. I am capable of learning anything.

Strongly Agree Agree Neutral Disagree Strongly Disagree

7. Your Teacher

a. My teacher knows my strengths and weaknesses.

Strongly Agree Agree Neutral Disagree Strongly Disagree

b. My teacher cares about me as an individual.

Strongly Agree Agree Neutral Disagree Strongly Disagree

c. My teacher gives me personal support and encouragement.

Strongly Agree Agree Neutral Disagree Strongly Disagree

d. My teacher challenges me to learn as much as I can.

Strongly Agree Agree Neutral Disagree Strongly Disagree

e. I have a good personal relationship with my teacher.

Strongly Agree Agree Neutral Disagree Strongly Disagree

8. Final Thoughts

a. I like the way my teacher teaches this class.

Strongly Agree Agree Neutral Disagree Strongly Disagree

b. I would like to take more classes like this one.

Strongly Agree Agree Neutral Disagree Strongly Disagree

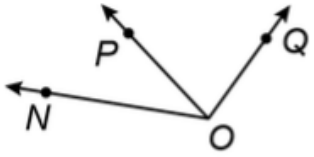
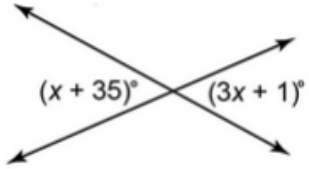
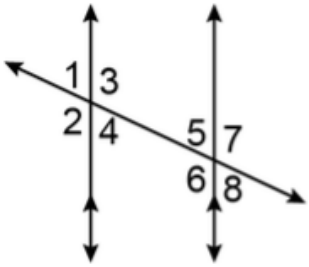
9. What do you like most about this class?

10. What would you change about this class?

11. Other comments

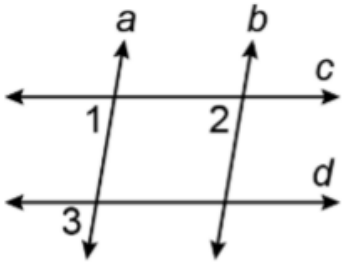
Appendix C

Pretest and Posttest District Assessment

Question Number	Question
1	If $m\angle NOP = 24°$ and $m\angle NOQ = 110°$, what is $m\angle POQ$?  ○ A. 62° ○ B. 86° ○ C. 134° ○ D. 156°
2	What is the value of x?  $x =$ ☐
3	Which pairs of angles are alternate interior angles? Select all that apply.  ☐ A. ∠3 and ∠6 ☐ B. ∠3 and ∠8 ☐ C. ∠4 and ∠5 ☐ D. ∠4 and ∠7 ☐ E. ∠1 and ∠8

4

If $a \parallel b$ and $m\angle 2 = 71°$, what is $m\angle 1$?



- A. 19°
- B. 71°
- C. 109°
- D. 142°

5

Which equation represents a line that is perpendicular to the line with equation $y = 2x - 8$? Select all that apply.

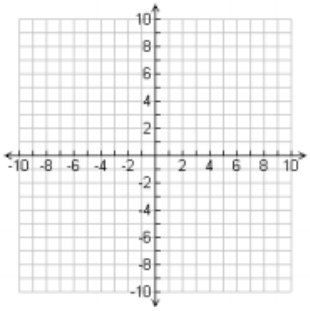
- ☐ A. $y = \frac{1}{2}x + 1$
- ☐ B. $y = -\frac{1}{2}x + 1$
- ☐ C. $x + 2y = 5$
- ☐ D. $-x + 2y = -3$
- ☐ E. $-x - 2y = 9$

(Hint: there are more than two correct answers)

6

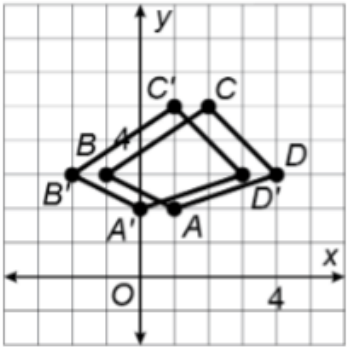
If point B has coordinates $(-8, 1)$, what are the coordinates of the point when it is reflected across the y-axis?

- A. (8, 1)
- B. (−8, −1)
- C. (−8, 1)
- D. (8, −1)



7

What translation rule maps *ABCD* to *A'B'C'D'* ?



A. $T_{(-1, 0)}$

B. $T_{(1, 0)}$

C. $T_{(0, -1)}$

D. $T_{(0, 1)}$

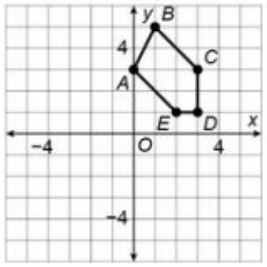
8

Triangle *ABC* has vertices *A*(1, 3), *B*(2, 5), and *C*(5, 3). What are the coordinates of *B'* after the translation described by the rule $T_{(1, 4)}$?

B' = (____)

9

Use pentagon *ABCDE*.



What are the coordinates of *B'* after the pentagon is rotated 90° about the origin?

A. (1, 5)

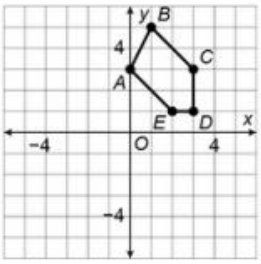
B. (−1, 5)

C. (−5, 1)

D. (5, 1)

10

Use pentagon *ABCDE*.



What are the coordinates of *E'* after the pentagon is rotated 270° about the origin?

A. (1, −2)

B. (1, 2)

C. (2, −1)

D. (2, 1)

11

How many lines of symmetry does a regular decagon have?

- A. 2
- B. 5
- C. 10
- D. 12

12

Which letter has rotational symmetry?

- E
- B
- Z
- V

13

Triangle *JKL* is reflected across the *y*-axis to create Triangle *J'K'L'*. Choose the words to create a true statement.

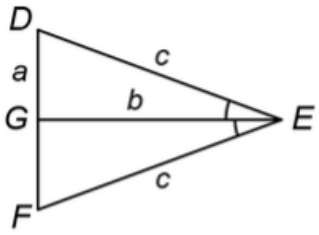
The two triangles [Choose...] congruent because the transformation is a rigid transformation, which [Choose...] the lengths of the sides and measures of all angles.

Choices for first blank...
are not
are

Choices for second blank...
changes
preserves

14

Use *DEF*.

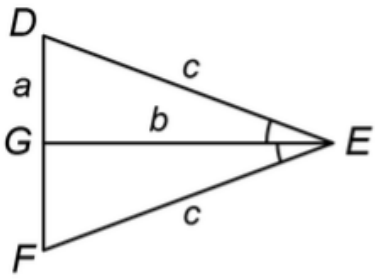


What is $m\angle DFE$ if $m\angle DEG = 18°$?

- A. 9°
- B. 18°
- C. 36°
- D. 72°

15

Use *DEF*.

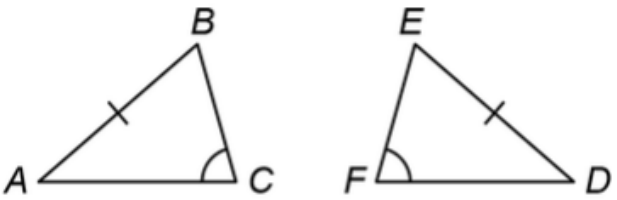


Given that $m\angle EGF = 90^\circ$, what is the value of *b* if *a* = 9 and *c* = 41?

- A. 32
- B. 40
- C. 42
- D. 50

16

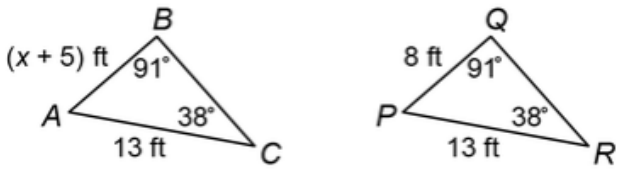
Which criterion can be used to prove the triangles are congruent?



- A. SSS
- B. SAS
- C. SSA
- D. none of these

17

What is the value of *x*?



x = ____

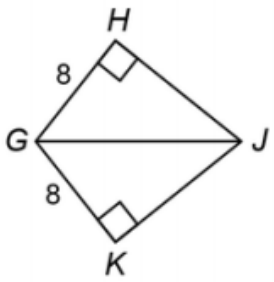
18

Which criteria can be used to prove triangles are congruent? Select all that apply.

- ☐ A. ASA
- ☐ B. AAS
- ☐ C. SAS
- ☐ D. SSA
- ☐ E. HL

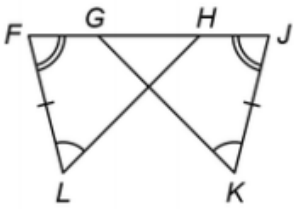
19

Which theorem can you use to prove that *GHJ* and *GKJ* are congruent?



- ○ A. ASA
- ○ B. SAS
- ○ C. SSS
- ○ D. HL

20



Which side is congruent to $\overline{GK}$?

- ○ A. $\overline{HL}$
- ○ B. $\overline{FJ}$
- ○ C. $\overline{FL}$
- ○ D. $\overline{HF}$

Appendix D

Interview Questions

- How do you feel when you arrive in your math class? (Physiological)
- How did you feel when you start your math problems? (Physiological)
- Did you feel these math problems were too hard or too easy? (Mastery)
- How do you feel when the math is too hard? (Mastery)
- How do you feel when the math is too easy? (Mastery)
- How do you feel when you get a high score on a math test? (Mastery)
- What do you think when another student gets finished with a math problem before you? (Vicarious)
- Do you always do your math homework? (Mastery)
- Do you ask your parents for help on your homework? (Mastery)
- How does your mom feel about math? (Vicarious)
- How does your dad feel about math? (Vicarious)
- Do you feel smart when you are doing math? (Physiological)
- Do you like doing math problems with a partner or in a group, or by yourself? (Vicarious)
- Do you like math more when it is in the morning or afternoon? (Physiological)
- Does you teacher encourage you by telling you how well you do in math? (Verbal)
- Do your parents encourage you by telling you how well you do in math? (Verbal)

All questions are based on Bandura's (1995) four sources of self-efficacy.

Appendix E

Assent Form

Modern Classroom Project

You are invited to be in a research study being done by *Micah Smith* from the University of Kentucky. You are invited because you are currently enrolled in his classroom and the school values your opinion.

If you agree to be in the study, your responses from 2 surveys and 1 exam will be used in the research. If you choose to not participate in the study under no circumstances will your refusal impact your grades or academic standings. There is no payment for participation

Your family will know that you are in the study. If anyone else is given information about you, they will not know your name. A number or initials will be used instead of your name.

If something makes you feel bad while you are in the study, please tell Katherine Ridner. If you decide at any time you do not want to finish the study, you may stop whenever you want.

You can ask Micah Smith or Principal Hale questions any time about anything in this study. You can also ask your parent any questions you might have about this study.

Signing this paper means that you have read this or had it read to you, and that you want to be in the study. If you do not want to be in the study, do not sign the paper. Being in the study is up to you, and no one will be mad if you do not sign this paper or even if you change your mind later. You agree that you have been told about this study and why it is being done and what to do.

_____ _____

Signature of Person Agreeing to be in the Study Date

_____ _____

Name of Person Obtaining Informed Assent Date

Appendix F

Consent Form

Benefits of the Modern Classroom Project in high school mathematics

Parental Consent

INVITATION TO PARTICIPATE:

Dear Parent,

My name is Micah Smith and I am your son's or daughter's mathematics teacher. I am conducting a research study to determine how effective the Modern Classroom Project is on student achievement. The purpose of this form is to provide you with information that will help you decide if you will give consent for your child to participate in this research.

KEY INFORMATION ABOUT THIS RESEARCH STUDY:

The following is a short summary of this study to help you decide whether you want your child to be a part of this study. Information that is more detailed is listed later on in this form.

The purpose of this study is to determine how the Modern Classroom Project can help students excel in mathematical understanding. Your child will be asked to fill out a survey and take a pretest and posttest. We expect that your child will be in this research study for the fall semester and will include materials the student will already be using. The main benefit is that our school is trying to utilize this practice and it will provide concrete evidence to present to our principal.

STUDY PURPOSE:

The purpose of this study is to address the following 2 questions:

1. How does the Modern Classroom Project affect students' self-efficacy?

2. In what ways does the Modern Classroom impact students' mastery of mathematical concepts?

NUMBER OF PARTICIPANTS:

If you agree to participate, your child will be one of 300 participants who will be participating in this research.

PROCEDURES FOR THE STUDY:

If you agree for your child to participate in the study, they will first take a survey at the beginning of the semester and take the same survey at the end of the fall semester. They will also take a pretest for unit 2 and a posttest which is the district assessment.

RISKS AND INCONVENIENCES:

There are minimal risks and inconveniences to participating in this study. These include:

That the child may be uncomfortable answering the survey or interview questions. The time the child spends for participating in the study might be considered inconvenience. There might be a risk of possible loss of confidentiality.

SAFEGUARDS:

To minimize these risks and inconveniences, the following measures will be taken: The child can skip any questions that they feel uncomfortable answering while taking the survey or during the interview. The child may skip any activity as part of the research and/or intervention. The child may be directed to a counseling or social support services. The surveys, interviews, or observations may be scheduled at a time that is convenient to the child and at a place that is private.

CONFIDENTIALITY:

Your child's responses will be anonymous or confidential; "anonymous" is applicable when unidentifiable data is collected (e.g. participants are assigned ID numbers during the study and/or there is no master list with participants' personal information), "confidential" is applicable when the researcher knows, collects, or has a record of the participant's name or other identifiable information such as e-mail address, phone number, address, but uses pseudonyms during reporting of the data, and the personal information is only accessed by the researcher or the research team who is doing the study.

The results if this study may be used in reports, presentations, or publications but your child's name will not be used.

VOLUNTARY PARTICIPATION:

Your child's participation in this study is voluntary. Your child may decline participation at any time. You may also withdraw your child from the study at any time; there will be no penalty on the child's grade. Likewise, if your child chooses not to participate or to withdraw from the study at any time, there will be no penalty.

BENEFITS OF TAKING PART IN THE STUDY:

The benefits of your child participating in this study is that is provides our school with concrete evidence on how this educational practice can support student understanding and self-efficacy.

CONTACT INFORMATION:

If you have questions about the study, please call me at (859) 381-3308 ext 2210 or e-mail me at micah.smith@fayette.kyschools.us If you have any questions about your child's rights as a participant in this research or if you feel your child has been placed at risk, you can contact the IRB Office.

PARENT'S CONSENT:

By signing below, you are giving consent for your child to participate in the above study.

Your child's name: _____

Parent's name: _____

Parent's Signature: _____

Date:_____

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