FLIPPED INSTRUCTION: AN INVESTIGATION INTO THE EFFECT OF LEARNING ENVIRONMENT ON STUDENT SELF-EFFICACY, LEARNING STYLE, AND ACADEMIC ACHIEVEMENT IN AN ALGEBRA I CLASSROOM

by

BARRY LYNN WIGINTON

ANGELA BENSON, COMMITTEE CHAIR

DOUG BARRETT
ROBERT MAYBEN
MARGARET RICE
JEREMY ZELKOWSKI

A DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in the
Department of Educational Leadership,
Policy, and Technology Studies
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2013

ABSTRACT

This study utilized an explanatory mixed-methods research design to investigate the effect of learning environment on student mathematics achievement, and mathematics self-efficacy, and student learning style in a ninth grade Algebra I classroom. The study also explored the lived experiences of the teachers and students in the three different learning environments and the effect students' learning style had on preference for learning environment.

Key findings of the study were: 1) students in the Flipped Active and Flipped Mastery learning environments scored significantly higher on mathematics achievement than students in the Traditional learning environment; 2) students in the Flipped Mastery learning environment scored significantly higher on mathematics self-efficacy than students in the Traditional learning environment; 3) students in both the Flipped Active and Flipped Mastery learning environments appreciated the level of control over the learning process but were dissatisfied by the inability to ask real-time questions; 4) students in the Flipped Mastery learning environment enjoyed working at an individualistic pace but struggled with falling behind; and 5) students preferring active, sensing, sequential, and verbal learning experiences expressed satisfaction with both the Flipped Active and Flipped Mastery learning environments.

The study findings suggest that classroom teachers should utilize the Flipped instructional approach to make more in-class time for active learning strategies; and implement mastery learning strategies to promote student responsibility, self-regulation, and ownership of the learning process. Future research should investigate the effect that Flipped instruction has on the learning environment at the middle and high school level as well as in subject areas other than mathematics.

ACKNOWLEDGEMENTS

I would like to express my most sincere appreciation to Dr. Angela Benson for her support and encouragement. Thank you for guiding me through this process and believing in me. I would also like to thank the members of my committee, Dr. Margaret Rice, Dr. Jeremy Zelkowski, Dr. Robert Mayben, and Dr. Doug Barrett. I want to thank each of you for your time and special talents through which each of you made this accomplishment possible.

I would also like to thank the school system and the classroom teachers that participated in the study. They will have to remain anonymous, but they know who they are and how much I appreciate them opening up their classrooms and giving their time and energy to this study.

I would also like to express my appreciation to my mentor and friend, Dr. Earl Gardner for his willingness to listen and provide valuable and timely advice. His confidence in my ability to complete this process was a constant source of reassurance.

I would like to thank my family for their encouragement and understanding during this process. My living parent, siblings, daughters, and grandchildren who have expressed support and encouragement and never complained about the times I had to spend working rather than playing.

Finally, I would like to thank Stephanie, my love and life companion. She silently endured periods of absence and neglect while I labored. She has been an encourager, advisor, and friend without whom none of this would have been possible.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I:

INTRODUCTION

Introduction

Our current educational model is broken and nothing short of revolution will divert it from its current path. This is the opinion of renowned educational expert, Sir Ken Robertson. He states that countries around the world recognize the need to reform their educational systems, but reform is not enough (Robinson, 2011, p. 10). He believes that the current instructional model marginalizes the talents of many students and in doing so, fails to prepare our students for personal and professional success in a rapidly changing and increasingly global world economy. In his opinion, “We not only need a higher percentage of our kids graduating from high school and college – more education – but we need more of them with the right education” (Robinson, 2011, p. 11). Perhaps an educational model that is less standardized and more personalized will improve this country’s ranking among other developed nations.

The United States currently ranks below other developed nations in elementary math and science (55th), high school completion rate (20th), and ratio of college students receiving undergraduate degrees in science or engineering (27th) (Koller, 2011). These alarming ratings demand a reevaluation of current educational policy and a reform of the educational practices that have resulted in our current dismal ranking among the developed nations of the world.

Technology continues to change the way we communicate, stay informed, and interact. The 2010 National Education Technology Plan, *Transforming American Education: Learning*

Powered by Technology, called for “engaging and empowering learning experiences for all learners” that places the focus on “what and how we teach to match what people need to know, how they learn, where and when they will learn, and who needs to learn” (U.S. Department of Education, 2010, p. 8). Recent advances in mobile technology are making the goals of the 2010 National Education Technology Plan a reality by making it possible for schools to provide engaging, empowering, and personalized learning environments. Faster Internet connections and the proliferation of mobile devices continue to make working, playing, and studying from almost any location more necessity than luxury.

However, while technology has been revolutionizing the way we live and work, educational systems around the country are struggling to keep pace. In fact, many school systems still require students to “power down” when they arrive on campus. In his article, *Computers Meet Classroom: Classroom Wins*, Cuban (1993) has suggested that the reason for this lack of significant change may lie in dominant cultural beliefs about what teaching and learning should look like and how schools should be organized for instruction.

In a 2007 *National Survey of High School Administrators*, 84% had written policies concerning cell phone use but only 24% of the schools surveyed allowed students to bring their cell phones to school (Obringer & Coffey, 2007). Since 2007, the number of schools providing students with personal computing devices or allowing students to bring smartphones and other Internet-connected mobile devices to school has greatly proliferated (Brown, 2013). According to the 2013 *Project Tomorrow* report, which surveyed over 364,000 students, representing over 8000 schools, approximately one-half of the high school students interviewed said they could use their personal devices at school (Speak Up National Findings, 2013).

This increase in the number of school systems allowing students to bring their own electronic devices is evidence that many school systems are beginning to see the necessity for change. The impetus to take advantage of the abundance of online digital content is driving many educational leaders to seek additional funding to provide one-to-one access to technology for their students. School systems that cannot afford to provide one-to-one access to technology for their students have begun revisiting their acceptable use policies to allow more students to bring mobile devices to school for instructional purposes and having positive results with a new policy called Bring-Your-Own-Device (BYOD) (Stephens, 2013).

As evidence of this impetus to take advantage of digital media, the Alabama Ahead Act was signed into law on May 25, 2012 by Governor Robert Bentley. This legislation dedicated $100,000,000 toward the cost of replacing printed textbooks with an electronic textbook alternative paired with a mobile device for viewing (Moseley, 2012). Acquisition of these interactive devices has the potential to do more than simply lighten the backpacks of Alabama students. Fully interactive textbooks may fuel the fire of an exciting trend in education called flipped instruction. Flipped instruction makes use of technology to reverse the location of where lecture and homework take place. By delivering lecture content via video lessons to students at home, teachers hope to utilize valuable face-to-face class time for more active learning strategies. Ultimately, many educators hope to utilize flipped instruction to provide individualized, student-centered instruction in a blended learning environment and provide a digital alternative to the traditional lecture-homework instructional model.

Statement of the Problem

According to *The Condition of College and Career Readiness Report* by ACT, Inc. (2011), the current instructional model, developed for the needs of the previous era, is no longer preparing high school students for college and career opportunities. According to the report, the national percentage of ACT-tested high school seniors who scored at benchmark level in mathematics was only 45%. A benchmark is an empirically-derived minimum score needed on an ACT tested subject to indicate a 50% chance of a student obtaining at least a B or higher grade, or about a 75% chance of obtaining a C or higher grade, in a corresponding college course. Basically, less than one-half of graduating seniors are academically ready for college level mathematics courses. This is only a small improvement over the 2009 and 2010 scores at 42% and 43%, respectively (ACT, 2009; ACT, 2010; ACT, 2011). These mediocre percentages have severe consequences for educational institutions, parents, students, and society in terms of economics and loss of productivity.

The ACT (2011) report quoted current U.S. Education Secretary, Arte Duncan, about what he had to say concerning the low ACT scores for high school seniors. He said, “These ACT results are another sign that States need to raise their academic standards and commit to education reforms that accelerate student achievement.” President Obama echoed this call for increased investments in education and innovation in the areas of math and science in his 2010 State of the Nation address. He referred to the current global educational climate as “Our Sputnik Moment” (*State of the Union Address*, 2011).

Classroom teachers and school administrators are also beginning to recognize the need for reform and many want to move from standardized, teacher-directed instruction to a more personalized, active learning environment where students are encouraged to use their creative minds in individual and collaborative projects. It is the effective use of technology in these types of learning experiences that will prepare students for the demands of a technological society where innovation and collaborative skills are highly valued (Bushweller, 2011; Davis, 2011; Keefe & Jenkins, 2002).

More evidence that educational reform may be favorable to a more individualized and student-centered instructional approach can be seen in recent changes in federal accountability. The U.S. Department of Education (2012) is now inviting each State educational agency to request a waiver of flexibility from the requirements of the *No Child Left Behind Act* of 2001. As of September 2012, 33 states have been approved for flexibility waivers with an additional 11 states awaiting approval (U.S. Department of Education, 2012). States receiving waivers will be required to develop their own rigorous and comprehensive plans to improve educational outcomes for students, close equity gaps, and improve the quality of instruction. The State of Alabama received approval for its *Alabama Plan 2020* on June 21, 2013 (Lyman, 2013). Hopefully, the new state plan will alleviate some of the frustration that teachers and students have experienced by promoting learning environments where each student is free to move through the curriculum at a pace that matches his/her aptitude and ability.

Meaningful educational reform begins in the classroom. But, how will classroom teachers meet the challenge of providing individualized, student-centered learning environments where the potential of the creative child is realized? Classroom teachers will need an efficient way to deliver content information asynchronously if face-to-face class time is to be used for active and engaging learning strategies. Flipped instruction may provide an alternative to the traditional instructional model by providing classroom teachers with the means to provide individualized, personalized, learning environments that may finally transform education.

Theoretical/Conceptual Framework

Introduction to Flipped Instruction

A grassroots movement is underway which many educators think will revolutionize the learning environments of many public schools. Teachers in middle and high school grades call it *flipped instruction* (Bergman & Sams, 2012) while their college and university counterparts often refer to the same concept as the *inverted classroom* (Gannod, 2007). For the purposes of this study, the term *flipped instruction* will be used to describe any learning environment that utilizes technology to reverse the location of where content gets introduced, and where it is reinforced through practice.

In traditional classrooms, course content is presented in a lecture format with the instructor conveying fact-based, procedural type information to the students in a face-to-face instructional setting. Students assume a passive role during the face-to-face portion of this type learning process. For homework, students are expected to apply the information they received in class to similar, but often more difficult, problems and situations. In challenging courses such as mathematics and science, struggling students are often frustrated and despondent. Courses taught using traditional methods move all students through the curriculum at the same pace regardless of mastery. Often, the classroom teacher has little time to assist individual students. This situation is compounded by the fact that students often have no one at home to turn to for assistance. The end result is student frustration, resulting in incomplete homework assignments and subsequently demonstrating poor performance on assessments. Repeated experiences such as these often result in low academic self-efficacy and loss of interest and effort (Bandura, 1977).

Flipped instruction compared to traditional. Flipped instruction does exactly what its name indicates by utilizing technology to deliver subject content knowledge in a multimedia format for viewing at home. Figure 1 diagrams the different aspects of flipped instruction and traditional Lecture/homework instruction.

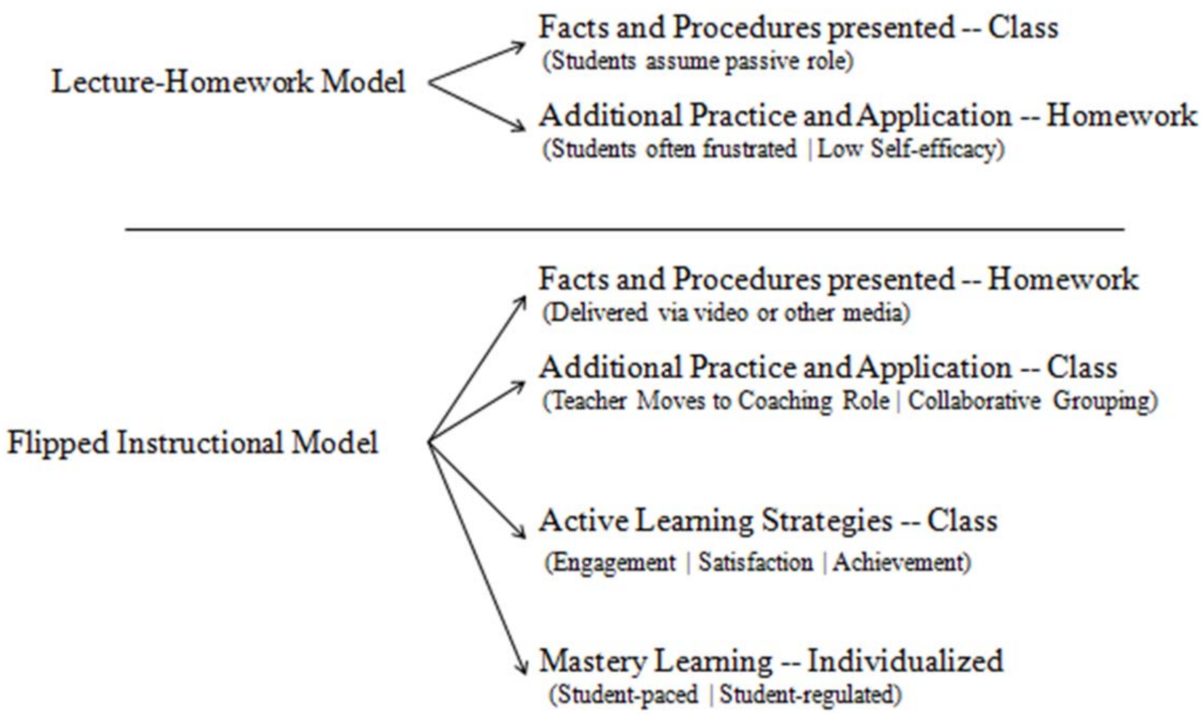


Figure 1. Model of Flipped Instruction Compared to Traditional Lecture-Homework

As Figure 1 illustrates, moving lecture content to homework can free up valuable class time for active learning and higher-level cognitive tasks (Alvarez, 2011; Bergmann & Sams, 2012; Gannod, 2007; Kennedy, 2012; Lage, Platt & Treglia, 2000; Staker, 2011; Talbert, 2012). Considerable research suggests that active learning promotes increased student engagement, satisfaction, and achievement (Armbruster, Patel, Johnson, & Weiss, 2009; Draper, 1997; Michael, 2006; Prince, 2004).

Flipped instruction is also an instructional model that makes mastery learning for large numbers of students both manageable and sustainable (Bergman & Sams, 2012). In flipped mastery learning, students work through self-facilitated packets of curriculum and advance by demonstrating a predetermined score on a mastery test. This self-regulated format frees the teacher to work with the students that need the most help while simultaneously allowing other students to move through the curriculum at a pace that best matches their aptitude and effort (Bergmann & Sams, 2012).

Role of technology in flipped instruction. Computer-assisted instruction is not a new idea. During the 1980s, the number of students-to-computer dropped from 125 to 18, and yet classroom instruction changed very little in response to this rapid growth in accessible technology (Cuban, 1993).

The past two decades have brought many changes in instructional technology and in how educators view the role of technology in education. Recent innovations in computers and software have made the process of recording, annotating, and posting video lessons online a simple process that many teachers can master without the need for formal professional development and training (Wang & Reeves, 2003, p. 58). Most flipped instruction teachers create videos of 10-15 minutes in duration, which may include narration, images, video, and interactive manipulatives. The most common flipped instruction videos are ones where the teacher uses an annotating pen to work problems while explaining the lesson (Alvarez, 2011; Talbert, 2012). What students see and hear is basically what they would see and hear during a typical lecture session. Recent advances in technology have given teachers this ability to digitally record pen strokes and narration easily and inexpensively. According to Bergmann and Sams (2012), flipped instruction would not be possible for most teachers without the ability to annotate and narrate the digital presentations.

Emerging technologies have also made student accessibility to these videos as easy as clicking a link on a web page or viewing from social media sites such as YouTube®. In fact, many high school students carry in their pocket a smartphone with more calculating power than was available on earth in 1940 (Robinson, 2011, p. 23). Twenty-first century students are comfortable learning in a digital format (Barone, 2003). Google®, YouTube®, and Wikipedia® have become the go-to locations for entry-level information on a myriad of topics. Flipped instruction teachers find that having their students view short videos prior to class is a positive way to get students to engage with the material in a way they did not with the traditional textbook (Carlisle, 2010).

Social Cognitive Theory

When teachers deliver lecture material digitally, the focus of the classroom shifts from teacher to student, from instruction to learning. This shift from a teacher-directed learning environment to a student-centered learning environment has significant implications for the individual student. In academically challenging courses such as mathematics, students are often anxious and doubtful of their ability to master the rigors of the course. These self-beliefs can be debilitating and may prevent many students from reaching their potential. In 1977, social cognitive theorist Albert Bandura wrote, *Self-efficacy: Toward a Unifying Theory of Behavioral Change*, and defined the term self-efficacy as a person's belief in their ability to succeed in specific situations. Bandura (1977) stated that a person's self-efficacy will determine what behavior will be initiated, how much effort they will put into the behavior, and for how long they will persist when confronted with obstacles. This has significant implications for the mathematics classroom as many students don't believe they can successfully complete challenging homework assignments and the requirements of a rigorous curriculum. Due to the specificity of self-efficacy, there is no way to determine the prevalence and impact it can have on education in general, however, multiple studies have shown that students with strong, positive self-efficacy in mathematics correlate to greater academic achievement in mathematics (Bevel, 2010; Fast, Lewis, Bryant, Bocian, Cardullo, Rettig & Hammond, 2010; Pajares & Miller, 1995; Peters, 2009).

Active learning. Perhaps the greatest advantage of flipped instruction is that it "flips" the location where low-level, procedural information is initiated, thereby freeing valuable class time for active learning strategies. Active learning is an instructional strategy that falls under the auspices of constructivist theory. Constructivism is a learning paradigm based on the idea that learners actively construct knowledge by interpreting new experiences in the context of prior knowledge and previous experiences (Marlowe & Page, 2005). Active learning is basically learning while doing. Chickering and Gamson (1987) include active learning as one of the seven principles of good educational practice. They insist that students must talk about what they are learning, write about it, relate it to past experiences, and then apply it to their daily lives. Jerome Bruner (1985) explained in his book, *Models of the Learner*, that, "It is the use of knowledge rather than knowledge itself that is affected by the nature of its consequences. Use implies performance; performance entails action" (p. 7).

Active learning is especially important in a classroom utilizing flipped instruction. When asked why teachers should flip their classroom, flipped instruction guru and author, Jonathan Bergmann, begins every conversation about flipped instruction with this question, "What is the best use of your face-to-face class time?"(Noonoo, 2012). Active learning means students must be actively involved and engaged in higher-order thinking tasks such as analysis, synthesis, and evaluation (Bonwell & Eison, 1991).

Active learning supports a student-centered learning environment where the focus is on learning, not instruction. Students take an active role in the learning process, which may result in increased engagement and overall course satisfaction. Active learning promotes the use of critical thinking skills and self-directed learning, both important 21st century skills (Toto & Nguyen, 2009).

Active learning in a flipped instruction classroom may also encourage more effective communication between students, teachers, and parents. Students watch the videos at home, then come to class ready to discuss how to work the problems or to clarify any confusion. The active nature of the classroom requires them to discuss the information they learned in the videos, usually working in pairs or small collaborative groups. An interesting side effect is that many teachers report that their students' parents watch the videos with their child. This has created greater transparency and communication between the parent and the teacher (Bergmann & Sams, 2012).

Mastery learning. An unanticipated aspect of flipped instruction is its potential to support mastery learning. Experienced flipped instruction teachers soon realize the potential for personalized, individualized instruction when academic content is moved online and face-to-face time is used to support students as they work toward mastery of the content at their own pace. Benjamin Bloom (1968) realized the potential of mastery learning for the majority of students. He stated:

> Most students, perhaps 90%, can master what we have to teach them, and it is the task of instruction to find the means which will enable our students to master the subject under consideration" (p.1). It seems reasonable to expect that some students will need more concrete illustrations and explanations than will others; some students may need more approval and reinforcement than others; and some students may need several repetitions of the explanation while others may be able to get it the first time. (p. 4)

It is unlikely that in 1968 Benjamin Bloom could have envisioned the role that technology would play in providing anytime, anywhere access to self-directed, self-regulated learning through recorded lecture and tutorial material. Over forty years later, the technology to provide this individualized learning environment has come of age through flipped instruction.

Bergman and Sams (2012) insist that the greatest benefit to any flipped instruction classroom is not the videos but rather the face-to-face class time that every teacher must reevaluate and redesign (p. 47). By utilizing in-class time for mastery learning, teachers can now use the technology to create a personalized learning environment that is supportive and manageable. Only recently has this technology become universally available and affordable. Many teachers suggest that flipped instruction makes them a better teacher because they now have more time to focus on their students. In a traditional, lecture-homework classroom, the teacher spends most of the class time delivering the content with relatively few opportunities to answer student questions. In a flipped instruction mastery classroom, students are actively engaged and self-directed. Students who are successfully mastering the content do not need the teacher's assistance; therefore almost all of the teacher's in-class time is spent working with struggling learners (Bergmann & Sams, 2012, p. 29; Gannod, Burge & Helmick, 2008, p. 779).

Statement of Purpose

The purpose of this study was to add to the research base of empirical information about the effectiveness of the Flipped instruction model as both an instructional strategy and as a pedagogical model for promoting active learning and mastery learning. The researcher sought to determine whether a relationship existed between the flipped instructional classroom utilizing active learning strategies and students' mathematics achievement. The researcher also sought to determine whether a relationship exists between the flipped instruction classroom utilizing mastery learning strategies and students' mathematics achievement. Additionally, the researcher sought to determine whether participation in a flipped instructional classroom had any effect on students' self-efficacy toward mathematics. Finally, the researcher sought to understand the lived experiences of students in a three different learning environments and whether learning style was an influencing factor in student preference for learning environment.

Significance of the Problem

Students entering their freshmen year of high school experience heightened expectations to become more autonomous and independent while simultaneously dealing with increasingly difficult academic work. Either from past experiences or vicarious experiences, many students enter their first algebra course with anxiety and fear of failure. If these students experience failure early in these courses, their self-efficacy will decline along with their grades. This can have a detrimental effect on their views about school and themselves (Zimmerman & Cleary, 2006).

According to the *ACT College and Career Readiness Report* (2011), only 45% of ACT-tested high school seniors scored at benchmark levels in mathematics. The percentage of Alabama students meeting benchmark levels in science was much lower at only 32%. This failure of secondary schools to adequately prepare students for the rigors of college-level work has severe consequences for the individual and society. Few empirical studies have been published on the effectiveness of flipped instruction in the K-12 learning environment. Even fewer empirical studies have focused on the effectiveness of Flipped instruction in mathematics education in the K-12 learning environment. A review of available research revealed few empirical studies investigating flipped instruction in middle and high school mathematics courses and no empirical studies investigating the potential of flipped instruction to alter the learning environment of ninth grade Algebra I students by incorporating active learning strategies or mastery learning strategies. Furthermore, the review of research revealed no empirical studies investigating the impact that flipped instruction learning environments have on student academic achievement, mathematical self-efficacy, lived experiences of both teachers and students, and the role of learning style in student preference for learning environment.

Research Questions

Four research questions guided this study. The four questions focused on the effect of learning environment on learner academic achievement, learner mathematics self-efficacy, student and teacher lived experiences, and learner preference for learning environment with respect to learning style.

1. How do students in classrooms utilizing flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies, compare academically on mathematics achievement?
2. How do students in classrooms utilizing flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional instruction with lecture-homework learning strategies, compare on mathematics self-efficacy?
3. How do the lived experiences of students and teachers in the flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies compare?
4. How do students' learning style affect preferences for learning environment?

Null Hypotheses

Two null hypotheses guided the quantitative portion of this study. The null hypotheses address research questions one and two.

H_o1: There is no statistically significant difference in the mean mathematics scores of students participating in classes utilizing varying instructional strategies.

H_o2: There is no statistically significant difference in the mean mathematics self-efficacy scores of students participating in classes utilizing varying instructional strategies.

Methods

This study utilized an explanatory mixed-methods research design. A one-way between groups multivariate analysis of covariance, MANCOVA, was conducted to examine the main and interaction effects of the group means on student academic achievement and mathematics self-efficacy while controlling for prior ability. Qualitative methods were used to gain a deeper understanding of the lived experiences of the teachers and students in the three different learning environments and to understand what effect students' learning style had on preference for learning environment. The qualitative portion of the study utilized a multiple case study design that enabled the researcher to analyze interview and observation data to look for common themes across the cases, represented by the three different learning environments. Data collection included individual structured interviews, focus group structured interviews, and direct observation of the three learning environments. Participants included 66 ninth grade Algebra I students and their Algebra I teachers.

Assumptions of the Study

General Assumptions

It was assumed that all participants in the study were able to read and understand the questions on each of the written surveys and that all participants in the case study understood the interview questions and was able to articulate their opinions effectively. It was also assumed that all experimental and control subjects had not previously been exposed to flipped instruction. It was discovered during the study that this was not the case. Because the study took place during the last semester of the school year, there were some students who had experienced both traditional and flipped instruction due to schedule changes. Finally, it was assumed that each instructor strictly adhered to the instructional format for each of the instructional settings under study. The only exception to this assumption was that the teacher in the Traditional Lecture/homework group did not assign practice problems to be completed at home but provided students time to work their problems at school. Students still practiced their problems, just not at a home location.

Statistical Assumptions

For all statistical tests, it is assumed that the data are metric, the samples are independent, and the selection of the participants to each of the classrooms was random. It is also assumed that the utilization of a pretest-posttest assessment would reduce the threat to internal validity and that statistical tests would verify the homogeneity of variance and normal distribution of the data.

Limitations of the Study

This study was limited to ninth grade students enrolled in Algebra I classes at a Class 5-A high school in a southeastern state. Because of the small sample size, it would be difficult to generalize the results of this study to a larger population. Additionally, it was not possible to study the flipped instruction groups and traditional lecture/homework group taught by the same teacher. All the teachers at the school that utilized flipped instruction utilized the strategy with all their classes. Consequently, a second Algebra I teacher at the same school, who taught using traditional lecture/homework methods, had to be included into the study.

Summary

Chapter I provided an introduction to flipped instruction as an emerging instructional method based upon recent advances in instructional technology and fueled by a desire to promote active learning and mastery learning in the K-12 academic setting. How flipped instruction fits into the conceptual framework of self-efficacy, active learning and mastery learning is also discussed. Chapter II presents a review of the available literature on flipped instruction and details the research efforts that have been conducted around this unique form of blended instruction.

Operational Definition of Terms

Active Learning - Active learning falls under the umbrella of social cognitive learning theory and is characterized by student discussion, collaboration, and performance rather than having them sit passively and listen to didactic lecture.

Blended Learning – Blended learning is characterized by combining features of two or more instructional strategies or learning environments. Horn and Staker (2011) include student control over time, place, path, and/or pace as part of their definition of blended learning.

Flipped instruction - An instructional method that is characterized by flipping the location where content is introduced and where it is applied. Flipped instruction utilizes instructional technology in the form of teacher-created tutorial videos to deliver lecture and procedural information to students at home via online delivery. According to Bergmann and Sams (2012), there is no singular definition of Flipped instruction, which is why some have classified it as another form of blended learning.

Learning Management System (LMS) – a web-based course management systems incorporating features to enable the instructor to deliver curricular materials, facilitate discussions, administer assessments, and report grades. For this study, the learning management system, MOODLE® will be utilized.

Mastery Learning – An instructional strategy in which the individual differences in the learners are related with the learning and teaching process (Bloom, 1968). Students move through the curriculum at a pace that matches their aptitude and effort and advance only after demonstrating a predetermined level of mastery.

Self-Efficacy – the belief that students have in their ability to master a task, skill, or procedure. Self-Efficacy tends to be task and context specific (Bandura, 1986) and accounts for many students ability to sustain difficult academic tasks (Schunk, 1983).

CHAPTER II:

REVIEW OF RELATED LITERATURE

Introduction

In the review of the literature, the researcher focused on six major themes: a) call for reform of the traditional instructional model, b) history of flipped instruction, c) flipped instruction as a form of blended instruction, d) flipped instruction as a learning environment to promote student self-efficacy, e) flipped instruction as a learning environment to promote active learning, and f) flipped instruction as a learning environment to promote mastery learning. In this review, the researcher examined scholarly and peer-reviewed documents from The University of Alabama online library databases including the ProQuest Dissertations and Theses database as well as publically available scholarly articles, purchased journals, and books.

Call for Reform

In the most recent edition of his groundbreaking book, *Out of Our Minds: Learning to be Creative*, Sir Ken Robinson (2011) explained the inconsistency between an educational system designed to prepare citizens for an industrial society and the type of educational system needed to prepare citizens to be competitive in today's global society. Robinson said,

> Mass systems of public education were developed primarily to meet the needs of the Industrial Revolution and, in many ways they mirror the principles of industrial production. They emphasize linearity, conformity, and standardization. One of the reasons they are not working now is that real life is organic, adaptable and diverse. (p. 8)

Educational theorists such as John Dewey and Edward Thorndike also believed that there was a better way to educate children than standardization and conformity. Hergenhahn and Olson (2005) quoted Edward Thorndike as saying, "…let the pupil find out nothing which he could possibly be told or shown. It is like trying to give students an educational fortune in much the same way someone leaves property in a will" (p. 71).

Negative Impact of NCLB on Learning Environment

In 1983, the landmark study, *A Nation at Risk*, brought to light the disturbing decline in U.S. educational performance as compared with other industrialized nations. The study called attention to the dismal academic abilities of high school seniors and urged for sweeping reforms in curriculum, expectations, time spent in meaningful study, and the quality of teachers and teaching in general. The study also demanded, "… the best effort and performance from all students, whether they are gifted or less able, affluent or disadvantaged, and whether they are destined for college, the farm, or industry" (NCEE, 1983, p. 24). This call-to-action was answered in part by federal legislation in the form of the *No Child Left Behind Act* (2002), which supported the rights of all children to a "fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments"(p. 1439). The legislation put into place accountability measures intended to improve test scores in the curricular areas of reading and mathematics. Many experts debate whether NCLB achieved its intended goal, but according to an independent study by Center on Education Policy in their 2007 report, *Answering the Question that Matters Most: Has Student Achievement Increased Since No Child Left Behind?*, student achievement has gone up. The report stated, "In most states with three or more years of comparable test data, student achievement in reading and math has gone up since 2002, the year NCLB was enacted" (p. 1). The report also conceded that the researchers could not definitively state whether there was a direct cause-and-effect relationship between the policies of NCLB and the increased achievement, just that since 2002, the number of states showing gains in test scores far outnumber the number of states showing declines in test scores.

Accepting the fact that achievement scores have indeed increased since the implementation of NCLB, we must consider at what cost? Likely an unintentional consequence, the legislative act has created a high-stakes environment where singular focus is placed on a limited scope of subjects, primarily mathematics and reading. This narrowing of the curriculum is to the detriment of creative subjects such as the arts and humanities and has created a culture of teaching only what gets tested (Guilfoyle, 2006; Grey, 2009). In a 2007 Center on Education Policy (CEP) report of a national survey of school districts, 62% of districts reported an increase in the amount of instructional time in their elementary schools for reading and math since the implementation of NCLB in 2002. The increase in minutes per week averaged 46% in English Language Arts, 37% in mathematics, and a 42% increase across the two subjects combined (p. 1).

Teaching only what gets tested in math and science also does little to prepare students for the type of skills they will need to be successful in a 21st century society. Former International Society for Technology in Education (ISTE) president, Jan Van Dam, is quoted in an issue of *Technology & Learning* as saying,

> Many districts are so overwhelmed and concerned about the NCLB requirements and potential financial repercussions of not complying, that for lots of them the safest route is the 'back-to-basics' approach - focusing entirely on 20th century skills at the expense of 21st century ones. (Salpeter, 2003, p. 19)

Of course, “teaching to the test” was never part of the NCLB mandate. The problem, in part, lies in the fact that few leaders in education possess a clear vision, or practical understanding, of how teachers will teach 21st century skills while still maintaining high standardized test scores. In a doctoral study involving eight New York State school superintendents; Fischer (2011) explored the superintendents' perceptions on implementing 21st century skills while simultaneously fulfilling the requirements of NCLB. The study revealed that the superintendents were divided between those having a clear vision of integrating 21st century skills into the curriculum and those that envisioned the need to integrate 21st century skills but were more focused on gains in academic achievement as determined by AYP.

Potential of Technology to Change the Learning Environment

At approximately the same time that NCLB was being written, the U. S. Department of Education (2000) recognized the need to take advantage of the revolutionary changes taking place in the world of technology by revising the *National Educational Technology Plan* of 1996. The plan was revised to reflect greater emphasis on the ubiquitous access to informational technology for every school, home, and community. The lofty goals of the report were reflected in its title, *eLearning: Putting a World-class Education at the Fingertips of All Children*. The plan called for a) increased access to technology for both teachers and students, b) teachers able to effectively use technology to help students achieve high academic standards, c) students possessing technology and information literacy skills, and d) digital content and networked applications which would transform teaching and learning (U.S. Department of Education, 2000, p. 33). It was the conclusion of the report that school improvement plans that included the use of technology to improve teaching and learning, would yield positive results.

The latest revision of the *National Educational Technology Plan* (2010) refined the goals of its predecessor in ways that will likely have important consequences for both teachers and students. Aptly titled, *Transforming American Education: Learning Powered by Technology*, the plan dealt with the engagement and the empowerment of students in the learning environment and the role that technology would play in promoting a personalized, individualized learning experience. One of the main goals of the plan was that, "All learners will have engaging and empowering learning experiences both in and out of school that prepare them to be active, creative, knowledgeable, and ethical participants in our globally networked society" (U.S. Department of Education, 2010, p. 9). If this goal is realized, new learning environments will be starkly different from the drill-and-practice paradigm created by the policies of NCLB. Engaging, empowering, active learning environments will require educators to rethink how instruction is delivered and how learning environments are organized. Another important goal of the 2010 *National Technology Education Plan* focused on reorganizing teaching and learning based on achieved competencies (mastery) rather than seat time (p. 68). The fundamental concept driving this goal is that individual students learn at different rates according to their unique abilities and proclivities. The plan calls for a redesigned educational system that utilizes anywhere, any time access to mobile technology, combined with differentiated instructional strategies, to move away from the time-based teaching/learning format to allow individual students to move through the curriculum at a pace best suited to their ability and aptitude.

New Emphasis on Career Readiness

While the battle to reform education rages on, the requirements and opportunities for employment have changed dramatically in recent years. Today, industry and business organizations need workers who are creative, innovative, and able to work collaboratively with others on diverse issues that could hardly be imagined a few years ago. Graduates will need to be proficient in the use of technology tools in order to transition seamlessly into the workforce. The expanse between what our schools are teaching and the skills students need to be successful after graduation widens. As a result, great numbers of young people, including college graduates, are unemployed and without the type of creativity and social acumen necessary to find work in this competitive world economy. In *Global Employment Trends for Youth* (2010), the International Labor Organization (ILO) reported that in 2009 there were 81 million unemployed young people (ages 15-24) in the world. This is an increase of 1.1% from the previous year, the greatest increase ever, and caused in part by the global economic instability. ILO forecasts that this unemployment trend for youth will continue for the foreseeable future and could have a devastating impact on young peoples' ability to enter the work force in the future (Elder, 2010).

One of the barriers that young workers face is the mismatch between the skills and knowledge that workers possess versus the skills and knowledge that employers seek. According to the report, mismatches in non-technical skills such as numeracy, literacy, and life skills are increasingly identified as key barriers to employment of young workers (Elder, 2010). Numeracy refers to a workers ability to use mathematical reasoning in real-world situations. Literacy refers to the ability to read for knowledge, write coherently and think critically. Life skills include the social skills of communication, collaboration, and critical thinking. This mismatch has been created, in part, because students are not able to transfer the procedural knowledge they learn in school to real-world employment situations. Sir Ken Robinson (2011) has worked with students, teachers, administrators and every type of business including Fortune 500 companies. In his conversations with business leaders, he reported

> …they complain that education isn't producing the thoughtful, creative, self-confident people they urgently need: people who are literate, numerate, who can analyze information and ideas; who can generate new ideas of their own and help to implement them; who can communicate clearly and work well with other people. They want education to provide such people, but too often they also cling to an uncritical belief in traditional academic education. (p. 15)

O'Brien and Hart (1999) make the connection between preparing students for employment and the active learning environment characterized by flipped instruction:

> It would seem therefore that the introduction of teaching methods which encourage active learning will not only improve the quality of understanding of the subject by students, but also provide the acquisition of working patterns and skills that employers seek in business graduates while, at the same time, ensuring that the tertiary education sector is fulfilling its educational, social and economic remit. (p. 78)

Many educational researchers agree that the current instructional model is outdated and ill equipped to deal with the demands of the Information Age (Elder, 2010; Grey, 2009; Guilfoyle, 2006; Robinson, 2011). It is clear that reforming traditional educational practices will not be sufficient to curb this disturbing trend. A radically different approach is needed.

History of Flipped Instruction

Early Adopters of the Flipped Approach

In the early 1960s, Gregor Novak began teaching evening physics classes. His students were adults, many who were already fatigued from a day of work. Novak wanted to find a way to modify his instructional approach to meet the needs of his students. He began breaking his physics content into smaller modules to be viewed prior to class. He then utilized active learning strategies during class to engage his students in discussion and problem solving (Rozycki, 1999).

In the 1980s, student availability to the personal computer increased dramatically, so Novak modified his instructional approach and created a software program that allowed his students to work through physics problems outside of class and at their own pace. More recently, with the assistance of a teaching colleague, Novak developed a Web-based classroom strategy called Just-in-Time Teaching (JiTT). With the JiTT approach, students completed short assignments that were due immediately before class. The instructor read the students' responses and formatively altered the lesson to meet the needs of the students. Students came to class with prior knowledge of the subject content and spend the class time actively collaborating with peers and their teacher (Novak, 2006). The essential component of the Novak approach was to modify lecture content and require it’s viewing outside of class to make time for more active learning strategies during class. Essentially, this is the same pedagogical approach as flipped instruction.

In the early 1990s, Eric Mazur, a physics professor at Harvard University, began experimenting with a strategy to increase student participation through active engagement. The underlying concept was to use formative questioning and an instructional strategy he called “peer instruction” to get students actively thinking and talking about physics concepts. Students were expected to read their physics textbooks prior to class to gain the requisite information to participate in the discussions. Reading the textbook prior to the class meeting meant less time had to be spent during class explaining the same basic concepts covered in detail in the textbook. Reducing the amount of time for lecture meant more time for peer instruction activities (Crouch, Watkins, Fagen, & Mazur, 2007, p. 14). Although Mazur and his colleagues were not using technology to “flip” their courses, they were in fact transforming the learning environment of their classes in much the same way as flipped instruction classrooms today. Mazur transformed his lengthy lecture material into a series of short presentations covering key points in much the same way a flipped instruction teacher reduces the textbook to a series of key video lessons lasting no longer than fifteen minutes. During class, Mazur’s students were given additional problems and encouraged to discuss their solutions with peers, often defending their method of solving the problems (Crouch et al., 2007).

Although Mazur’s students expressed satisfaction with the new active format and consistently rated the class highly, many also complained that they had difficulty reading the technical physics textbook (Crouch et al., 2007, p. 14). The peer instruction approach has not worked as well for other Harvard physics professors as it has for Dr. Mazur (Berrett, 2012).

Melissa Franklin, then chair of Harvard's physics department explained why she believed Peer Instruction has not worked as well for all faculty members. She stated,

> It demands that faculty members be good at answering students' questions on the spot, even when their misconceptions are not yet clear because they are still processing the information. It can also be very labor intensive for faculty members who do not have teaching support…it requires a professor to read questions that students submit before class. (Berrett, 2012, p. 5)

Ms. Franklin's statement suggests that flipped instruction is not for every teacher and school officials should proceed with support and caution when making implementation decisions.

Technology in the 1990s had yet to evolve to the point where even Harvard professors could easily move lecture content to a digital platform. Even if they could, their students would have had no easy access to the material. Still, Dr. Mazur is one of the visionaries of flipped instruction. As early as the 1990s, he saw the potential for using technology to transform education. In a 1991 article, he wrote, "I believe we are just seeing the beginning of this process and the computer will soon become an integral part of education" (Mazur, 1991, p. 38).

Role of Technology in Flipped Instruction

In 1996, researchers at Miami University in Ohio conducted an experiment that compared the learning preferences of students in an "inverted," introductory economics classroom format. The term, "inverted classroom," is often used synonymously with flipped instruction. The students averaged 18 years of age and were predominantly Caucasian from upper-middle class families. Researchers were interested in finding an instructional model that would accommodate the widest variety of learning styles with the least loss of content coverage. Researchers correlated the various models of learning styles from Reichmann and Grasha, Kolb, and Myers-Briggs to the types of multimedia from which students could choose (Lage et al., 2000, p. 40). Students were required to read content material from their textbooks prior to discussing the topic in class. Optionally, they could view lectures on the topic that were available on VHS videotape. The videotape could be viewed in the library or copied for home viewing. Lecture material was also available in PowerPoint® format with recorded narration. The PowerPoint® files could be downloaded from a Web site or a printed copy could be purchased. The format of the inverted classroom included a question/answer session or a mini-lecture activity to clarify any misunderstandings from the assigned reading or lecture recordings. This was followed by an experiment or activity in which students actively discussed content material with each other and the instructor. Groups of students were also required to present content information to the entire class in an informal presentation (Lage et al., 2000).

Results of the Lage et al. (2000) study revealed that the majority of students were favorable toward the inverted classroom design. Students rated the inverted classroom a favorable score of 3.9 out of 5.0 on the Likert scale. Students rated group work a favorable score of 3.7 out of 5.0. Instructors in the study reported more student motivation and attributed this to the increased demand for students to take ownership of the learning process (Lage et al., 2000, p. 37). It was the conclusion of the study that the inverted classroom clearly allowed students of all learning styles to use the method that is best suited to their needs.

Jeremy Strayer (2007) published his doctoral thesis on the effect of what he called the "classroom flip" on learning environment. In his research study, he compared the learning environment in a traditional classroom with that of a flipped instruction classroom that utilized an intelligent tutoring system used to deliver the course content outside of class. Using a mixed method approach, Strayer administered the *College and University Classroom Environment Inventory* (CUCEI) questionnaire to two classes of introductory statistics students enrolled at a Midwestern university. The students were predominantly Caucasian from middle class families.

The CUCEI questionnaire is designed to measure student perceptions of their actual learning environment as well as opinions of what an ideal learning environment might constitute. The questionnaire was grounded in Moos theory (Moos, 1973). Independent *t*-tests were used to compare the flipped instruction group with the control group. Significant values were found for subsets of the CUCEI including innovation, task orientation, and cooperation. Using multivariate analysis of variance (MANOVA) for the quantitative analysis of the questionnaire data, Strayer determined that students in the flipped instruction group significantly preferred an environment with greater innovation and collaboration when compared to the traditional group. However, the flipped instruction group was significantly less satisfied with how the learning environment oriented them toward the assigned tasks when compared with the traditional group. Quantitative data were used to guide the qualitative portion of the study. Strayer used student interviews, in-class observations, student reflections, and focus group interviews to determine how students perceived their learning environment. Strayer concluded that even though the students in the flipped classroom had difficulty making sense of some of their learning activities, they preferred a classroom with more innovation and collaboration (Strayer, 2007).

Web 2.0 and Flipped instruction

In the years since the Novak and Mazur studies, instructional technology has radically improved. Obsolete VHS videotape has been replaced by online services such as YouTube® and TeacherTube®. These social media sites have made sharing via the Internet as easy as clicking on a hyperlink. Free learning management systems have become available to classroom teachers that incorporate lessons, multimedia, and assessments. New interactive textbooks are being created for use with mobile tablets such as the iPad, incorporating not only information, but interactive multimedia and video tutorials as well (Hu, 2011).

The ability to annotate lecture recordings has also re-energized the flipped instruction movement by enabling teachers with little or no professional development training to create interactive, informative mini-lectures and make these available to their students anywhere, anytime. Students view recorded tutorials or lectures at home, freeing up limited class time for more active learning strategies (Gannod, 2007; Kellogg, 2009; Walter-Perez & Dong, 2012). This revolution in instructional technology has many educators excited about the possibility of creating learning environments that promote individualized, personalized learning.

Referred to as the "inverted classroom" by their higher-education counterparts, this reversal of location where the subject content is introduced and where it is applied has recently been dubbed flipped instruction by a new generation of K-12 educators. Although there are many variations, most teachers who "flip" their instruction are using video recordings of what they would normally cover in class as homework assignments for their students. Students watch the videos as they take notes and write down any questions they have (Alvarez, 2011; Bergmann & Sams, 2012; Gannod, 2007; Lage et al., 2000).

Jon Bergmann and Aaron Sams are two chemistry teachers that are given credit for bringing this innovative instructional strategy to the forefront of instructional technology and pedagogical discussions. They have provided perhaps the most simple and functional explanation of a "flipped classroom." Bergman and Sams stated, "Basically the concept of a flipped class is this; that which is traditionally done in class is now done at home; that which is traditionally done as homework is now completed in class" (Bergmann & Sams, 2012, p. 13). Both Bergmann and Sams are quick to clarify that they did not invent Flipped instruction and that there is no one single method for implementing the strategy. They created their own videos using screen-capture software and made it available to students online or as downloads to their students' mobile devices.

Social media has contributed to the flipped instruction movement. Bergman, Sams, and others routinely post their video lessons online for other teachers to use. Online sharing and collaboration among flipped instruction practitioners is breaking many of the barriers to implementation and helping beginning flipped instructors incorporate videos created by others. Flipped instruction teachers often including Khan Academy® videos and practice problems into their courses. Khan Academy® is a not-for-profit organization providing digital videos on a wide variety of educational topics (Khan, 2012).

Conceptual Framework of Flipped instruction

Although it sounds simple enough, the idea of flipped instruction can be much more involved when incorporating elements of blended instruction, active learning, and individualized instruction. Regardless of whether you call it, flipped instruction or an inverted classroom, the instructional principles behind this form of blended instruction are getting attention from educational leaders and practitioners around the country. By reversing the sequence of instruction, innovative educators are revolutionizing the way students learn by making better use of class time for active and mastery learning. Flipped instruction also shifts the focus of learning from the teacher to the student, which has an affirming effect on self-regulation and self-efficacy (Bland, 2006). Figure 2 illustrates how flipped instruction can be used to alter the learning environment in increasingly student-centered ways.

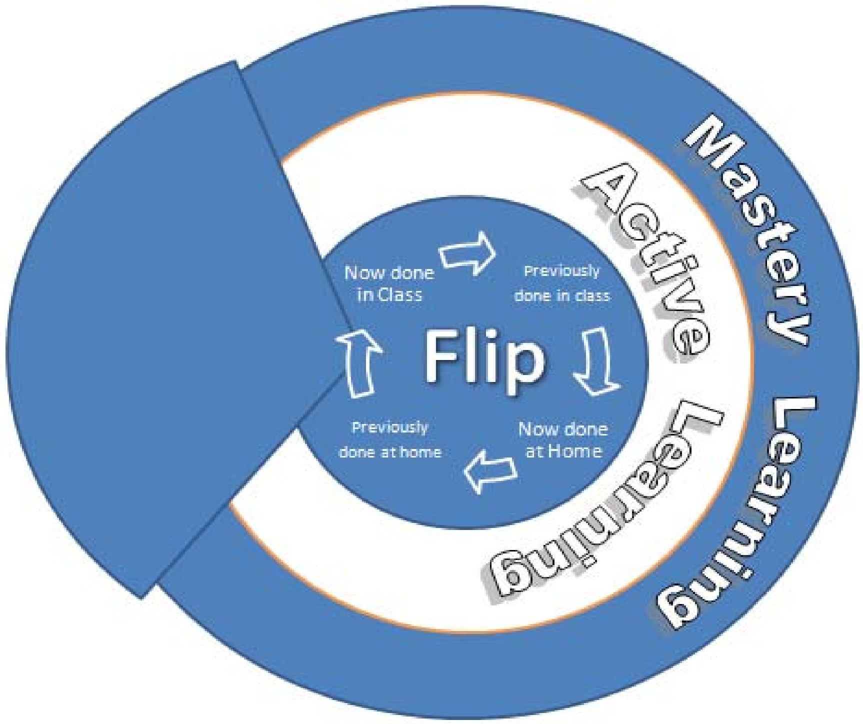


Figure 2. Flipped Instruction Conceptual Framework.

The first tier, commonly referred to as a "basic flip," is the most basic level and is characterized by using online video, digital textbook, or other forms of media to move lecture content to the home learning environment. Face-to-face class time can be used to do work normally reserved for homework, namely work practice problems similar to those viewed by students on the teacher-created videos. This first tier of flipped instruction does not have to include any elements of active learning. The purpose is to simply provide more assistance to students as they practice the skills they need to be successful in the course.

Teachers wishing to maximize face-to-face time can add to the model by incorporating active learning strategies, tier 2, which promote higher-order thinking, social learning, and 21st century skills. Students still get first exposure to subject content by watching teacher-created videos at home.

Experienced teachers of flipped instruction can take full advantage of the online delivery of lecture material and implement a third tier of mastery-level learning where each student works at his/her own pace. Managing a flipped mastery classroom typically requires that the teacher deliver course information, assignments, and assessments through a course management system. Gannod et al. (2008) stated that the advantage of providing online access to content in a self-paced learning environment is that "the learner can access the information at their own pace and continually reference recorded material" (Section 3.2, para. 3). In mastery learning, students advance only after demonstrating a pre-determined level of mastery.

Each level has its unique advantages and challenges. Instructors may elect to use flipped instruction techniques with active learning strategies, mastery learning strategies, or both.

Flipped Instruction as Blended Instruction

Because flipped instruction delivers at least part of the instruction in a face-to-face learning environment and another portion of the instruction at home, many researchers and educators consider flipped instruction a form of blended learning (Alvarez, 2011; Bergmann & Sams, 2012; Horn & Staker, 2011; Kaner & Fieldler, 2005, Toto & Nguyen, 2009). Dziuban, Hartman and Moskal (2005) described blended learning as a shift from lecture to student-centered instruction where students have an opportunity to become actively engaged, potentially learning more than in a traditional on-campus classroom. Horn and Staker (2011) defined blended learning as, "any time a student learns at least in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace" (p. 3). This definition fits perfectly with the flipped instruction model in use today. Flipped instruction is best described as the flex model of blended learning, an online platform in which most of the curricula is delivered online while teachers provide on-site support through in-person tutoring and small group sessions (Horn & Staker, 2011, p. 4).

Advancements in technology make blended learning more appealing. Early adoption of this flipped form of instruction by Lage et al. (2000) at Miami University in Ohio deviated only slightly from this definition in that they used analog media and Microsoft® PowerPoint presentations to deliver their lecture material. VHS videotape was being widely used at the time and provided an easy and economical method of flipping the location where lecture is delivered. They did make the narrated PowerPoint lectures available to their economics students via Web download.

As evidence of how rapidly technology has evolved, researchers from the same university published a conference paper on their experience using flipped instruction in software engineering courses (Gannod et al., 2008). These researchers conducted a study of flipped instruction where the lecture content was delivered through video-on-demand; a term that means that students can gain access to the video files from the Web and could do so at a time of their choosing.

Recent changes in web-based technology are enabling classroom teachers to blend the best features of synchronous face-to-face learning with the flexibility of asynchronous online instruction (Kaner & Fiedler, 2005; Staker, 2011). An increasing number of teachers are moving to blended instruction because they believe this format provides the best opportunity to focus on high-value activities such as critical thinking and project-based instruction (Horn & Staker, 2011, p. 7). Flipping the location of lecture delivery fundamentally changes the learning environment by freeing face-to-face class time for engaging, active learning strategies which have been shown to increase retention of important concepts and improve student satisfaction (ACT & The Education Trust, 2005; Armbruster et al., 2009; Bonwell & Eison, 1991).

An emerging e-culture is another important reason why many people think that technology and blended instruction are essential to students' success in 21st century society. People use technology everyday to communicate, stay informed, travel, shop, and do their banking. Why should schools be the only place where technology is not ubiquitous? Many people believe that schools should do more to prepare students for their e-future (Wang & Reeves, 2003). In a report written for the North American Council for Online Learning (NACOL), Watson (2008) recognized the potential for blended instruction. According to Watson, "blended instruction combines the best elements of online and face-to-face learning. It is likely to emerge as the predominant model of the future - and to become far more common than either one alone" (p. 3).

Effectiveness of blended learning as an instructional model. There is on-going research into the debate as to whether blended instruction is as effective as the Traditional Lecture-homework instructional model at preparing students for college and career readiness? A study by ACT and The Education Trust (2005) reported that high schools that provide all students with high-level courses, qualified teachers, flexible teaching styles, and extra tutorial support are more successful in preparing their students for college and career. A meta-analysis of research literature from 1996 – 2008 examined the effectiveness of online, blended, and traditional learning. The meta-analysis found significant data supporting blended instruction as more effective than traditional face-to-face learning (Means, Toyama, Murphy, Bakia & Jones, 2010). The effect size comparing blended with face-to-face instruction was +0.35, $p < .001$, indicating that blended learning had stronger learning outcomes when compared with traditional instruction (p. 19).

A study conducted by Barkley (2010) compared the effectiveness of blended instruction with traditional instruction in an eighth grade Algebra class and discovered that blended instruction was just as effective as traditional instruction in terms of academic achievement, student engagement, and academic achievement with regard to learning styles. The researcher subjected an experimental group to the blended instructional design by having them watch online video tutorials as homework then work additional problems in class with instructor support. Essentially, the researcher was conducting a flipped instructional blended design. The flipped instruction group scored higher than the traditional control group on each area investigated but no significance was determined. A limitation of the action research study was that the researcher was also the instructor of both the experimental and the control groups. It is possible that this may have had an influence on the no significance result. The no significance findings of this study suggest that a flipped instruction form of blended instruction is as effective at teaching eighth-grade algebra as traditional methods.

A growing body of research comparing blended learning with traditional face-to-face instruction on student achievement is favoring blended instruction as being more effective (Barkley, 2010; Condie & Livingston, 2007; Means et al., 2010; Watson, 2008). The flipped instruction model has been categorized as a form of blended instruction (Alvarez, 2007). Using technology to deliver low-level fact-based information to students at home in order to make better use of face-to-face time for active learning is the guiding principle behind blended learning (Watson, 2008) and behind flipped instruction.

Flipped Instruction to Promote Self-efficacy

Flipped instruction does more than reverse the location where content is delivered; it reverses the focus from instruction to learning; from the teacher to the student. In a Flipped instruction classroom, the responsibility to obtain the factual information is shifted to the student, making the student essentially regulator of his or her own learning (Bland, 2006). The effect of students assuming more ownership over their learning environment may result in greater autonomy and increased responsibility, which may in turn translate into greater self-efficacy (Bandura, 2006).

Importance of self-efficacy in mathematics. Academic self-efficacy is important in mathematics education because students with low self-efficacy have a tendency to avoid taking subjects in which they perceive they will not do well (Schunk & Meece, 2005). Academic self-efficacy is a measure of the confidence a student has to successfully complete a given task. It influences the choices that students make and the courses of action they pursue (Pajares, 1996). Studies have shown a positive correlation between academic self-efficacy and academic achievement (Bevel, 2010; Fast et al., 2010; Pajares & Miller, 1995). In academically challenging courses such as mathematics, students are often assigned problems that require a significant commitment to higher-order thinking and the problem-solving process. In such courses, self-efficacy is essential to motivation and self-regulation. Zimmerman, Bandura, and Martinez-Pons (1992) explained, “Academic self-regulation is concerned with the degree to which students are metacognitively, motivationally, and behaviorally proactive regulators of their own learning process” (p. 664). According to Schunk (1983), “A heightened sense of efficacy sustains task involvement and results in greater achievement. Lower percepts of self-efficacy tend to lead to less persistence and lower achievement” (p. 92).

Self-efficacy and self-regulation are at the core of flipped instruction. Students must assume responsibility to watch the tutorial videos prior to class as well as be proactive in their problem-solving approaches during face-to-face active learning strategies. Consequently, because students in flipped classrooms are responsible for watching the recorded videos to obtain the initial information, they need to be self-motivated in order to be "consistently successful" (Gannod et al., 2008).

Flipped instruction promotes higher student self-efficacy. Many students avoid higher-level math courses due to low academic self-efficacy (Schunk, 1983). Bandura (1977) stated that interventions designed to change behavior can be successful at increasing student self-efficacy and reducing avoidance behavior. In *Self-efficacy: Toward a Unifying Theory of Behavioral Change*, Bandura (1977) identified four sources of information that impact an individual's self-efficacy. The most determining source of information comes from the student's performance accomplishments. Past successes or failures determine an individual's confidence, or the lack thereof, in their ability to master specific tasks. Failures are especially damaging to self-efficacy when they happen early in the learning experience (Bandura, 1977, p. 195). Because lessons are available to students in digital video format in a Flipped instruction classroom, students are able to pause, rewind, and repeat lessons as many times as they feel necessary to master the skill (Bergmann & Sams, 2012, p. 24). This type of learning environment reduces the physiological factors of anxiety and fear and increases the students' confidence by removing the stress of having to solve problems unsupported. Typically, the only homework requirement for the student is to take notes as they watch the video. Some flipped instruction teachers build pauses into the video to remind students of important information they need to include in their notes. What is removed is the frustration many students feel of having to apply information and skills from lecture to problems that may be more difficult than the examples the teacher worked in class.

Self-efficacy can also be influenced by vicariously observing peers as they successfully work through challenging problems (Bandura, 1977). In a social-learning setting, such as the flipped instruction in-class practice sessions, students observe their peers mastering a particular skill, which in turn gives them the confidence that they will also be able to master the same skill (Schunk & Meece, 2005). The problem with traditional lecture-homework classrooms is that homework problems are worked in isolation, denying students the opportunity to boost their confidence by observing their peers successfully mastering the problems. In a flipped instruction classroom, students work mathematics problems in small group settings, often utilizing peer-to-peer tutoring (Bergmann & Sams, 2012. p. 15). Students are encouraged to work on the problems collaboratively, which builds a sense of community, not competition.

Bandura was quick to point out that vicarious experiences are not as powerful in promoting self-efficacy as personal accomplishments and are quickly replaced with doubt after only a few failures (Bandura, 1977, p. 197). This negative aspect of vicarious experience is lessened in the flipped instruction classroom because the focus is on learning, not the assigning of a grade. Each student has daily opportunities to master the content in a safe, social-learning environment. By the time they take the exam, they have received multiple opportunities to experience success in solving problems and applying concepts.

Students can also develop confidence through meaningful and authentic persuasion and praise. Such social encouragement reduces anxiety and boosts confidence if the praise is genuine and well-deserved (Bandura, 1977). In flipped instruction, struggling students get more one-on-one attention from the teacher because the teacher has been freed from the task of lecturing and can move about the class working with students on an individual or small group basis. The flipped instruction model allows more student-to-teacher and student-to-student interaction because of the self-paced format and the collaborative learning groups (Bergmann & Sams, 2012, p. 25).

Flipped instruction promotes self-efficacy by altering learning environment. Student self-efficacy can be influenced by a number of factors including past and current behavior, personal factors, and learning environment. It is the latter that can be influenced most effectively through flipped instruction.

In 1986, Albert Bandura published, *Social Foundations of Thought and Action: A Social Cognitive Theory*, which included his conception of triadic reciprocality. Triadic reciprocality examined the interacting influences of behavior, environment, and personal factors. When an individual reflects on an experience and interprets the results of their performance based on their behavior, this provides information that alters beliefs about their ability to succeed (self-efficacy). This change in personal beliefs in turn alters their environment and their subsequent performances. Judgments based on these beliefs are specific to both task and situation, so students may have strong self-efficacy for one subject and not another (Pajares, 1996). They may even have strong self-efficacy for working with equations but not inequalities. This is because one of the sources of self-efficacy is personal experience. The combination of these personal experiences (behaviors) with specific environments and other personal factors creates an interaction that Bandura called *reciprocal determinism* (Pajares, 1996). When an individual experiences successful attainment of some task, self-efficacy tends to increase, which in turn encourages the individual to engage in similar activities in the future. If however, the individual is unsuccessful, this will have a reverse effect on self-efficacy, causing them to avoid similar activities in the future. According to this theory, classroom students view all new phenomena through the filter of their prior experiences, beliefs, fears, and feelings. Self-reflection influences the choices they make and the course of action they take in future events (Pajares, 1996). In light of this information, it is imperative that educators create learning environments that reduce the fear and anxiety of challenging academic courses and support students in learning situations where they have the best chance of successfully mastering the content. Figure 3 describes Bandura's conception of triadic reciprociality as it relates to the flipped instruction learning environment.

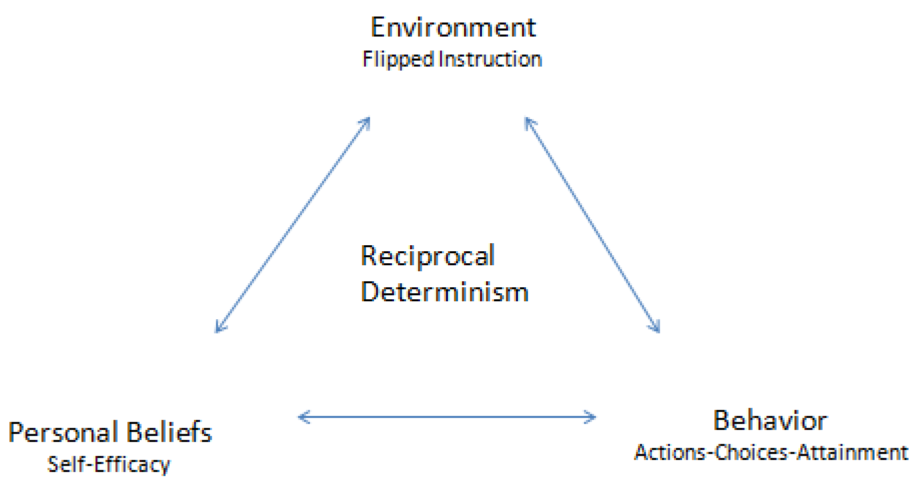


Figure 3. Conception of triadic reciprocality modified for flipped instruction (Bandura, 1986).

Bandura's reciprocal determinism may be modified to accommodate flipped instruction by altering the learning environment and providing students increased opportunities to master challenging mathematics curriculum. Teachers can affect the academic attainments experienced by the students, which in turn will alter their self-efficacy. This change in self-efficacy will, in turn, result in changes in behavior (effort, persistence) that will affect the learning environment through motivation and effort.

Flipped instruction to promote self-efficacy through self-regulation. Zimmerman et al. (1992) explained, "Academic self-regulation is concerned with the degree to which students are metacognitively, motivationally, and behaviorally proactive regulators of their own learning process" (p. 664). Academic self-regulation is at the core of flipped instruction. Students must assume the responsibility to watch the video tutorials prior to class or they will be unprepared to participate in the type of active learning activities that have come to characterize flipped instruction. Zimmerman et al. (1992) conducted an experiment to investigate the role of self-efficacy beliefs and personal goal setting on academic attainment. The sample included 102 ninth and tenth grade students from two high schools. All subjects, 50 males and 52 females, were enrolled in social studies classes at one of the two high schools. The survey instrument, *Children's Multidimensional Self-Efficacy Scales*, measured student perceived self-efficacy in two subsets. Subset one dealt with self-efficacy for self-regulated learning and contained 11 items. Subset two dealt with self-efficacy for academic achievement and contained nine items. Parents also completed the survey to ascertain their perceptions of how their child would do academically in the social studies posttest. At the end of the semester, students' grades were compared to their grades from last year and compared to their perceived self-efficacy in the areas of self-regulation and academic achievement. Several interesting conclusions were derived from this study. Prior grade attainment (last year's grades) correlated with student academic self-efficacy and goal setting, but only through the parents' academic goals for their children. Additionally, parents relied on prior grade attainment when setting goals for their children but children relied on self-efficacy beliefs as well as their parents' aspirations (Zimmerman et al., 1992, p. 672). Personal goals play a key role in students' attainment achievement reaffirming that the higher the perceived self-efficacy, the higher the goals students set for themselves (Zimmerman et al., 1992, p. 673).

Flipped instruction creates a learning environment where students are encouraged to regulate their learning behavior by setting high academic goals for themselves and practicing self-discipline in their study habits. Combined with active learning strategies employed in class, Flipped instruction may provide the most flexible and appropriate learning environment to support student self-efficacy and self-regulated learning, allowing students of all learning styles to use a method, or methods, that best suits them (Lage et al., 2000). Addressing diverse student learning styles is one of the main reasons why teachers “flip” their classrooms (Toto & Nguyen, 2009). Practitioners believe providing individualized instruction that meets the learning needs of all students to be the best use of face-to-face instruction time (Bergmann & Sams, 2012).

Flipped Instruction to Promote Active Learning

Effectiveness of active learning. According to Bonwell and Eison, (1991), active learning is any instructional activity involving students doing something and thinking about what they are doing (p. 2). Valuable class time is made available by moving low-level factual information online. More face-to-face class time can then be utilized for active learning strategies, which have been shown to increase student engagement and improve academic performance (Armbruster et al., 2009; Prince, 2004). Zappe, Leicht, Messner, Litzinger, and Lee (2009) conducted a study investigating the perceptions of undergraduates (N = 100) enrolled in an architectural engineering course. The majority of students (74%) agreed that the active learning strategies used in the Flipped Active class helped them develop a stronger understanding of engineering. An additional 24.7% found the active learning strategies used in the Flipped Active classroom somewhat helpful. However, the majority of students did not want the class flipped all of the time, rather preferring the class to be flipped only about one-half of the time (Students' Perception Section, para. 2).

Armbruster et al. (2009) conducted a three-year study on the effects of active learning strategies in an undergraduate introductory biology course. The number of subjects each year of the study was approximately the same (N=190). The researchers placed students into collaborative groups, four students to each group, for all in-class activities and projects. Each day, groups were presented with either a quantitative or conceptual problem to solve. While solving the problem, students were encouraged to discuss their ideas with the members of their group and then report out to the entire class when they had arrived at a solution to the problem. The researchers administered an opinion survey to gather data on the subjects' perceptions of the active learning strategies. Researchers also compared the results of an end-of-course final exam that contained identical questions during the three-year duration of the study. After analyzing the data, researchers found significant differences between the classes of students that received active learning strategies and classes that did not. Student course satisfaction was significantly higher at the 0.5 alpha level. Student performance on the final exam also increased during the three-year interval. Teacher use of higher-order questioning also increased during the three year period as teachers implemented more active learning strategies in their classrooms. Bonwell and Eison (1991) stated that students need to use higher-order thinking skills such as analysis, synthesis, and evaluation in order to benefit from active learning strategies (p. 2). The results of the study provide strong evidence that active learning strategies are effective at helping students to reach high levels of academic attainment (p. 211).

After analyzing available research literature to examine the effectiveness of active learning in teaching engineering courses, Prince (2004) concluded that faculty should structure their courses to promote collaborative and cooperative learning environments, two forms of active learning (p. 7). He recognized there is much ambiguity among the research authors over exactly what was being studied and exactly how they interpreted what works. However, from the literature he concluded that active learning instructional strategies have much potential to increase student engagement and student achievement.

Discussion and collaboration in active learning. According to Bonwell and Eison (1991), discussion is one of the most utilized ways of providing active learning experiences in the classroom or online. Discussion is an essential component of the active classroom:

> One of the best, and most common, methods of active learning is discussion. Discussion promotes retention, motivates students to want to learn more, and helps students to think deeply about the content so they can transfer the knowledge to new learning situations. (p. 3)

Sezer (2010) designed a study to investigate the perceptions of mathematics students in community college and high school pre-algebra classes. The sequence of instruction was flipped. Instead of presenting the abstract mathematical concepts first, as in the traditional method, instructors introduced real-world application problems for the students to work. Students were expected to solve the problems using prior knowledge and problem-solving strategies. The teacher was to be the resource of last resort. The goal of the study was to incorporate more active learning strategies such as collaboration, communication, and problem solving so students would take a more active role in the learning process. Classwork centered on the solving of word problems, which the majority of students dreaded and found confusing. The instructor placed students in groups and encouraged them to work through the problems using prior knowledge and problem-solving strategies. Lectures were limited to a fraction of class time to allow more time for the active learning activities. Student interviews were conducted to determine student perceptions of the active learning classroom activities. Students' commented that at first they were resistant to the change but gradually began to learn how to solve real-world problems using active learning strategies. Both classes were for non-math majors who had been exposed to the content previously, but not mastered it. Student engagement and confidence increased as a result of the active learning strategies.

Flipped Instruction to Promote Mastery Learning

Theoretical framework for mastery learning. Learning for mastery has been part of the educational vernacular beginning with the work of Jerome Bruner and Benjamin Bloom. In his landmark work, *The Process of Education*, Bruner (1960) stated that “Ideally, schools should allow students to go ahead in different subjects as rapidly as they can” (p. 11). In *Toward a Theory of Instruction*, Bruner (1966) introduced the concept that any theory of instruction should specify the most effective sequences in which to present the materials to be learned (p. 41). Bruner said, “In short, the sequence in which a learner encounters materials within a domain of knowledge affects the difficulty he will have in achieving mastery” (p. 49). Learners, even adult learners should begin with the most concrete experience (enactive), following by diagrams or pictorials (iconic), and finally abstract representations (symbolically)(p. 49). By sequencing instructional materials following Bruner’s theory of instruction, classroom teachers can ensure that students are able to master subject content.

In his article, “Learning for Mastery,” Bloom (1968) explained the concept of mastery learning:

> Conversely, if the students are normally distributed with respect to aptitude, but the kind and quality of instruction and the amount of time available for learning are made appropriate to the characteristics and needs of each student, the majority of students may be expected to achieve mastery of the subject. (p. 3)

Even though it would be difficult to refute the pragmatism and practicality of this statement, over 44 years later relatively few educators, beyond those that teach elementary school, are applying mastery learning principles to their instructional strategies (Cooperman, 2011).

Bloom (1968) believed that it is the rate of learning that is the variable, not the aptitude of the student. He conjectured that there are a small percentage of students in any subject that have a special aptitude for that subject and will out-perform most other students. Conversely, there are students with little aptitude, perhaps even with a disability that precludes them from ever mastering a particular subject, regardless of time allowed. But, for over 90% of people, given sufficient time and the appropriate level of assistance, mastery of any subject at a high level, is possible (p. 3). Bloom also believed that teachers could better serve the needs of their students by modifying their instructional practices. He stated,

> Teachers are frequently unaware of the fact that they are providing more favorable conditions of learning for some students than they are for other students. Generally, they are under the impression that all students in their classes are given equal opportunity for learning. (p. 11)

The reason for this inequity is that teachers frequently direct their teaching and explanations to some students and ignore others. They encourage active participation from a few achieving students and ignore others (p. 11). Bloom said that about 80% of students do poorly under conventional instruction as compared to how they might do under one-to-one tutoring as a result of unequal attention.

Flipped instruction creates a learning environment where mastery learning feedback and corrective measures can be used to increase academic achievement for all students. Teachers, assume more of a coaching or tutorial role in the classroom, which according to Bloom (1984) can provide more equitable opportunity for all students to reach academic mastery.

Digitized curriculum and mastery learning. The seemingly insurmountable problem associated with implementing mastery learning is time and manageability. However, the recent proliferation of web-based, multimedia tools and services has generated new interest among some educational professionals. Thanks, in part to the emergence of digitalized curriculum and flipped instruction, mastery learning in mathematics has achieved some documented success.

After implementing a flipped mastery instructional approach, Byron High School in Minnesota experienced an increase in mathematics mastery from 29.9% in 2006 to 73.8% in 2011, as measured by the Minnesota Comprehensive Assessments. The school's ACT scores have also risen from an average composite score of 21.2% in 2006 to 24.5% in 2011 (Fulton, 2012, p. 20). At Byron High School, students watch a 10-minute video on a mathematics concept, then work at their own pace. When they can show mastery, they are allowed to move on to the next lesson. Not every institution will experience success on such a scale but the potential to provide personalized instruction and mastery learning through flipped instruction is being realized by some.

Arguably the most recognized names in flipped instruction today, Bergman and Sams (2012) believe that mastery learning can be made manageable through Flipped instruction because it allows lecture material to be presented asynchronously, thereby making mathematics content differentiation possible for individual students. Matching mathematics curriculum to individualized pacing personalizes the learning to meet the needs of the individual student (Bergman & Sams, 2012; Horn & Staker, 2011). By moving content online, teachers no longer have to stand in front of the class, moving every student along at the same pace, but are now free to provide a more personal level of tutoring than would normally be possible in a traditional lecture-homework format. Face-to-face time is used to help students who are struggling

(Bergman & Sams, 2012, p. 23) and it is in the best interest of the student to make the best use of the resident expert to help them understand the concepts (p. 7). Students who have mastered the assigned content are free to work ahead or work on projects.

Effectiveness of flipped mastery. When the goal is mastery, students focus on developing new knowledge and new skills to demonstrate their understanding of the objectives. “The process of learning itself is valued, and the attainment of mastery is seen as dependent on effort” (Ames & Archer, 1988, p. 260). Ames and Archer (1988) investigated how specific motivational patterns are related to mastery and performance goals in students (N = 168) attending middle/high school for the academically advanced. Findings suggest that a mastery goal orientation may foster a way of thinking that is necessary to sustain student involvement in learning (p. 264, para. 1 under Discussion) and when students perceived their class as emphasizing a mastery goal, they were more likely to report using effective learning strategies, prefer tasks that offer challenge, like their class more, and believe that effort and success are co-varying (p. 264, para. 2 under Discussion). Researchers used individual student scores as the unit of analysis rather than using students’ mean scores (p. 261). Individual student's perceived ability was a significant predictor of learning strategies, task choices, and attitudes. Students’ perception of a mastery goal in the classroom remained a highly significant predictor for reporting using effective learning strategies (partial r = .49), and preference for challenge (partial r = .34) (p. 263).

Bloom (1984) described two similar studies conducted by graduate students at the University of Chicago where they compared student learning under three different conditions; conventional, mastery learning, and one-on-one tutoring. In each study, remarkable differences in student achievement was measured under the three different learning conditions. Figure 4 illustrates these remarkable differences in student achievement.

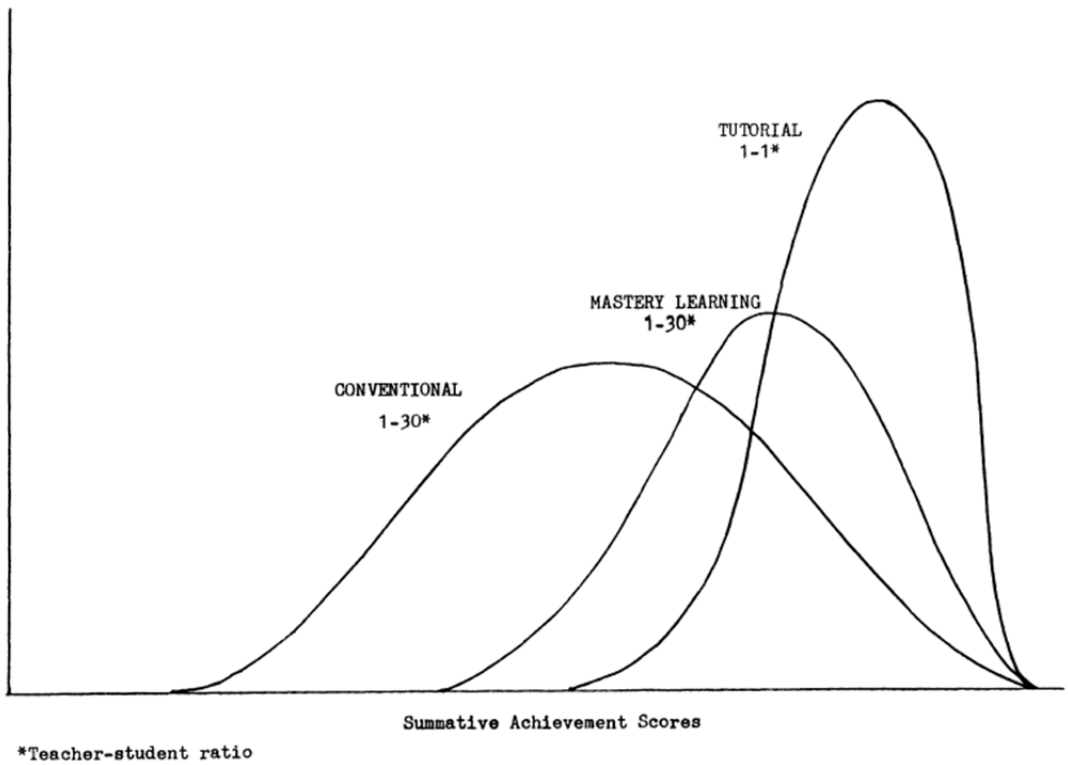


Figure 4. Achievement distribution for students. Bloom (1984) distribution under conventional, mastery learning, and tutorial instruction.

In the publication, Bloom seeks to find a practical alternative to one-to-one tutorial; as such an instructional method would be too costly and inefficient (p. 4). Bloom and his graduate assistants explored a strategy to improve students' processing of conventional instruction. He surmised that if students could develop good study habits, improve their reading skills, and spend more time on studying, they would improve their academic achievement with no change to instructional methods. What Bloom proposed was to provide students with the cognitive prerequisites they would need to be successful by implementing mastery learning feedback and corrective procedures. He believed that average student achievement could reach the 84th percentile by implementing these procedures and students would become more positive about their ability to learn the subject (efficacy) and therefore would put in more active learning time. Bloom conducted an experiment with high school Algebra I and French I students. In the experimental group, the instructors gave the students the final exam from the prior course and then provided mastery learning feedback and corrective procedures. The instructors then gave the students a parallel test on which the students achieved 80% mastery (p. 7).

Miles (2010) conducted a quasi-experimental study involving eighth-grade students attending a suburban middle school located in a southeastern state. The purpose of the study was to examine the effect of mastery learning on student academic achievement in mathematics as well as examine the effect of mastery learning on student achievement goal orientations, perceptions of classroom goal structures, and academic efficacy. Mastery learning strategies were derived from Task, Authority, Recognition, Grouping, Evaluation, and Time (TARGET) framework and strategies (p. 4). For this review, only the effect of mastery learning on student academic achievement and academic efficacy was examined.

The researcher used two quantitative instruments to measure the effect of mastery learning. To test for effect of mastery learning strategies on academic achievement, students were given a mathematics pretest that correlated to the state mathematics standards for the grade and course sequence. The pretest was administered during the first two weeks of the fall semester and a posttest was administered during the last two weeks of the same semester. Both pretest and posttest was administered using the STAR Math computerized testing program. Pretest and posttest data was analyzed using pair samples *t*-test to note any achievement gains between the experimental group (N = 36) receiving mastery learning strategies and control group (N = 43) using traditional learning strategies. Analysis of the data revealed that the experimental group ($M_D = 64.39$, $S_D = 45.32$) receiving the mastery learning strategies from the TARGET framework experienced larger gains on the STAR Math test than the control group ($M_D = 31.95$, $S_D = 28.11$). The achievement gains by the experimental group receiving mastery learning strategies was significant using paired samples *t* test, $t(77) = 3.887$, $p < 0.000$ (p. 113). The researcher used a modified Motivational Orientation Inventory (MOI) combined with a repeated measures study to measure the effect of a mastery approach on the construct of student academic efficacy. Students ($N = 57$) were randomly selected from the population of eighth-grade students receiving mastery learning treatment were administered a pretest-posttest to examine the differences in academic efficacy. Student academic efficacy measured $M_D = .139$ with a pretest $M = 3.821$, $S_D = .655$ and a posttest $M = 3.960$, $SD = .733$. The changes in academic efficacy were not significant $t(56) = 1.276$, $p = .207$ (p. 107).

Flipped instruction can be an effective instructional strategy for promoting active learning or mastery learning, but which strategy is best for students? As we have seen, many researchers agree that active learning strategies such as discussion and problem solving are more engaging than less passive forms of instruction, such as lecture. However, not all researchers believe that active learning is equally effective regarding student achievement across all student groups. Weltman and Whiteside (2010) conducted an experiment involving over 300 business students in seven different statistics classes. In the experiment, each student was exposed to three different methods of instruction: traditional, hybrid (a mix of traditional and fully-active learning), and fully-active learning. An assessment was given directly after receiving instruction. Overall, traditional instruction showed the highest test scores, followed by the hybrid (p. 7). There were significant differences in the effects of the different teaching methods according to student grade point average (GPA). Weltman and Whiteside's experiment showed that for increasing levels of active learning strategy utilized, student test scores for students with higher

GPAs, actually dropped. The reverse was true for students will low GPAs. However, it seems that this relationship is only true at the extremes (traditional vs. fully-active) since the relationship between the hybrid instructional method and GPA tends to meet around the overall mean, or as the authors termed it, "converge to the mean" (p. 9). The researchers used a linear mixed model in the analysis of the data and offered a possible explanation for the drop in test scores of the students with GPAs. They speculated that students have been conditioned through repeated exposure to traditional instructional methods to succeed in this type classroom and when those methods are changed, the adjustment to the new instructional style results in a drop in test scores (p. 9).

The Weltman and Whiteside experiment sheds light on the need for instructional methods and strategies that meet the needs of individual students. The design of the Flipped instruction classroom makes individualized, personalized instruction both manageable and replicable through the use of instructional technology. Flipped instruction classroom teachers can create digital portfolios for units of study that will allow students to work through the material at a pace that best suits their needs, aptitudes, and interests.

Summary

While active learning and mastery learning environments have been heavily researched, little empirical research has been conducted on how flipped instruction alters the learning environment to promote active and mastery learning in the secondary mathematics classroom. Most of the current information about flipped instruction can be found in practitioner journals that claim dramatic increases in mathematics test scores and report increased student satisfaction. However, there are little empirical research investigating the flipped active, flipped mastery, and traditional lecture/homework Algebra I classrooms in terms of academic achievement, student self-efficacy, and student preference for learning environment based on learning style.

Flipped instruction has been characterized as a form of blended instruction, blending components of traditional face-to-face instruction with the most effective components of distance learning. This study will add to the empirical data by investigating flipped instruction as a blended instructional approach with ninth grade Algebra I students. Previous studies have focused on flipped instruction in college-level mathematics, physics, and engineering courses. Previous studies have investigated the phenomena using exclusively quantitative methods. This study will add to the empirical data by investigating flipped instruction from the lived experiences and perceptions of secondary mathematics students.

Data from numerous studies support the hypothesis that blended instruction is as effective as traditional lecture-homework learning environments at promoting student achievement. However, the researcher found no studies investigating the effectiveness of the flipped active, flipped mastery, and traditional lecture/homework learning environments at promoting academic achievement and mathematics self-efficacy in the Algebra I classroom. The researcher also found no qualitative studies investigating student preference for learning environment based on learning style.

CHAPTER III:

RESEARCH METHODS

Introduction

The purpose of this study was to examine the effect of learning environment on student mathematics achievement and mathematics self-efficacy, and to investigate the lived experiences of students and teachers in three learning environments:

a) Flipped instruction with active learning strategies;

b) Flipped instruction with mastery learning strategies; and

c) Traditional instruction with lecture/homework learning strategies.

The researcher also sought to determine whether a student's learning style played a role in their preference for the type of learning environment.

According to Yin (2009), the most important step in any research study is defining the research questions. The research questions ultimately determine which instruments, methods, and analyses the researcher will use. Both quantitative and qualitative research methods are often necessary to gain the most complete understanding of the phenomenon (p. 10). Creswell (2009) described a mixed-methods study as more than simply collecting both quantitative and qualitative data. He described a mixed-methods study as a "continuum," in which the researcher uses both types of data "in tandem" so that the strength of the study is greater than would be possible using quantitative or qualitative approaches alone (p. 4).

This study utilized an explanatory mixed-methods research design. An explanatory mixed-methods research design is the most commonly used design in educational research, with distinct advantages over the triangulation mixed-methods design for both the researcher and the reader in that the researcher is not required to converge the two types of data and can report them separately using clear and easily identifiable headings in the report (Creswell, 2008). Case study research is an appropriate form of qualitative method to use when the researcher wishes to understand how or why something happens. Yin (2009) explains that research questions that ask "how" and "why" are often explanatory in nature and lead to the use of case studies for the qualitative component (p. 9). Creswell (2008) describes an explanatory mixed-methods research design as a good design to use when the researcher wishes to build on the strengths of both quantitative and qualitative data (p. 552).

This chapter describes the quantitative methods and instruments used to investigate research questions one and two, the rationale for their selection, and a detailed description of the procedures used to collect and analyze the data. Following the quantitative section is a description of the qualitative methods and procedures used to collect and analyze the qualitative data to investigate research questions three and four.

Research Questions, Null Hypotheses, and Research Method

This explanatory mixed-methods study investigated four research questions. Research questions one and two, along with the associated null hypotheses, were investigated using quantitative methods. Research questions three and four were investigated using qualitative methods.

RQ1: How do students in classrooms utilizing Flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies, compare academically on mathematics achievement?

H_o1: There is no statistically significant difference in the mean mathematics scores of students participating in classes utilizing varying instructional strategies.

RQ2: How do students in classrooms utilizing Flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies, compare on mathematics self-efficacy?

H_o2: There is no statistically significant difference in the mean mathematics self-efficacy scores of students participating in classes utilizing varying instructional strategies.

RQ3: How do the lived experiences of students and teachers in the Flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies compare?

RQ4: How do students' learning style affect preferences for learning environment?

Setting and Selection of Participants

The research study was conducted in three Algebra I classrooms, covering the same state-mandated course of study, in a 5-A high school located in the southeastern United States. The high school belongs to a five-school, city school system and is the only high school in the system. The high school serves a student population of 776 in grades nine through 12. Three administrators and 61 faculty members are employed at the school. Classes are arranged around four, 90-minute blocks with a 30-minute flex period added to each day to provide students time to work homework and gain tutoring assistance. The Alabama State Department of Education and the Southern Association of Colleges and Schools accredit the high school. Sixty-nine percent of the 2011 graduating class took the ACT exam, receiving an average composite score of 21.2. The graduation rate is 89%, placing it in the top 20% of high schools in the state, with respect to number of students successfully completing their graduations requirements on time (Alabama State Department of Education, 2011).

School administrators selected students for all Algebra I classrooms randomly, without regard to the learning environment being utilized, thereby ensuring random selection of subjects in an authentic educational setting. As in all studies, there exists the possibility that multiple groups are not equivalent prior to receiving the experimental treatment. Non-equivalent groups are therefore a potential threat to the internal validity of the study (Trochim 2006). To compensate for this potential threat, and any influence that may be attributed to prior differences in the groups, a pretest-posttest design was utilized in the collection of all quantitative data. Use of a pretest-posttest design can reduce the risk that any differences between the groups on the posttest are due to anything other than the treatment received (Gribbons & Herman, 1997).

Selection of two different instructors at the high school was necessary due to the fact that the high school had only one teacher that utilized Flipped instruction and she utilized this method exclusively. A second teacher was selected who utilized the Traditional Lecture/homework method exclusively in her Algebra I classes.

Description of the Cases

Ms. Smith, a pseudonym, utilized flipped instruction in all her Algebra I courses. She had two years of prior experience teaching in a flipped instruction classroom. For the 16-week duration of the study, Ms. Smith utilized active learning strategies in her second block flipped instruction classroom, denoted as Class A (flipped active). In her third block flipped instruction classroom, Ms. Smith utilized active and mastery learning strategies, denoted as Class B (flipped Mastery). Ms. Jones, a pseudonym, utilized traditional lecture-homework instructional strategies in her fourth block classroom, denoted as Class C (traditional lecture/homework).

Classrooms A, B, and C followed the same state-mandated course of study. The two teachers participated in regular planning sessions to ensure consistent sequencing of topics but did not utilize the same instructional strategies.

Participants

Participants in the study were 66 ninth grade students enrolled in Algebra I courses at the high school and their Algebra I teachers. Class A originally had 24 participants, however three did not return the Parental Informed Consent form and one transferred to a different class due to a scheduling conflict. These students were eliminated from the study, leaving a total of 20 for Class A. Class B began and ended the study with a total of 24 students. Class C had 24 students with two students not returning the Parental Informed Consent form, leaving 22 students to participate in the study.

The student population reflected the ethnic makeup of the city with the majority of students Caucasian (86.4%), with smaller percentages of African American (12.1%), Hispanic (1.5%), and other ethnicities (< 1%). Females (60.6 %) outnumbered males (39.4%). See Table 1 for a breakdown of gender, age, and ethnicity ("Walker high school," 2013).

Table 1

Participant Demographics

Class	Male	Female	N	MA	Ethnicity		
					Caucasian	African American	Hispanic
A	9	11	20	14	17	2	1
B	10	14	24	14	23	1	0
C	7	15	22	15	17	5	0
Total	26	40	66		57	8	1

Note. MA represents the mean age of participants in each group.

Quantitative Instrumentation

In the explanatory mixed-method design of this study, quantitative methods were used to investigate research questions one and two. This section describes the instrument selected for each research question and the rationale for its selection.

Research Question One and Instrument

Research Question One - How do students in classrooms utilizing flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional instruction with lecture-homework learning strategies, compare academically on mathematics achievement?

The researcher selected the ACT QualityCore® End-of-Course Assessment (QualityCore® EOC) for Algebra I as the instrument for investigating quantitatively how the three learning environments compare academically on mathematics achievement. Similar versions of the QualityCore® EOC were given as a pretest and posttest to increase the validity of the study by controlling for prior mathematics ability.

The QualityCore® EOC is an ideal instrument for measuring student mathematics achievement for several reasons. First, the QualityCore® EOC was created by ACT, Inc. and The Education Trust to "…measure a set of empirically derived course standards representing a solid evidence-based foundation in mathematics" (ACT & The Education Trust, 2005). Secondly, ACT is a widely recognized, not-for-profit organization that complies with the *Code of Professional Responsibilities in Educational Measurement* and have developed the QualityCore® EOC to help students prepare for success in post-secondary education as well as help teachers ensure their courses and instructional practices are likely to promote student success.

ACT and The Education Trust collaborated on a study to determine the courses, level of rigor, and instructional practices that are most likely to lead to student success. Their collaborative report, *On Course for Success* (2005) focused on schools with high minority and low-income student populations that produce graduates who meet or exceed the ACT College Readiness Benchmarks. Their recommendations and the resulting ACT Course Standards form the foundation for the test specifications of the QualityCore® EOC (ACT, 2010, p. 2).

The QualityCore® EOC assessments are modular and include both multiple-choice test items as well as a constructed-response component. Each multiple-choice test item is aligned to one of the standards identified by the study described in the collaborative report, *On Course for Success* (2005), as well as a depth-of-knowledge level. There are three levels of increasing complexity. Level one requires only recall information about mathematical procedures. Level two requires more complex thinking than level one, requiring students to make some decisions about how they are going to solve the problem. Level three requires more abstract, strategic thinking involving planning, explaining, justifying and supporting solutions with evidence. A slightly greater percentage of the questions from the four benchmark sections of the Algebra I assessment require level two thinking (ACT, 2010, p. 3).

ACT has put great effort into selecting and evaluating test items to include in the QualityCore® EOC. Item writers are chosen from a pool of well-qualified high school teachers with extensive content knowledge and represent a cross section of genders, ethnic groups, and geographic locations (ACT, 2010, p. 4). Test items are then examined and refined by ACT test development specialists to ensure the items align to the standards established by the study described in *On Course for Success* (2005). Test items are then reviewed by fairness experts who ensure that the language and the content of each question is not offensive to any student, regardless of geography, socioeconomic factors, or cultural background (ACT, 2010, p. 5). Finally, test items are field tested in public and private high schools by a minimum of 500 students who have taken the corresponding course. After the test items are scored, the data undergoes statistical analysis to determine suitability for inclusion in the QualityCore® EOC (ACT, 2010, p. 6).

The assessment results reported by the QualityCore® EOC included individual student raw scores which represent the number of correct responses to the test items. Raw data is disaggregated into subscores that inform how the student performed in each of the four benchmark sections:

a) number sense/operations/graph skills;

b) quadratic equations/functions;

c) nonlinear equations/functions; and

d) expressions/equations/functions in first degree.

Also included with the raw scores is a QualityCore® Score for each student. This QualityCore® Score is a converted, non-mathematical value, obtained through a process of statistical scaling/equating procedures (ACT, 2010, p. 7). The QualityCore® Score informs the student, parent, teacher, and school system how the student is likely to perform in a college-level course and provides a comparison with students in the class, school, district, and state. All students taking the QualityCore® EOC receives both a QualityCore® Score and an estimated PLAN Score range. QualityCore® Scores range from 125 at the lowest end of the scale to 175 at the highest end of the scale (ACT, 2010, p. 7). Estimated PLAN Scores range from six to 32 with a score of 19 representing benchmark level for Algebra I (ACT, 2010, p. 53). The lowest QualityCore® Score that a student could make and still be at benchmark level is 147. ACT has established a College Readiness Benchmark Score that represents the minimum score a student could make to indicate a 50% chance of obtaining a B or higher grade, or a 75% chance of obtaining a C or higher grade in the corresponding first-year college course. For Algebra I, the equivalent scores would be as follows: a) PLAN Score of 19; b) QualityCore® Score of 147; and c) ACT test score of 22 (ACT, 2010, p. 10). Therefore, a student who scores a minimum QualityCore® Score of 147 has a 50% chance of obtaining a B or higher grade, or a 75% chance of obtaining a C or higher grade in a first year Algebra I course. Additional reports provide class averages disaggregated by gender, ethnicity, or question type (ACT, 2010, p. 11). A sample student report is included in Appendix A.

A final reason why the QualityCore® EOC is an important instrument for the study lies in the fact that this assessment is an Alabama State Department of Education graduation requirement and will account for some percentage of the student's overall grade for the Algebra I course. Education officials have yet to determine the exact percentage that the test will count toward a students' final grade in Algebra I but up to 20% is anticipated. Because of the importance of this assessment to the student, it seems reasonable that maximum effort was attempted on the assessment, thereby providing this researcher with the most accurate data for comparison of how learning environment may influence student academic achievement in the various learning environments under study. A sample QualityCore® EOC assessment, the assessment that was administered to students as the QualityCore® pretest is included in Appendix A, along with sample teacher and sample student reports.

Research Question Two and Instrument

Research Question Two - How do students in classrooms utilizing flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional instruction with lecture-homework learning strategies, compare on mathematics self-efficacy?

The instrument chosen to measure students' academic self-efficacy is the Mathematics Self-Efficacy Scale- Revised (MSES-R). The MSES-R was originally developed by Betz and Hackett (1983) for the purpose of assessing the mathematics self-efficacy beliefs of college students. Three domains were included in the survey which include everyday math tasks, math problems, and math-based college courses. The three domains contain 52 questions, with responses to each question set up on a 5-point scale (p. 332). Betz and Hackett (1983) reported internal reliabilities of math tasks (.90), math problems (.93), and math-based college courses (.92). The reliability of the total 52 item scale was .96 (p. 334).

Pajares and Kranzler (1997) reported a Cronbach's alpha of .92 using a version of the math problems subscale of the MSES-R with high school students. Questions in the math problems subset are therefore applicable to high school Algebra I students. Additionally, Bandura (1986) stated that self-efficacy judgments are both context-specific and task-specific and consequently, there exists the need for specificity when using academic self-efficacy scales. Following this logic, only the math problems subset, containing 18 of the original 52 items, was included in the revised survey instrument. It is important to note that students did not actually work the mathematics problems on the MSES-R, but simply indicated their confidence to work the problem using a 5-point Likert scale. As a consequence, time required to take the survey was minimal, approximately fifteen minutes. The math problems subset has been shown to have an internal reliability of .93 (Beetz & Hackett, 1983). A copy of the MSES-R problem-solving subset that was administered to students in this study is included in Appendix B.

Qualitative Methods

This study utilized an explanatory mixed-method design. A qualitative multiple case study design was used to investigate research questions three and four. This section describes the case study research design and provides the rationale for its selection.

Research Question Three and Multiple Case Study

Research Question Three - How do the lived experiences of students and teachers in the Flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies compare?

Yin (2009) stated that case studies are an appropriate research tool when examining contemporary events when the relevant behaviors cannot be manipulated. Merriam (2002) defines a case study as "…an intensive description and analysis of a phenomenon or social unit such as an individual, group, institution, or community." The case study seeks to understand, and describe in detail, a single phenomenon (p. 8).

Case study research is appropriate for addressing research questions investigating "how" and "why" situations (Yin, 2009, p. 8). Qualitative data can provide a greater understanding of the learning environment than could be possible through the use of quantitative data alone (Creswell, 2009). "If researchers want to understand how a treatment is being perceived by the subject, the subject must be studied in their context and in the way they operate" (Gillham, 2000, p. 11).

A single case, represented by a single student would fail to take into account the complete spectrum of learning styles typically found in a mathematics classroom. For this reason, the researcher has selected a multiple-case study research study design. In his book, *Multiple Case Study Analysis*, Robert E. Stake (2006) stated that when individual cases share a common characteristic or condition, the common characteristic or condition can be best understood by studying the individual cases (p. 6). Merriam (2010) stated that for an investigation to be a case study, "a bounded system would be selected because it is typical, unique, experimental, or highly successful" (p. 8). For this study, the bounded system was the learning environments represented by the three different cases denoted as Class A (flipped active), Class B (flipped mastery), and Class C (traditional lecture/homework). When determining the unit of analysis, Baxter and Jack (2008) suggested that the researcher decide whether the purpose of the study is to investigate the individual or the program (pp. 545-546). In this study, it was the program, or rather what was going on in the learning environment that was of interest to the researcher. Therefore, the unit of analysis in this study was the lived experiences of the students and teachers in each of the learning environments. Merriam (2002) stated that the units of analysis, not the topic of investigation, characterize a case study (p. 8).

Commonly used methods for collecting qualitative data include documentation, archival records, interviews, direct observations, participant observations, and physical artifacts (Yin, 2009, p. 102). For this case study, the researcher conducted individual structured interviews of students and teachers, focus group structured interviews of students, and direct observation of students and teachers in their respective learning environments as the three instruments for collecting qualitative data.

Data collection was continuous and ongoing throughout the research period, rather than in phases. The researcher conducted the individual structured interviews on three different occasions. On each occasion, the researcher interviewed a maximum of four students from each of the learning environments. A total of 10 students were individually interviewed from Class B and Class C but only nine from Class A. One student from Class A, after participating in the individual interview decided he did not want to participate in the interview portion of the study and his interview data was removed before analysis. The student signed the Assent forms for participation in the MSES-R survey. His data were included in that quantitative portion of the study. A total of 29 individual student interviews were conducted. Individual student interviews lasted 10-15 minutes in duration. The researcher conducted individual teacher interviews during planning periods on the same dates as the individual student interviews. Teacher interviews were 30-45 minutes in duration. The researcher conducted focus group structured interviews and direct observation of learning environments on different dates than the individual student and individual teacher interviews. Focus group interviews were 45-60 minutes in duration and direct observations lasted approximately 30 minutes. The researcher alternated the portion of class that was observed to get a more complete picture of what was happening in the classroom.

To select students for participation in the interview process, the researcher utilized first random and then purposeful sampling. Students for individual interviews were first selected randomly using a random number generator. From the random selections, the researcher then purposefully selected students that represented the four domains of learning styles. A complete description of the selection process is included in the Data Collection section of this chapter.

Research Question Four and Multiple Case Study

Research Question Four - How do students' learning style affect preferences for learning environment? The instrument used to determine students' particular learning style was the Soloman and Felder Index of Learning Styles Questionnaire (ILS) A copy of the ILS can be found in Appendix C. This 44-item online survey used a forced-choice dichotomy to assess student learning preferences using four learning dimensions: active/reflective (A-R), sensing/intuitive (Sn-I), visual/verbal (Vs-Vb), and sequential/global (Sq-G) (Felder & Spurlin

2005, p. 104). This model for identifying learning styles, along with the accompanying questionnaire, was created in 1988 by Richard Felder and Linda Silverman. According to Felder and Spurlin (2005), the web-based version of the ILS is taken hundreds of thousands of times each year and has been included in a number of published studies (p. 103). Permission is granted on the creators' web site to use the ILS free of charge if the purpose is for research. The dimensions of the model bear similarity to other learning style models, including the models of Kolb and the Myers-Briggs Type Indicator (p. 103). Felder and Spurlin (2005) explained, "Each learning style dimension has associated with it 11-forced choice items, with each option (a or b) corresponding to one or the other category (e.g., active vs reflective)" (p. 104). One of the advantages of using the online version of the ILS is the immediate production of a printable student profile with scores for all four dimensions and a brief explanation of the meanings of each dimension (p. 104).

Results from the ILS were used to identify the learning style preferences of students in the three learning environments. The purpose of identifying student learning preferences was to select students for participation in the interview process who represented the largest spectrum of learning styles. Data from the ILS were compared to data collected from interviews and observations to paint a complete picture of whether learning style had an effect on preference for learning environment.

Data Collection

Data collection occurred during a 16-week period beginning the first week of January 2013 and ending the second week in May 2013. On January 9th, 2013 the researcher met with all participants in their relative classrooms and explained the purpose of the study. In accordance with approved Institutional Review Board (IRB) procedures, all students in the study were presented with an Informed Consent letter to be delivered to their parent or guardian explaining that the minor child had been invited to participate in the study based upon their inclusion in a classroom that was participating in the research study. The parent letter explained the non-harmful nature and purpose of the study and provided contact information in case the parent/guardian had questions or concerns. The letter asked permission for the minor student to participate in two surveys over the course of the 16-week study. The letter explained that participation, or non-participation had no effect on their child's grade in the course nor would they be punished in any way if they decided to not participate. Students were also asked to read and sign an Assent form prior to participation. A copy of the Informed Consent that was sent home to the parents and the Assent form that was given to the students are included in Appendix D and Appendix E, respectively.

MSES-R

The administration of the MSES-R pretest took place at the beginning of the research period on January 23th, 2013. Students who had returned the Informed Consent form were addressed in person by the researcher to explain the purpose of the MSES-R and were given the opportunity to participate in the pretest survey. The researcher read the Assent form to the students and asked if there were any questions. Students who elected to participate signed the Assent form and completed the pretest MSES-R survey in approximately 15 minutes. After all students had completed the survey, one student collected the surveys in an envelope and delivered the envelope to the researcher. Upon inspection, all students in each group completed the survey. Data from the pretest survey were entered into IBM® SPSS Statistical software and saved on a password-protected computer to which only the researcher has the password. The posttest was administered near the end of the research period on May 2, 2013. Posttest MSES-R survey data were added to the pretest data and analyzed.

All paper copies of the pretest and posttest surveys were stored in a locked filing cabinet to which the researcher had the only key. The paper surveys will be kept for a period of three years at which time they will be destroyed.

ILS Determination of Learning Styles

The researcher had two purposes for collecting students' learning style profiles. First, to ensure a random and representative selection of all learning style dimensions among the interview candidates, and secondly to answer the research question about whether learning style has an affect on student preference for learning environment.

Students from all three learning environments completed the Index of Learning Styles Questionnaire (ILS) on January 28th, 2013. Because the ILS is delivered online, administration of the survey was conducted in one of the high school computer labs. The ILS reported student responses to the forced-choice questions along a continuum within each of the following dimensions: Active-Reflective, Sensing-Intuitive, Visual-Verbal, and Sequential-Global. The Felder and Solomon (n.d) criteria for classification of learning style preference divides each student's score for each learning style dimension into three possible categories: a) strong preference (9-11), b) moderate preference (5-7), and c) balanced (1-3). This scoring information was conveniently printed on each student profile, making the analysis of each students learning style profile simple and consistent.

The researcher adhered to the following protocol. Prior to taking the survey, students were assigned a code number to enter into the appropriate field on the online ILS. Before beginning the survey, the researcher checked each computer to ensure that the student had entered the appropriate code correctly. A record of the student code numbers was stored in a spreadsheet electronic file by the researcher to ensure anonymity and later used to identify students of particular learning styles for inclusion in individual and focus group interviews. These records were kept confidential and secured on a password-protected computer. Only the researcher had access to the codes and ILS reports. After completing the online survey, students printed the report that included their code number and placed their report into an envelope. A sample report is included in Appendix B.

Individual Structured Interview

As previously stated, the researcher utilized random, purposeful sampling of interview candidates. Creswell (2009) has recommended selecting participants that can provide information about the phenomenon being studied. Since the phenomenon under study involved learning style preferences, it made sense to include a representative sampling of all learning dimensions in the individual and focus group interviews. Consequently, the researcher selected candidates from each learning style dimension until a sufficient list was compiled. All students selected were given an Assent form and asked to participate in either an individual or focus group interview.

Individual student interviews were conducted by the researcher in the assistant principal's office in compliance with IRB privacy and confidentiality protocols and lasted approximately 15 minutes. As a condition for participation in the interview process, only students who had returned the Informed Consent form from their parents indicating that permission was given for their minor child to be audiotaped were selected. Prior to the interview, students were asked to read and sign an Assent form with specific reference to the interview process with an additional box to check if they agreed to be audiotaped. The purpose of the interview and participant's rights according to the Institutional Review Board (IRB) guidelines were also explained to the interviewee at this time. Transcripts created from the audio recordings were returned to the participants to verify accuracy of content. Students signed the printed transcript as acknowledgement of accuracy. All transcripts were kept confidential and stored in a locked cabinet in the researcher's office and on a password-protected computer.

According to Yin (2009), the purpose of the interviewer's questions is to keep the interviewer on track and asking consistent questions across all interviewees (p. 86). Stake (2006) added that deeper research questions can be used to guide data collection from direct observation, student documents, and individual structured interviews. It was important to the researcher to ask questions which informed about the lived experiences of the students and teachers in each of the different learning environments but also to aid in determining whether learning style played a role in preference for learning environment. The interview questions were used to guide the interview of each participant across learning environments. A copy of the questions can be found in Appendix F.

Focus Group Structured Interview

Eight students were randomly and then purposefully selected to participate in a focus group structured interview for their particular class. Random selection was used to prevent bias and purposeful selection from the random selection ensured a complete spectrum of learning style interviewees. One focus group interview was conducted in each of the classes. The interviews took place during the last 60 minutes of class on the days that the researcher conducted classroom observations. According to Patton (2002), a focus group interview is an interview with a small group of people (6-10) on a specific topic. The purpose is to "get a variety of perspectives and increase confidence in whatever patterns emerge" (Patton, 2002, p. 385). Patton describes the advantage of a focus group over just individual interviews alone:

> The twist is that, unlike a series of one-on-one interviews, in a focus group participants get to hear each other's responses and to make additional comments beyond their own original responses as they hear what other people have to say. (p. 386)

Patton (2002) also states that the focus group interview allows the researcher to quickly assess whether there is a consistent, shared viewpoint or great diversity of views (p. 386).

The researcher made every effort to include representatives from each of the learning style dimensions but attempted to exclude any student that had been previously selected for an individual interview. The same questions and follow-up questions were used in the focus group structured interview as in the individual structured interviews. Focus-group interviews were also audio-recorded, transcribed, and returned to the students for verification of accuracy.

Teacher Structured Interviews

The researcher conducted two interviews with each classroom teacher. One interview took place at the beginning of the research period and the second took place near the end. The structured interview questions were designed to assess the teacher's perceptions about the effectiveness of their instructional method and their perception of how well the instructional method met the needs of the students in that particular class. All teacher interviews took place in the teacher's classroom during their assigned planning period. All interviews were audio-recorded, transcribed, and returned to the teachers for verification of accuracy. Interviews were 30-45 minutes in duration. A list of teacher interview questions can be found in Appendix G.

Direct Observation of Learning Environment

In addition to individual and focus group interviews, the researcher collected data from the direct observation of students and teachers from each of the three learning environments.

Case studies in these situations rely on direct observation and interviews of the persons involved in the events (Yin, 2009, p. 11). These three sources of data formed the "…basis for the triangulation of data for the purpose of corroborating the same fact or phenomenon"(Yin, 2009, p. 116). Yin (2009) stated, "Using multiple sources of evidence can help deal with the problems of establishing the construct validity and reliability of the case study evidence" (p. 114).

The researcher arranged with the principal and cooperating classroom teachers to be a non-participating observer in each of the learning environments. The researcher arrived at the classroom immediately before class began to avoid disrupting instruction and to avoid undue attention being drawn toward the researcher. The researcher took notes of the classroom setting, participants' location within the classroom, method of instruction, and the participants' apparent level of engagement. All observations became part of the researcher's case study database and aided in maintaining a chain of evidence (Yin, 2009, p. 122). A Direct Observational Form has been included in APPENDIX H.

ACT QualityCore® End-of-Course Assessment

The administration of this assessment at the study location provides an excellent opportunity for the researcher to obtain highly valid and reliable data for the comparison of learning environments represented by flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional instruction with lecture-homework learning strategies, with respect to predicting college readiness based on achievement in Algebra I (see section, "Research Question One and Instrument, p. 58). School officials originally intended for all Algebra I students to take the ACT-administered QualityCore® EOC assessment as both a pretest and a posttest. Several factors, including indecision at the State Department of Education concerning the percentage to which this assessment would count toward the student's final grade, as well as the expense of administering the ACT-administered QualityCore® EOC assessment, led school officials to the decision to self-administer the sample QualityCore® EOC to all Algebra I students in September 2012. This sample test was obtained from the ACT, Inc. Web site by school officials and included the same level of Algebra I problems that are on the ACT-administered assessment. All Algebra I students took the ACT-administered, online QualityCore® EOC assessment as a posttest in May 2013. School officials made both pretest and posttest data available to the researcher who entered the scores in a spreadsheet and stored the file on a password protected computer.

Data Analysis

Quantitative Analysis of Self-Efficacy

Data from the MSES-R student survey pretest and posttest was entered into IBM® SPSS Statistical software and analyzed. Means and standard deviations were calculated for Classes A, B and C. A one-way between groups multivariate analysis of covariance (MANCOVA) was used to determine the main effects and interaction effects of three different learning environments on MSES-R posttest scores while controlling for covariates. MSES-R pretest and QualityCore® EOC pretest scores served as covariates. In MANCOVA, the linear combination of dependent variables is adjusted for differences in the covariates (Tabachnick & Fidell, 2001, p. 340). MANCOVA is useful as a noise-reducing device where variance associated with the covariates is removed from error variance. Smaller error variance provides a more powerful test of mean differences among groups (Tabachnick & Fidell, 2001, p. 324). Significance between the groups would indicate that the type of learning environment had an effect on student mathematics self-efficacy. Partial Eta Squared values would indicate the size of the difference.

Quantitative Analysis of QualityCore® EOC

Data from the QualityCore® EOC pretest and posttest were entered into IBM® SPSS Statistical software and analyzed. Means and standard deviations were calculated for Classes A, B and C. A one-way between groups multivariate analysis of covariance (MANCOVA) was used to determine the main effects and interaction effects of three different learning environments on QualityCore® posttest scores after controlling for QualityCore® EOC pretest scores and Mathematics Self-efficacy pretest scores. QualityCore® EOC pretest scores and Mathematics Self-efficacy pretest scores served as covariates. Significance between the groups would indicate that the type of learning environment had an effect on student mathematics achievement. Partial Eta Squared would indicate the size of the difference.

Qualitative Multiple Case Study Analysis

The data collected from the individual and focus group structured interviews were transcribed from the digital recordings. Interview data from each participant were analyzed separately and as immediately after the interview as possible. After all interviews had been conducted, the researcher read through all transcripts to get an overall sense of all the interviews. Next, the researcher utilized Creswell's (2008) strategy for identifying topics within each of the transcripts and assigned "lean" codes to each topic (p. 252). Lean coding is the process of only assigning a few codes to a transcript during the first read through (Creswell, 2008). The coded data were then reduced to categories and then to themes. According to Creswell (2008), themes are similar codes aggregated together to form a major idea (p. 256).

To remain focused, the researcher repeatedly referred back to the research questions. After conducting within-case analysis for each of the three learning environments, the researcher used cross-case analysis to look for more general trends. Cross-case analysis provides the data necessary for theory building (Merriam, 1998).

Researcher Positionality

"Interpretation in qualitative research means that the researcher steps back and forms some larger meaning about the phenomenon based on personal views, comparisons with past studies, or both" (Creswell, 2008, p. 265). Since it is impossible to separate the interpretation from the interpreter, it is important to state any preconceptions or bias that the researcher might possess.

I have been an educator for 21 years. In my career, I have taught the same subject to the same age students as is represented in this case study. My educational philosophy is that the most important factor in any classroom is the classroom teacher and the methods and strategies that teacher brings to bear in his/her classroom. As an experienced educator, I also have an opinion of what constitutes an effective teacher and consequently, a well-managed and orderly classroom. These opinions create certain predispositions toward what I consider an effective learning environment.

For the past 13 years of my career, I have been employed by the Alabama State Department of Education in the Office of Technology Initiatives. My job responsibilities as technology integration specialist place me in the role of trainer and mentor to classroom teachers in over 100 schools. Consequently, I have a vested interest in promoting the effective use of instructional technology and believe there is great potential for its use in promoting learning both in and out of the classroom.

My role as researcher at the high school where the study took place was both advantageous and problematic. Because the students, teachers, and administration were accustomed to seeing me walking their hallways as I came into the school to conduct professional development training, my presence as an observer and interviewer did not cause undue distraction. Consequently, I feel that the teachers and students were more open with me about their opinions concerning their learning environments. However, as a technology integration specialist working with the school system to assist teachers in the effective use of technology, I found myself favoring the learning environment where I felt technology was being utilized most effectively.

I had to constantly remind myself that my role of researcher was independent of my role as an instructional technology specialist. By addressing my opinions about teaching, learning and technology early in the study, it is my hope that I have avoided any bias in my collection, analysis, or interpretation of the data.

CHAPTER IV:

QUANTITATIVE ANALYSIS OF STUDENT ACHIEVEMENT AND SELF-EFFICACY DATA

Introduction

The purpose of this mix methods study was to examine the effect of learning environment on student mathematics achievement and mathematics self-efficacy, and to investigate the lived experiences of students and teachers in three learning environments:

a) Flipped instruction with active learning strategies;

b) Flipped instruction with mastery learning strategies; and

c) Traditional Instruction with lecture/homework learning strategies.

The researcher also sought to determine whether learning style played a role in the students' preference for the type of learning environment.

Participants were 66, ninth-grade Algebra I students and two Algebra I teachers from a 5-A classification high school located in the southeastern United States. To gain the most complete picture of what was happening in the learning environments, the researcher utilized a mixed methods approach in which quantitative statistical data was complemented with qualitative interview and observational data to paint the most accurate picture of the instructional phenomenon.

For the purpose of clarity, the findings of this study have been divided into four chapters and presented by research question. Chapter IV presents the quantitative analysis of student achievement data and self-efficacy data, research questions one and two, respectively. Chapter V presents the with-case analysis of the lived experiences of teachers and students in the three learning environments. Chapter VI presents the within-case analysis of learning style preference for learning environment, and chapter seven presents the cross-case analysis for the lived experiences of teachers and students and learning style preferences for learning environment, research questions three and four, respectively.

Research Question One and Null Hypothesis One

RQ1: How do students in classrooms utilizing Flipped instruction with active learning strategies, Flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies, compare academically on mathematics achievement?

Ho1: There is no statistically significant difference in the mean mathematics achievement scores of students participating in classes utilizing varying instructional strategies.

Research Design and Analysis – RQ1

The research design included a pretest and posttest of the QualityCore® EOC assessment, which is the state adopted end-of-course assessment for ninth grade Algebra I students in Alabama. The 72 question QualityCore® EOC sample assessment pretest was obtained by school officials from the Act Inc. website and administrated to all Algebra I students in the fall of 2012. School officials used ScanTron® sheets to score the QualityCore® EOC sample assessment pretest and the researcher obtained individual student scores from the school by permission. The QualityCore® EOC assessment posttest was administered online in April of 2013 to all Algebra I students in compliance with State testing requirements. ACT Inc. scored the QualityCore® EOC assessment posttest and reported individual student scores to the school system testing coordinator. The researcher obtained QualityCore® EOC assessment posttest scores from the school system testing coordinator by permission.

A one-way between groups multivariate analysis of covariance (MANCOVA) was utilized to determine the main effects and interaction effects of three different learning environments (flipped active, flipped mastery, traditional) on ACT QualityCore® EOC posttest scores after controlling for the covariates, QualityCore® EOC pretest scores and Mathematics self-efficacy pretest scores.

Assumptions Testing

MANCOVA assumes linear relationships among all pairs of dependent variables and all pairs of covariates. Deviations from linearity reduce the power of the statistical tests (Tabachnick & Fidell, 2001, p. 330). There was a linear relationship between pretest and posttest scores in each group, as assessed by scatterplot. There was homogeneity of variance-covariances matrices, as assessed by Box's test of equality of covariance matrices ($p = .459$). QualityCore® EOC posttest scores were normally distributed for the flipped mastery and traditional groups ($p > .05$), but not for the flipped active group ($p = .018$). Because the Shapiro-Wilk’s score for the flipped active group on the QualityCore® EOC posttest indicates that the scores were not normally distributed, a value for the posttest z-values for skewness and kurtosis was calculated. Table two displays the calculated z-scores for skewness and kurtosis. All calculated z-scores for the three groups were within the range of scores for normal distribution.

Table 2

Z-values for Skewness and Kurtosis of QualityCore®EOC Posttest Data

Group	Skewness	Std. Error	Z score	Kurtosis	Std. Error	Z score
Flipped Active	-1.19	.524	-2.27	1.097	1.014	1.08
Flipped Mastery	0.254	.472	.538	-.359	.918	-.391
Traditional	-2.05	.501	-.409	-.046	.972	-.047

Note. For $p > .01$, the z-scores of all groups are normally distributed, falling within the range of $^{+}2.58$ to $^{-}2.58$.

After calculation of the z-values for skewness and kurtosis, QualityCore® EOC scores were determined to be normally distributed for the flipped active group with a skewness of -1.19 (SE = 0.524) and kurtosis of 1.097 (SE =1.014), for flipped mastery with a skewness of 0.254 (SE = .472) and kurtosis of -.359(SE = .918) and for traditional with a skewness of -2.05 (SE = 0.501) and kurtosis of -.046 (SE = 0.972). Z-values falling within the range of -2.58 to +2.58 were considered to be normally distributed. A possible explanation for the significant Shapiro-Wilk's value on the flipped active posttest is the presence of an outlier and an extreme outlier as assessed by boxplot, as displayed in Figure 5.

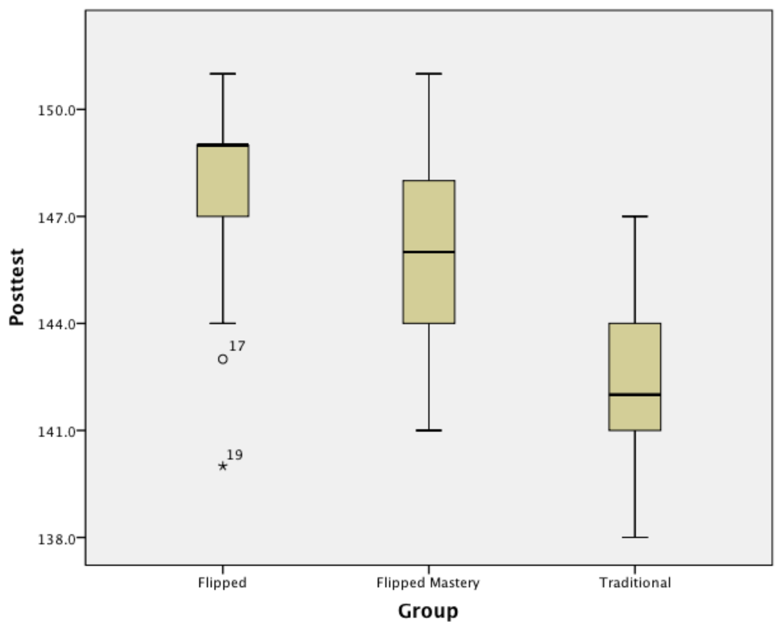


Figure 5. Boxplot showing outliers for achievement data.

According to Pallant (2007), the potential impact of univariate outliers can be assessed by comparing the mean score to the 5% trimmed mean score. A trimmed mean score is calculated by IBM® SPSS statistical software by removing the top and bottom 5% of cases and reporting a new mean for that variable. To determine whether these outliers had a significant effect on the analysis of the data, a comparison of mean scores to 5% trimmed mean scores was conducted. A comparison of the flipped active group (M = 147.526) mean score and the 5% trimmed mean score (147.751) indicated only a 0.23 point difference between the means. Pallant (2007) recommends further investigation of the extreme scores only if the mean score and 5% trimmed mean score are very different. A difference of only 0.23 between the means would indicate that the influence of the outliers is minimal.

Tabachnick and Fidell (2001) state that with small, unequal samples, normality of the dependent variables is assessed by reliance on judgment (p. 329). Because the difference in mean scores is so small and the fact that these data are actual student scores and not errors in data inputting, the decision was made that these outliers should not be removed from the data set and further data analysis would continue with the assumption of normal distribution of data. There were no multivariate outliers in the data, as assessed by Mahalanobis distance ($p > .001$). Homogeneity of Variance is verified by Levene's Test ($p > .01$).

Results of Statistical Analysis of Achievement Data – RQ1

Students in the flipped active group scored higher on the QualityCore® EOC assessment posttest (M = 147.53, SD = 2.9) than students in the flipped mastery (M = 146.17, SD = 2.6) and students in the traditional group (M = 142.33, SD = 2.3). The means and standard deviations for the three groups, along with the total number of students who took the QualityCore® EOC pretest and QualityCore® EOC assessment posttest, can be found in Table 3.

Table 3

Means and Standard Deviations for QualityCore® EOC Posttest

Group	N	M	SD
Flipped Active	19	147.5	2.9
Flipped Mastery	22	146.0	2.5
Traditional	21	142.3	2.3
Total	62		

Note. N = 62 represents the total number of students with both pretest and posttest data.

Wilks' lambda was used to test significance of the main effects and interactions. According to Tabachnick and Fidell (2001), Wilks' lambda is the criterion of choice for this test (p. 348.). There was a statistically significant difference between the groups on the combined dependent variables, $F\ (4, 112) = 11.025$, $p < .0005$; Wilks' $\Lambda = .566$; partial $\eta2 = .247$. There was a statistically significant difference in QualityCore® EOC assessment posttest scores between the students from different learning environments, $F\ (2, 57) = 116.956$, $p < .05$; partial $\eta^2 = .383$. Partial Eta Squared represents the proportion of the variance in the dependent variable that can be explained by the independent variable (Pallant, 2007, p. 287). The value in this case is .383, indicating that 38.3% of the variation is due to the independent variable, learning environment. According to Cohen (1988), an effect size of .10 would be considered small, an effect size of .25 would be considered medium, and an effect size of .40 would be considered large. According to these criteria, an effect size of .383 can be considered large.

Pairwise comparisons showed that there was a statistically significant difference between the Traditional group and the flipped active group on the QualityCore® EOC assessment posttest ($p < .05$). There was also a statistically significant difference between the traditional group and the flipped mastery group ($p < .05$). There was no statistically significant difference between the flipped active group and the flipped mastery group ($p > .05$). The null hypothesis is rejected with significant differences existing between the Traditional group and both the flipped active and flipped mastery groups. Achievement scores on the QualityCore® EOC assessment posttest were significantly less in the traditional group when controlling for prior ability.

Research Question Two and Research Hypothesis Two

RQ2: How do students in classrooms utilizing flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional Instruction with lecture-homework learning strategies, compare on mathematics self-efficacy?

Ho2: There is no statistically significant difference in the mean mathematics self-efficacy scores of students participating in classes utilizing varying instructional strategies.

Research Design and Analysis – RQ2

The research design included a pretest and posttest of the Mathematics Self-Efficacy Scale-Revised (MSES-R). For the purposes of this study, only the mathematics problems subset of the MSES-R was administered. Pajares and Kranzler (1997) reported a Cronbach's alpha of .92 using a version of the mathematics problems subscale of the MSES-R with high school students. The survey items in the mathematics problems subset of the MSES-R were examined by the researcher, as well as the teachers in the flipped and traditional classrooms, and determined to be applicable to high school Algebra I students. The MSES-R mathematics subset pretest was administered to the study participants at the beginning of the research phase on February 5th, 2013, following all approved guidelines and procedures stipulated by the Institute Review Board (IRB). The MSES-R mathematics subset posttest was administered on May 2nd, 2013. Raw scores were recorded in a spreadsheet on the researcher's computer and copies of the completed surveys were locked securely in a file cabinet in the researcher's office.

Assumptions Testing

A one-way between groups multivariate analysis of covariance (MANCOVA) was utilized to determine the main effects and interaction effects of three different learning environments (flipped active, flipped mastery, traditional) on MSES-R posttest scores after controlling for MSES-R pretest scores. There was a linear relationship between pretest and posttest scores in each group, as assessed by scatterplot. There was homogeneity of variance-covariance matrices, as assessed by Box's test of equality of covariance matrices (p= .459). MSES-R posttest scores were normally distributed for all groups as assessed by Shapiro-Wilk's test for normality ($p > .05$).

There was the presence of one univariate outlier in the flipped active group at data point four, as illustrated in Figure 6.

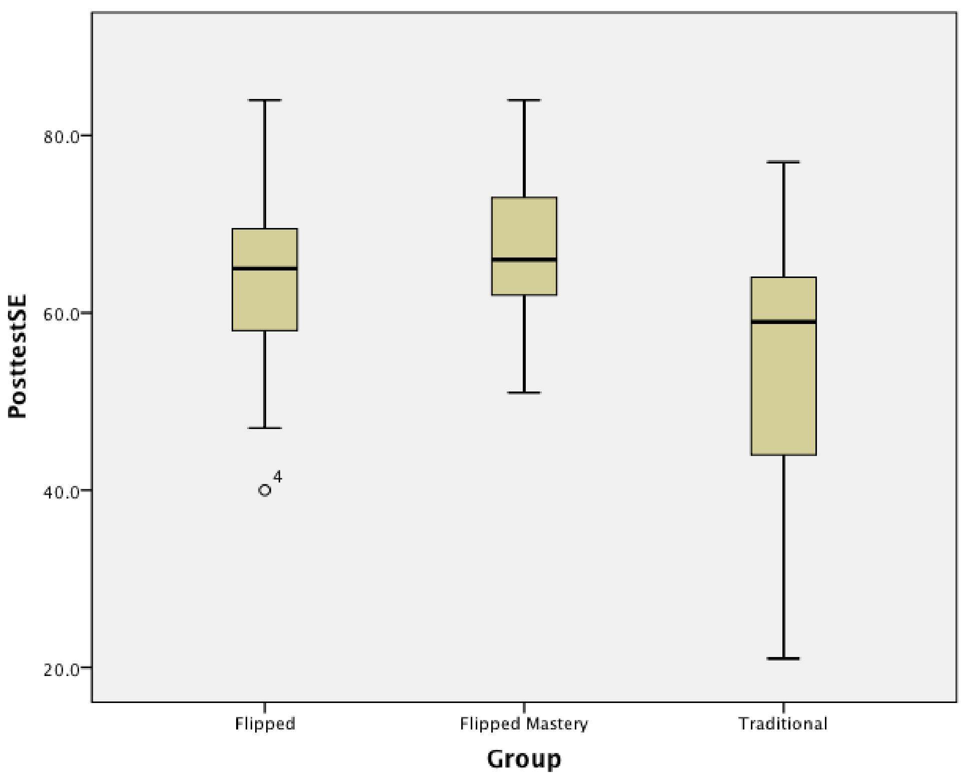


Figure 6. Boxplot showing outliers for self-efficacy data.

The outlier was not extreme and was not considered significant because the Shapiro-Wilk's test for the flipped active group indicated a normal distribution ($p > .05$). There were no multivariate outliers in the data, as assessed by Mahalanobis distance ($p > .001$). Homogeneity of Variance is verified by Levene's Test ($p > .01$).

Results of Statistical Analysis of Self-efficacy Data – RQ2

Students in the flipped mastery group scored higher on the MSES-R posttest (M = 66.8, SD = 8.8) than students in the flipped active group (M = 64.1, SD = 11.2) and students in the traditional group (M = 55.05, SD = 12.4). The total number of students who took both the MSES-R pretest and posttest, along with the means and standard deviations for the groups, can be found in Table 4.

Table 4

Means and Standard Deviations for MSES-R Posttest

Group	N	M	SD
Flipped Mastery	19	66.8	8.8
Flipped Active	22	64.1	11.2
Traditional	21	55.1	12.4
Total	62		

Note. N = 62 represents the total number of students with both pretest and posttest data.

There was a statistically significant difference between the groups on the combined dependent variables, $F(4, 112) = 11.025$, $p < .0005$; Wilks' $\Lambda = .566$; partial $\eta^2 = .247$. There was a statistically significant difference in MSES-R posttest scores between the students from different learning environments, $F(2, 57) = 563.142$, $p<.05$; partial $\eta2 = .128$. Partial Eta Squared represents the proportion of the variance in the dependent variable that can be explained by the independent variable (Pallant, 2007, p. 287). The value in this case is .128, indicating that 12.8% of the variation is due to the independent variable, learning environment. According to Cohen

(1988), an effect size of .10 would be considered small, an effect size of .25 would be considered medium, and an effect size of .40 would be considered large. According to these criteria, an effect size of .128 can be considered small.

Pairwise comparisons showed that there was a statistically significant difference between the Traditional group and the flipped mastery group on the MSES-R posttest ($p < .05$). There was no statistically significant difference between the traditional group and the flipped active group ($p > .05$). There was no statistically significant difference between the flipped active group and the flipped Mastery group ($p >.05$).

The null hypothesis is rejected with significant differences existing between the traditional group and the flipped mastery group. MSES-R scores were significantly less in the traditional group when controlling for prior ability.

Summary of Findings from Quantitative Analysis of Student Achievement and Self-efficacy

Chapter IV presented the findings of the quantitative portion of the mixed methods study and addressed research questions one and two. Research question one sought to determine how the three learning environments represented by Class A (flipped active), Class B (flipped mastery) and Class C (traditional lecture/homework) compare academically on mathematics achievement. According to the results of the MANCOVA, students in Class A (flipped active) and students in Class B (flipped mastery) scored significantly higher on the QualityCore® EOC assessment than students in Class C (traditional lecture/homework) with an effect size of .383. There was no statistically significant difference between Class A (flipped active) and Class B (flipped mastery). Because the groups varied significantly on mathematics achievement, the null hypothesis was rejected.

Research question two sought to determine how the three learning environments represented by Class A (flipped active), Class B (flipped mastery) and Class C (traditional lecture/homework) compare on mathematics self-efficacy. According to the results of the MANCOVA, students in Class B (flipped mastery) scored significantly higher on the MSES-R than students in Class C (traditional lecture/homework) with an effect size of .128. There was no statistically significant difference between Class A (flipped active) and Class C (traditional lecture/homework. There was no statistically significant difference between Class A (flipped active) and Class B (flipped mastery). Because the groups varied significantly on mathematics self-efficacy, the null hypothesis was rejected.

Chapters V, VI, and VII will present the findings of the qualitative portion of the mixed methods study and seek to answer research questions three and four. Chapter V presents a within-case analysis of the lived experiences of teachers and students in the three learning environments represented by Class A (flipped active), Class B (flipped mastery), and Class C (traditional lecture/homework). Chapter VI presents a within-case analysis of student learning style preferences for a particular learning environment. Chapter VII presents a cross-case analysis of the lived experiences of teachers and students as well as the learning style preferences of students for a particular learning environment.

CHAPTER V:

WITHIN-CASE ANALYSIS OF LIVED EXPERIENCES OF TEACHERS AND STUDENTS

Introduction

Within-case analysis of the three learning environments included an examination of data from individual structured interviews, focus group structured interviews, and direct classroom observation. Each within-case analysis sought to understand the lived experiences of the teachers and students in each case. The cross-case analysis presented in chapter seven will examine similarities and differences between the cases.

Research Question Three

How do the lived experiences of students and teachers in the flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional Instruction with lecture-homework learning strategies compare?

Within-case Analysis for Class A

Within-case analysis of Class A provided detailed information about the lived experiences of teachers and students in the flipped active classroom. The goal of the within-case report was to provide a comprehensive description of the flipped active classroom, enabling the reader to feel as though they have been an active participant, thereby determining whether the findings can be generalized to their own unique situation (Baxter & Jack, 2008).

Introduction and Participants

Ms. Smith taught in the learning environment denoted as Class A (flipped active). She was selected for the study because of her experience using flipped instruction in her Algebra I mathematics classroom. Instead of listening to a lecture and taking notes during class, students in Ms. Smith's class learned how to work algebra problems by watching teacher-created videos at home. In class, they practiced working similar problems with the assistance of an online tutorial, their classmates, and teacher.

Class A (flipped active) was a technology-rich classroom where students made use of school-issued iPads to access instructional videos, online textbooks and online tutorials. Students had access to the iPads both at school and at home. All students had access to online resources at school through the school's Wi-Fi network. Some, but not all, students had Wi-Fi access at home. Students without home Wi-Fi access had to download their videos to their iPads while at school, or watch their video lessons at school.

The active learning strategies Ms. Smith utilized in her flipped active classroom included peer-to-peer discussion and small group sharing of problem-solving strategies. The flipped active approach required students to watch a teacher-created video of the assigned lesson prior to attending class. Students accessed the video from the teacher's online website (blog) and took notes as they watched the video. During class, the students participated in a "start up" or review of previously learned material. After the start up, they spent the rest of the period working problems. Depending on the day of the week, students worked problems individually, in pairs, or in small groups. Students in Class A (flipped active) were required to work in collaborative groups on Tuesday and Thursday of each week and had the option of working together at other times, including outside of class.

Viewing of teacher-created lessons was assigned for two or three nights each week. On the following day after each assigned lecture video, Ms. Smith checked each student's written notes taken while watching the video lesson, and assigned a completion grade. Ms. Smith explained why she “flipped” her algebra classes. She said,

> Originally, I guess I was trying to find something new because I felt like I wasn’t meeting the needs of the kids. A fellow teacher and I watched a video on TED Talks about the flipped classroom so we decided to attempt to flip one of our classes. This is how I became a believer. I picked the unit and made it all flipped, meaning show the videos where they have to do the lecture notes at home, outside of class, where they have a better understanding of it when we come in to talk about it. We did discuss it and we got to work more problems in the classroom. At the completion of that unit, I didn’t have a single F on a test. Blew my mind!

Ms. Smith explained how she incorporated active learning in the face-to-face portion of her class. To establish a weekly routine, she explained how she set up the particular active learning strategy to align with the day of the week:

> Monday is a “ME” day. I give them the warm-up, or start up. I give them a chance to look at it because it is over all past material and because I’m trying to remediate topics that we have already gone over. But I go over that, so that is “Me”. I go over every single one and give notes like they have never seen it before. Tuesday is the second day of the week so they work in pairs. Wednesday is a work-it-out day, kind of like a pretest day to see where you stand for Friday. Thursday is the fourth day of the week so they are in teams. That is, teams of three or four. Friday is the finale day and that is the day that I grade the work. Throughout the week they are grading it to see where they stand but it doesn’t count as a grade.

Ms. Smith described her flipped active students’ progress in terms of grades and content coverage compared to classes from previous years when she was using a more traditional model of instruction. She said,

> I would say that they are ahead of where a traditional class would be. I’ve taught traditionally and remember what it is like to not have that feedback. It has helped their understanding. The State [State Dept. of Education] has put more into the course of study. They have jammed it with more we have to discuss and talk about so I would say that they are ahead.

In addition to the teacher interview, the researcher conducted nine individual interviews and one focus group interview in Class A (flipped active). The purpose of the focus group interview was to eliminate extreme points of view and gain an overall perception of the participants in the learning environment. The purpose of the individual interviews was to gain detailed information about the perception of different students based upon their lived experiences and their learning style preferences. The original plan was to interview ten students but one of the interviewees decided after his interview was recorded and transcribed that he no longer wished to participate in the interview process. Since he signed the Assent form to participate in the surveys, only his interview data were removed from the analysis. Table 5 provides a summary of all participants for Class A including their learning style profile and the type of interview in which they participated.

Table 5

Class A Interview Participant Information

Participant (Pseudonym)	Age	Gender	Ethnicity	Learning Style Profile				Interview Type
				A/R	Sn/I	Vs/Vb	Sq/G	
Martha	15	F	C	SR	B	MV	B	I
Leon	15	M	C	MA	B	SVs	MSq	I
Gail	14	F	A	MA	MI	B	SSq	I
Nancy	14	F	C	B	MSn	SVs	BSq	I
Charlotte	15	F	C	B	SI	B	MG	I
Andy	15	M	C	MR	B	B	B	I
Paul	14	M	C	MA	MSn	MVs	MSq	I
Janet	15	F	C	B	MSn	MVs	B	I
Quintin	14	M	H	B	SSn	MVs	B	I
Frances	14	F	A	B	MSn	B	B	G
Edward	15	M	C	SA	B	MVs	B	G
Kelly	15	F	C	B	MSn	MVs	MSq	G
Ingrid	14	F	C	MA	MSn	B	B	G
Betty	14	F	C	MA	MSn	B	B	G
Otis	15	M	C	MA	B	MVs	MSq	G
Ruth	15	F	C	B	MSn	B	MSq	G

Note. Ethnicity; A = African American, C = Caucasian, H = Hispanic. For each learning style dimension, students are categorized as moderate (M), strong (S), or balanced (B). The first letter in the code represents the category, followed by the learning style dimension.

Interview

Even in the south, February is bitterly cold. I remember dreading the thought of spending the entire day interviewing students in the conference room adjacent to the assistant-principal's office. Such places are always cold and usually dusty. But I had prepared for this day and was eager to begin talking with students about their experiences in the flipped active classroom. I have to admit, I had my expectations, as well as reservations, about interviewing teenagers. It had been almost 13 years since I had taught ninth grade students and I remembered how difficult it sometimes was getting them to open up and talk about how they felt. Still, as I walked the long hallway to Ms. Smith's classroom, rehearsing in my head what I was going to say to them, I felt a tiny bit of nervous excitement.

It was nine-thirty on a Wednesday morning and students were scurrying into the classroom, many still looking as though they had just crawled out of bed. Ms. Smith, an energetic teacher with eight years of classroom experience, greeted me at the door and offered me a seat at the back of the room while she took attendance and attempted to bring the class to order. In contrast to their sleepy appearance, the students were noisy and boisterous. I must confess, my teacher instincts told me that even for a student-centered classroom, the students in this particular classroom were a bit too unruly. Most of the students were sitting at their desks, talking quietly to classmates sitting near them. However, several students were out of their desks, walking about the classroom, talking with other students and even calling to classmates across the room. I made an observational note of the level of noise and made allowance for the fact that different teachers have different tolerance levels for student behavior in the classroom. I also made a mental note to ask students how much the noise in the learning environment affected their ability to concentrate.

I had several students to interview on this day so I was eager to get started. After a short time, Ms. Smith re-introduced me to the class and gave me the floor to explain that today was interview day and certain students had been selected to participate. I say, reintroduced, because I had previously spoken to the class to explain the study and to administer the MSES-R and the ILS surveys. Selected randomly from the class, and purposefully by learning style strength, a hesitant girl named Charlotte was to be my first interviewee of the study. As we made our way down the long hallway I tried to make small talk but Charlotte only responded with polite "yes, sir" or "no, sir." I remember thinking, "This is going to be a very long day," but much to my relief, the interviewees from Class A were open to my questions and eager for their opinions to be heard. The following themes evolved from the interview data and are presented by research question.

Themes Presented by Research Question Three

Research question three deals with the lived experiences of students and teachers in the three different cases. The researcher wanted to investigate student perceptions about whether this "flipped" way of delivering content was effective in helping students understand algebra concepts and problem solving. Themes derived from the data included: content delivery, learning environment, types of questions, and student satisfaction with the flipped active learning environment. The content delivery theme focused primarily on what students' liked and disliked concerning the exclusive use of video and online tutorials to learn algebra content. The learning environment theme focused on students' perceptions of individual versus collaborative work in the face-to-face learning environment and how students felt about working in a less structured and often chaotic learning environment. The types of questions theme focused on students' perceptions of word problems with a real-world connection. The satisfaction theme focused on how students felt about the flipped active format and what they would change about the course if given the opportunity.

Advantage of video over lecture. Ms. Smith delivered the majority of instruction to the students via teacher-created video in order to afford more face-to-face class time for collaborative problem solving and practice. Students were assigned two or three videos each week to view at home. They were required to take notes to demonstrate that they had actually watched the videos. Ms. Smith began each class with a review of previously covered material before allowing students to work their practice problems in collaborative groups. She utilized a procedure where students worked independently on certain days of the week and collaboratively on other days. Students agreed that watching the videos was pretty much the same as listening to a lecture. The primary difference is that you watch a video of the teacher's pen strokes and verbal narration rather than having the full experience of a live teacher in the front of the classroom. Students stated that the videos were easier to understand than the textbook. Quintin said he learned better from the videos. He said,

> Instead of using books, we use videos. And we learn from it. It teaches us better than the book does. It can show you how to work a problem easier and better with shortcuts and formulas that can help you. I like that they explain the problem more easier.

Many students focused on how the technology gave them more control and accessibility to the math content allowing them to use the technology to manage their out-of-class work. Janet liked the convenience of having the videos posted online:

> We watch videos instead of doing bookwork and we use technology more than books. I can watch the videos anywhere I'm at. I usually watch them in flex at school or at home if I don't have enough time at school. I don't have to have my book with me. I can just pull out my phone and watch them.

A major advantage of the videos over traditional lecture was the ability to rewind, review, or makeup lessons. Nancy said, “You can go back and watch it again if you don’t get some parts.” Frances agreed,

> It’s better! Like in eighth grade when you are in class and like they go over it fast and you can’t go back and listen to what they said. But on the videos you can always go back and watch the videos. That is what she tells us to do. She tells us to go back and watch the videos cause it helps.

Betty described a time when having the videos helped her stay caught up even while she was confined at home with an illness. She said,

> I had the flu a couple weeks back and we went over some new material and I didn’t get a chance to get it and when I went to the blog and there were a few things of what we were going over and I just looked at it and it helped a little bit.

Students in Class A found other unique ways of using the videos. Andy liked being able to fast-forward through the videos to, as he put it, “Get right to the point”. He explained,

> In flipped you get more of the problems and that is more helpful than her just giving you notes, definitions, and this and that and explaining every little thing to the whole class. On the video, she is straight to the point, cause they are short.

Another student surprised me with her reason why she liked watching the videos over learning from the teacher in class. Janet said, “You can listen to it by yourself so there is not other people talking when she [teacher] is trying to work it at the board.”

Disadvantage of inability to ask questions. However, not all of the student comments about the videos were positive. One particular issue, reiterated time after time, dealt with students’ inability to ask questions while viewing the videos at home. Most agreed that taking notes while watching the video was comparable to taking notes in class, however they didn’t feel that they could get their questions answered immediately or satisfactorily. Janet was one of the students who liked the video format but this aspect of not having a live teacher troubled her. She said, “People don’t get to ask questions as much because we just watch videos and we have less people teaching us how to do it." When asked if she learned algebra concepts from the videos as well as from a teacher in class, she said,

> I would say not as well. Because when the teacher is teaching in a traditional classroom, you would be able to ask questions as soon as they come to your mind. It seems like when you are watching the video, you have to wait until the next day and you might have forgotten. You just don't remember when she is going over it in the classroom. You don't remember what you first got when you initially got introduced to the problem.

Other students agreed that even though they wrote down their questions, they either forgot to ask their question the next day or felt that their questions were never adequately addressed. Leon said, "I mean, it would help me more if I could ask questions, if she was writing it on the board." When I asked him why he didn't ask his question the next day, he said, "We go over it. [video] We don't spend a lot of time on it. It is after our start up when we go over what we wrote down and stuff." Betty thought it would be a better idea to show the videos in class and then discuss them as a group. She said:

> If she showed the video in class and she said, "Do we have any questions?" Then we could ask them right then and there and we wouldn't have to try and remember them the next day or two days later. We could just raise our hand and let her know, "I don't understand this part! Can you do another problem just like that one?" I think that would be better.

This appeared to be a critical issue since so many students in the Flipped Active classroom mentioned this as something that bothered them about learning exclusively from the videos.

Disadvantage of content misalignment. Another issue concerning the video lessons was a perceived misalignment between the content on the video and what was being reinforced in the face-to-face portion of class. Several students mentioned that while the content on the videos was close, it did not exactly explain the math procedures the same way as the teacher did in class. Also, students perceived that the problems on assessments were not exactly like the problems on the videos. Neither the students nor the teacher attributed any discrepancy to the fact that multiple teachers created the videos. During my interview with Ms. Smith, she told me that she initially used only videos she created herself, but in an effort to save time and effort, she had begun incorporating videos created by other teachers at the high school who also taught the same Algebra I concepts using Flipped instruction. Students stated that they had no preference for one teacher's videos over another, because in their words, "It's just math." Ms. Smith told me that she had heard students commenting about other teachers' mannerisms on the videos but had not heard anything about the video content not aligning to follow-up instruction or to the test. Several students stated that they were frustrated that the video didn't always align perfectly with the way their teacher worked the problem in class. Martha described it like this:

> She has a blog set up and we go in through that website. She normally has the videos uploaded and sometimes she makes the videos, sometimes she gets them off of Youtube® and sometimes another teacher does them. And she also uploads the link in case it don't work and we watch them and she only talks about half of it. It like it's this part of it and a whole another section that is left off in class. Like for example the lesson is about all positives and the next day you will have positives and negatives and it's really confusing! It like fits pretty close but it doesn't cover everything.

Charlotte added, "Yeah, like certain problems that we work I wouldn't see them exactly on the test. It might confuse me." When I asked Charlotte why she thought the videos weren't exactly like the problems on the test, she replied,

> Some of the videos are made by Ms. Smith and some by other teachers. They have the same course they are supposed to be teaching but the teachers might have been teaching something different than what she is putting on the test.

Preference of textbook over online tutorial. Only four of the nine students interviewed from the Flipped Active class mentioned using online tutorials such as Khan Academy. Three of the four did not prefer the online tutorial to using the traditional textbook. Martha said, "I'd rather have a book so I could go back and see how to do it and find examples on how to do it, find more rules on it." Andy did not feel that the content on Khan Academy aligned to his video lessons. He said,

> I hate Khan Academy! You have to go through and input the answer after you work the problem and sometimes you get a problem that is not anything we are doing currently and you can't skip it so you have to keep clicking on "Give Hints," "Give Hints" until you get the answer. It takes too long.

Betty would have preferred more worksheet practice because she didn't feel that the practice on Khan Academy counted for a grade. She said, "She never sends home worksheets. All we do is the Khan Academy and even if we do get proficient, she doesn't put that in as a grade." Only one student interviewed preferred the online tutorials to the textbook. Quintin said, "Khan Academy. It shows you solutions and easier ways and if you are wrong, it tells you the right answer."

Student interview and classroom observation indicated that Khan Academy and the online textbook were the primary curricular materials used by students to practice their math problems. Students also stated that, on occasion, they used a variety of other learning materials including workbooks and group projects.

Collaborative learning environment. In Class A (flipped active), what is typically done in class is now done at home. The practice problems that students would typically have done at home are now done during class in a more relaxed learning environment characterized by active learning strategies. Active learning strategies typically involve increased student collaboration, discussion, and performance. Classroom observations documented students working in a variety of grouping arrangements. Ms. Smith incorporated protocols within the flipped active learning environment to encourage students to work collaboratively. Although Tuesdays and Thursdays were the only days designated for required collaboration, collaboration between students occurred organically throughout the week, both during and after school. Students stated that they utilized social media and email to discuss problem-solving strategies after school. During class, students worked in pairs on Tuesdays, individually on Wednesdays, and in small groups on Thursdays. Monday was reserved for the teacher who used direct teaching methods to clarify misconceptions or provide intervention. Friday was reserved for assessment.

I asked the students how they felt about the flipped active learning environment and specifically whether they preferred to work alone, with a partner, or in a group. Six of the nine students from the individual interviews preferred working practice problems with a partner or small group of students. Nancy said, “I like working with a partner so we can talk it out.”

Of the students who stated that they preferred to work collaboratively, several stipulated that the quality of the partner(s) was extremely important. Leon said, “I would probably get it better if I worked with a person if that person was serious about it.” Paul said, “It depends on who is in my group. If it is someone that won’t talk all the time then it will be productive.”

Distractions in the learning environment. I was concerned that the increased noise level in a classroom using active learning strategies would prove disruptive to students’ ability to work their practice problems. All of the students agreed that the flipped active class was noisier than its traditional counterpart, but the majority of students from both the individual and focus group interviews agreed that they could “block out” the classroom noise as long as other students were not calling out their name, or otherwise distracting them. Coping strategies included listening to music with earbuds attached to their school-issued iPads or selecting groups with students less likely to exhibit off-task behavior.

Many of the students who preferred working alone cited classroom distractions as the reason. Focus group participants, Ruth and Frances, claimed that the classroom noise prevented them from concentrating on their work. Ruth said, “When people try to talk to you when you are working a problem it disrupts your whole concentration. So you have to re-concentrate.”

Frances added, “Sometimes when she is helping us out, people will be talking behind you and stuff and you will turn around and then she tries to talk over them so you can’t really listen and it kind of confuses you.” Interestingly, Ruth and Frances were the students most often observed by the researcher as being the loudest and most disruptive in class. Ruth and Frances were often out of their seats talking loudly across the room.

Types of questions. Ms. Smith was beginning to incorporate more problems of increasing complexity into her flipped active classroom. In her interview, she stated that she had attended a conference on preparing students for the QualityCore® EOC assessment. At this conference, she learned about the different levels of question complexity and realized that she needed to incorporate more level three questions, or word problems. She realized that the majority of questions her students worked were mainly procedural level, requiring only memorization to solve. I asked students how they felt about working word problems. As expected, none of the students I interviewed confessed a love for working word problems and all found them confusing and frustrating. Charlotte said,

> We did a word problem in start up (review) this morning. The word problem was kind of confusing because I didn’t remember all the steps or what to do first. It just kind of psyched me out when I first saw it because you see lots of words and numbers. Kind of hard to figure out how you are going to form them into a problem. If I saw them enough I think I would stop doing that but I don’t think the teacher goes over them enough.

Deciding on a strategic plan of action was the major frustration for students in Class A when it came to working word problems. Gail said, “We don’t really understand them. If you don’t know where to start, how are we going to get the answer?”

Presented with a difficult and confusing word problem, students preferred to work the problem in a large group rather than alone. Additionally, the majority of students indicated that they would be more interested in working word problems if there was a real-world connection.

During the focus group interview, Ruth said, “Why don’t we use math we can use in daily life? Instead of going over stuff that don’t make any sense and we are never going to use, why don’t we go over something that we are actually going to use?”

Satisfaction with flipped active classroom. The flipped active classroom is a relatively new concept that has been made more attractive to classroom teachers by the increased availability of mobile learning devices such as the iPad. The concept was entirely new to the students in the flipped active classroom since all of their previous experience had been in classes where the content was taught using traditional methods. Student satisfaction with a course, or the method in which a course is delivered, is an important factor in student success. Studies have shown that active learning strategies increase student satisfaction and achievement (Armbruster, et al., 2009; Prince, 2004).

***Teacher assistance*.** I asked students in the individual and focus group interviews, “Do you like your flipped algebra class and what, if anything, would you change?” Six of the nine students who were interviewed individually said they liked their flipped algebra classroom. Gail said, “I do like math class. I like it a lot!” Nancy said, “I like how we usually do homework because last year we had regular homework where at home I would always be confused and I’d have to get my mother to help me but now the teacher can help you in the classroom.”

***Less restrictive learning environment*.** Several students stated that they enjoyed the relaxed, collaborative learning environment of the flipped active classroom over traditional classrooms. Paul liked getting to use technology in a less-restrictive learning environment. He said,

> I like how we get the iPad and we can actually use them, where in some classes we don’t get to use them much. Ms. Smith’s class I really like because she is not strict. She lets us have more freedom on the iPads.

Students who said they liked the flipped active classroom also said they would like more review of the video content during class and reiterated the need for consistency between what they watched on the video and what was being reinforced in class.

Dissatisfaction with flipped active format. Three of the nine students from the individual interviews and the majority of the students from the focus group interview stated that they did not like the flipped classroom and expressed a desire for more direct instruction. Martha bluntly stated that she wanted, “A more peaceful environment with the old textbook.” Charlotte didn’t feel that the flipped active classroom was achieving its goals. She said, “But I think the point of it was so you could get more work done in class and go over more problems and I don’t think that is being done.” Several interviewees in the focus group interview complained that their grades were lower than in previous years. They believed that they were not getting enough daily grades to buffer the test grades. Ruth remembers greener pastures. She said,

> What I liked about my class last year was that my teacher was really hands-on and she taught real well. She would give us daily grades and if we didn’t understand the vocabulary she would make us look it up and then she would use it in a problem. She would make us work through it and see how to use it in a problem. Our grades were higher in there.

Betty reminisced,

> My teacher last year, we had a lot of daily grades and homework and I never had below a 98 all last year and in 7th grade. I have a 60 something in Ms. Smith’s class and I mean, like everyone said, if we had more daily grades.

Within-case Analysis for Class B

Within-case analysis of Class B provided detailed information about the lived experiences of teachers and students in the flipped mastery classroom. The goal of the within-case report was to provide a comprehensive description of the flipped mastery classroom, enabling the reader to feel as though they have been an active participant, thereby determining whether the findings can be generalized to their own unique situation (Baxter & Jack, 2008).

Introduction and Participants

In addition to Class A (flipped active), Ms. Smith also taught in the learning environment denoted as Class B (flipped mastery). The semester in which the study took place was her first teaching experience in a flipped Mastery classroom.

As with Class A, Class B was a technology-rich classroom where students made use of school-issued iPads to access instructional videos, online textbooks, and online tutorials. Students had access to the school-issued iPads both at school and at home. All students had access to online resources at school through the school’s Wi-Fi network. Some, but not all, students had Wi-Fi access at home.

Students in Class B (flipped mastery) worked independently in a mastery learning instructional environment. Rather than accessing the teacher-created videos from a blog, students in Class B (flipped mastery) obtained all of their curricular materials from a learning management system (LMS). Ms. Smith used the features of the LMS to organize and administer units of curricular materials that include readings, video lessons, interactive tutorials, and quizzes. Students worked through the curriculum at their own pace, typically watching the video lessons for homework and receiving student-to-teacher and/or student-to-student assistance during the face-to-face portion of class, hence following the Flipped instruction model. Students in Class B (flipped mastery) had the option of watching the videos and practicing on the online tutorials at school or at home. Students advanced to the next unit-of-study only after demonstrating an 80% level of mastery. Features of the LMS made repeated quizzing and mastery testing manageable so the teacher could be available to serve in a tutoring/guiding role.

The instructional protocols remained the same throughout the course for each unit of Algebra I content.

1. Students watched the videos and took notes on the problem-solving procedure.
2. Students practiced similar problems on the Khan Academy math practice website or on Interact Math, the online textbook. Students were free to choose which online tutorial they used but were required to achieve 80% each tutorial lesson before being allowed to attempt a checkpoint quiz.
3. If students achieved an 80% mastery score on the checkpoint quiz, they proceeded to the next lesson and ultimately to the unit test.

As a consequence of the implementation of mastery learning strategies, responsibility for the learning process was shifted from the teacher to the student. Students also had to self-regulate the pacing of the curriculum, only advancing by demonstrating mastery of Algebra I curricular units. During her interview, Ms. Smith explained her rationale for wanting to try flipped mastery with one of her Algebra I classes. She said,

> In the flipped active classroom, the students were benefiting because they got to work more in class with me but I still had some kids falling through the gap, which was aggravating! And that pushed me to take the flipped classroom to the next level. I wanted them [students] to develop a sense of responsibility. The flipped active classroom is flipped, but for the most part, I'm still in the spotlight. In the flipped mastery classroom, the kids are in the spotlight and I run to them saying, "What do you need?"

After experiencing all three learning environments, Ms. Smith explained how the flipped mastery class is different than the flipped active class for both the teacher and the students. She described how flipped mastery was forcing the shift from teacher-centered to student-centered instruction.

> I've done traditional, I've done flipped, and now I have done flipped mastery. I know that what I'm doing right now, the flipped mastery, it is the hardest. It is the most difficult because I am a three-ring circus juggling act! It is scheduled chaos, or managed chaos,

> but what the kids are getting out of this is off the chart! How many times can you say that when you are teaching kids that your eyes will just fill up with tears that you are choking back because you are feeling such an emotion from the accomplishment of what these kids are doing? Well, I can tell you, that was a little bit in the flipped classroom; it really was not in the traditional. The easiest teaching I've ever done is traditional. In the flipped classroom you have a little bit more work, which is more on the organizing side, because you want to have things beforehand. Why am I willing to work harder? Because of the kids! Is that not why I became a teacher? I want them to be successful and I want them to "get it".

Later in the semester, I interviewed Ms. Smith again to see how her flipped mastery class was progressing. She said,

> I still have some children that are a little carefree. Then I have some kids that hit the door, the books fly open, and they say, "We got six days left in here and oh my gosh!" They are on it! It is amazing for me to see the teamwork in that mastery classroom. Kids are trying to achieve on their own, trying to get done with it so they don't have to rush and take a test and then you got a kid that is still struggling on the first test of the last nine weeks trying to master it and that child will stop what they are doing and go help that struggling kid. It's beautiful! It's beautiful to see!

Ms. Smith described how the flipped mastery learning environment was impacting the students in more ways than simply learning algebra concepts. She said,

> Most definitely levels of maturity and taking responsibility. Mastery forces student-centered learning and responsibility. It forces time management…HELLO! Real world stuff! I think that the kids that have been in the Flipped Mastery class are going to succeed better.

Ms. Smith described evidence of increased student engagement and ownership as a result of the flipped mastery learning environment that she had witnessed. She said,

> It is super exciting! Last week I told this girl that she made an 84 and tears started streaming down her face. Everyone was like, "Why are you crying?" She was like, "Ya'll, I just mastered!" And the class clapped and she was grinning from ear-to-ear…you know, it is amazing! This is evidence that they are really working, not just going through the checklist to graduation. They are super focused on mastering something. This other girl, she has been working hard and when she mastered, her eyes filled with tears and I'm like "Ya'll stop! I'm going to cry!" I get emotional with them because I'm working just as hard as they are! I'm everywhere, flying around trying to meet their needs. It is so rewarding! They are learning that just getting by is not acceptable. Even here at the end, they feel the time crunch. They beg me to let them take

that 70 score or that 68 score but I go, "No! We are not settling for average! Let's go again!"

In addition to the teacher interview, the researcher conducted ten individual student interviews and one focus group student interview in Class B. The structured interviews were designed to gain a better understanding of what it is like to teach or learn in a flipped mastery learning environment. Table 6 provides a summary of all student participants, including their particular learning style strengths and the type of interview in which they participated.

Table 6

Class B Interview Participant Information

Participant (Pseudonym)	Age	Gender	Ethnicity	Learning Style Profile				Interview Type
				A/R	I/Sn	Vs/Vb	Sq/G	
Oscar	16	M	C	B	SI	SVs	SSq	I
Sue	14	F	C	B	SI	B	MG	I
Loren	14	F	C	SA	B	B	B	I
Tina	15	F	A	MA	B	MVs	MSq	I
Donna	14	F	C	B	MSn	SVs	B	I
Peter	15	M	C	B	MSn	MVs	B	I
Ernest	15	M	C	SA	B	SVs	B	I
Cheryl	14	F	C	B	B	MVb	MSq	I
Luke	14	M	C	B	B	MVs	MSq	I
Robert	15	M	C	B	B	B	MSq	I
Ned	14	M	C	MA	B	B	B	G
June	14	F	C	SA	B	MVs	B	G
Tessa	15	F	C	MA	MI	MVs	MSq	G
Lucy	15	F	C	B	B	B	MSq	G
Zack	14	M	C	MA	MSn	MVs	MSq	G
Alvis	14	M	C	MA	B	B	B	G
Mark	14	M	C	B	MSn	B	B	G
Fred	14	M	C	B	MI	MVs	B	G

Note: C = Caucasian, A = African American, H = Hispanic, I = Individual, G = Group. For each learning style dimension, students are categorized as moderate (M), strong (S), or balanced (B). The first letter in the code represents the category, followed by the learning style dimension.

Interview

Walking back up the long hallway toward Ms. Smith's classroom, I was feeling pretty good about the interviews I had just conducted with four of her flipped active students from Class A. The interviews had gone pretty much according to plan. One after another, students had made their way to the assistant principal's office located at the opposite end of the building. Much to my relief, all of the students willingly signed their Assent forms and agreed to have their interview audio-recorded.

I returned to Ms. Smith's classroom to repeat my explanation of the purpose of the interviews with her third block flipped mastery class, and to select four students to participate in the individual structured interviews. The hallway was full of students making their way to their next class. Along with the students, I bobbed and weaved my way toward Ms. Smith's class, mentally preparing myself for another round of interviews.

As I arrived in the classroom, students were locating their seating assignments from a projected chart Ms. Smith had displayed on the board. The majority of students were chatting enthusiastically as Ms. Smith reminded them to take their seats and begin work. With an audible groan, but little resistance, students began powering up iPads, putting in earbuds, and resumed working on their lessons.

I took this opportunity to walk about the classroom and observed specifically what the students were doing. I observed the majority of students accessing the course management system to gain access to a video lesson, an online tutorial, or a checkpoint quiz. Ms. Smith was a flurry of activity, answering questions about specific problems, opening up content on the LMS for students who had mastered a particular section, and assigning paper copies of unit tests for students who were attempting to mastery. Classroom management was made less efficient by students coming to her desk to show their video notes, evidence they had watched the videos and completed the practice assignments. This time-consuming, daily procedure was the method for verifying that students were ready for the teacher to open up a checkpoint quiz or take a unit test.

The purpose for the seating arrangement became evident as Ms. Smith began distributing printed unit tests to one side of the room. Students on the other side of the room watched videos, practiced problems using the online tutorial, or talked with their classmates in small collaborative groups. The room was as Ms. Smith described in her interview, managed chaos, and she was indeed taking on the appearance of a circus-juggling act. I observed that much of Ms. Smith's time was devoted to managing the LMS to make units of Algebra I content available to students as they mastered checkpoint quizzes and unit tests. Even with the use of the LMS, managing a classroom of 24 individually paced students, left Ms. Smith little time for providing students with individualized and personalized tutoring.

After the class fell into its routine, I asked Ms. Smith if it would be a good time to take my first interviewee down to the interview room. So began my second set of interviews for the day. The following themes evolved from the interview data and are presented by research question.

Themes Presented by Research Question Three

The researcher wanted to investigate student perceptions of whether the flipped mastery learning environment was effective in helping the students understand algebra concepts and problem solving. Interviewees in all groups were asked the same structured interview questions; therefore the themes that emerged from all groups were similar. Themes that emerged from Class B (flipped mastery) focused on content delivery, learning environment, types of questions, and student satisfaction with the flipped mastery format. The content delivery theme primarily focused on what students said they liked, or did not like, about learning algebra exclusively through the use of online video and online tutorials. The learning environment theme focused on students' perceptions of the face-to-face learning environment in terms of receiving assistance from peers and the teacher, as well as their ability to concentrate in a more chaotic learning environment. The types of questions theme focused on students' perceptions of word problems with a real-world connection. The satisfaction theme focused on how students felt about the flipped mastery format and what they would change about the course if given the opportunity.

Advantage of video over lecture. My first interview question concerned the video lessons and whether students felt they learned as well from watching the videos as listening to the teacher in class. The majority of students liked learning to work algebra problems using the teacher-created videos. They liked that the videos afforded them the freedom to learn at a pace that matched their ability and they liked being able to watch the videos at home, school, or as one girl put it, "On my iPhone wherever I am." Several students stated they liked having the ability to rewind and review certain lessons to increase understanding or prepare for assessments. Seven of the ten students interviewed individually stated that they felt the videos were effective in helping them learn their lessons.

Tina said,

> I like the videos because I understand that they actually work things out in front of us and for the traditional classroom they go ahead even if you are not ready to go ahead but now we get to go at our own pace so it is better. Sometimes I think the teacher in front of the room is good too but I like the videos because it is just me learning it and I can go back and see what she actually meant.

Cheryl said,

> She doesn't teach us one-on-one. We watch videos on the lesson that we are doing so we can spend more time on that particular one if we need more help. Also, when we finish watching that video we can do practices on it before going on to the next one. I feel it is about the same. Sometimes they [videos] are a little vague but I can usually get it by just

> working some problems out and seeing what I did wrong. The thing is, when I first went over it by myself and watched the video and took the practice I didn't get it at first. When we had the exam, I went back over it and found out that I can do it better. I had to go back through all the lessons and could actually do most of the stuff I had done before. I guess over time I learned it better.

Loren agreed, "Sometimes I watch it more than once. I take my notes and sometimes when you are taking notes you don't really take everything in. So then I go back and watch it again."

I observed students watching the videos during the face-to-face portion of class. When I asked the students of Class B where they watched the videos, all of them stated that they watched them at home, during class, or anywhere they have Internet access. Oscar said,

> It [LMS] still has the videos and it gives lessons and if you have any questions after the video or during all you have to do is ask and she would answer them. I usually do the video in class because if I have a question I can ask it right then and there instead of having to wait and maybe forgetting the question.

Students had the opportunity to watch the videos at home or during class and the majority of students indicated that they preferred to watch them during class.

Disadvantage of learning by video. Not all students felt that they learned as well from the videos. Luke said, "I like being taught by a teacher more than a video. If the teacher is teaching you, you can ask her questions but you can't ask questions to the video." Sue said,

> I mean, I can learn it but I have an easier time when I'm being taught it. If I have someone work the problems out on the board, I have an easier time understanding it rather than watching a video because you can ask questions a little bit easier when you are all together in a classroom and everyone has a chance to have input on it rather than you being the only one watching it.

Robert described why he thought the videos were not as effective for some students as they could have been.

> I know the teacher is still talking but sometimes I think I wish she was still at the board because I know the video tells you everything but if you don't understand the video you can't ask the video questions. And if she was at the board she could show another example. Since the videos are so short she could maybe make it a little bit longer and list more examples. We are supposed to take notes but she lets us do screenshots of the video

> to show we watched it. You don't really have to write anything down so when you get ready to do the checkpoint quizzes, you don't really know how to do it. It's not really good. Basically that is your teaching time so it would be like sitting in the classroom and not listening to your teacher.

The students' interviews revealed that when the teacher-created videos were viewed at home, an essential "just-in-time" component of the learning process is missing. Robert's interview revealed that at least some of the students were taking shortcuts when watching the videos and might not have gotten as much out of the instruction as they could have.

Disadvantage of content misalignment. Another concern students had was that the videos didn't always align perfectly with the online tutorial or the assessment. During the focus group interview, one student said, "Some of the videos don't help you that much. They show you some problems in there but the problems on Khan Academy is totally different from the problems she show us." Several of the students nodded their heads in agreement. Another student added,

> Yes, the thing about the videos, there was one problem on solving terms for the second variable and the video was talking about a triangle or something. The video was totally different from anything I'm on right now and I was totally lost!

Preference of online tutorial over textbook. My second interview question concerning the learning environment addressed students' perception of the effectiveness of using the online tutoring site versus the textbook. At this point in the study, the traditional paper textbook had been replaced by an online version. Students could use either the Khan Academy practice site or Interactive Math, the online textbook. All of the students in Class B that I interviewed preferred the Khan Academy practice site to the Interact Math online textbook. Luke said, "Some of the hints on Interact Math confuse me." Peter said, "I like Khan Academy because it is pretty easy to do." Peter explained that Ms. Smith directed students to the appropriate tutorial by placing links inside the lessons on Moodle. The Khan Academy practice site presented questions to which the student typed a numerical answer or completed a graph. The site also provided the option of receiving hints on how to work the problem. I asked several students what they thought about Khan Academy and the hint feature. Cheryl said,

> Khan Academy you have to do like a certain number of problems right. If you get like a group of eight in a row right, you can move on to the next thing because you have pretty much mastered it. But if you get four and miss the others, it will tell you that you need to do some more practice problems. It tells you what percentage you got right and if you got like 80% then you're good.

Cheryl went on to explain how she used the hint feature as a tutorial. She said,

> Sometimes when I have just watched a video and try a practice problem I don't fully understand everything so I do like another one as an example. I use that hint to see how to work it out fully but after I get that down and copy down all the steps usually I learn from that one problem to go on to the next ones.

Ernest used the same strategy. He said, "I use the hints on Khan Academy and write them all down on my paper then I go to the next problem. I use my hints from the one problem to work the others."

Disadvantage of using Khan Academy®. During observations of the flipped mastery classroom, I noticed that there were a great number of students calling for the teacher to come over and assist them. One of the students told me something that shed some light on why so many students felt they needed their teacher's assistance, even though they had the video and the online tutorials to answer their questions. Robert said,

> You have to master Khan Academy® practice problems before you can take a checkpoint quiz. Every time you work a problem correctly, Khan Academy® give you a certain number of leaves. Like if there is a problem and you get everything right, you get three leaves. So it says you can ask for a hint but every time you ask for a hint it would be like putting the answer in and missing it so you have to start back over. It takes away a leaf if you ask for a hint so if you don't understand it doesn't help you at all. So everyone is constantly calling Ms. Smith, Ms. Smith…. There is only one of her and like kids are running everywhere!

Students may have perceived that the Khan Academy® practice site was penalizing them for asking for assistance. The fact that students did not want to be penalized by the online tutorial may have been one reason why there was an increased number of students asking for personal assistance during class instead of going back to the video or asking Khan Academy for a hint.

Changing roles. The day-to-day lived experiences of the teacher and students in the flipped mastery learning environment was quite different than any learning environment I had observed. My overall impression, the teacher was extremely busy and the students were effectively engaged. Because each student worked at an individual pace, the role of the teacher changed from content delivery to content management. The teacher's activities alternated between grading assessments, opening up sections on the learning management system for students who had mastered a section, and dealing with administrative tasks. Numerous students were calling for Ms. Smith's assistance, requiring her to move about the room tutoring and answering questions. This task was made more difficult by the fact that every student was potentially working on a different topic. Ms. Smith stated that she found managing all the diverse needs of her flipped mastery students to be much more demanding than managing either the flipped active or traditional learning environments.

In my observations of the flipped mastery classroom, students appeared engaged and self-directed. Students appeared to enjoy the task-oriented classroom atmosphere and the freedom to move about the classroom, giving and receiving assistance. Because so many students were calling for the teacher's assistance, the noise level was high. I asked students how they felt about the classroom environment in terms of working with other students. Tina said,

> She [Ms. Smith] is grading tests because people are passing tests in or she is telling other people they need to hurry up and get on the quiz or to start the practices or the videos or she's telling them "I don't have this video from you!" She must make sure everyone has what they are on. If I'm done I will go back and teach other people how to do it cause

> people ask me how to do stuff in class and I will have to stop and help them because she can barely teach them because other people are coming up to her. People that are ahead teach people who are behind.

I observed this type of peer tutoring on every observation. Student were permitted, and encouraged, to seek assistance from peers while watching video lessons and practicing using the online tutorials. It was not uncommon to see a group of three or four students leave their seats and go to the dry-erase board to work out problems. Ernest said,

> I like walking around. If I see something that interest me I go to my buddy and show him about the problem or I can get up and go to Tina and she can help me. That is what I like about this class.

Luke said, “I like working with a group because everyone has their own way of working, asking questions, and working it out.”

The focus group had conflicting opinions of how they felt about the support they received in class from their peers and the teacher. Zack said:

> All of us back there are pretty much working on the same thing so we kind of help each other out. Like if one of us is in front of the others, we will help each out figure out how to solve the problem.

However, Ned added, “Sometimes it is hard though when everyone is on different things.” Alvis said, “Yeah, when you go to her [Ms. Smith] for help, she will try and get another student to help you and they might not understand it as well or be able to explain it as well as she could.” Ned said:

> Like one time I went to ask her a question and she was sitting at her desk grading tests or something and she said to go ask someone. But I still didn’t understand it so I had to figure it out myself.

I asked the students in the focus group whether they thought peer tutoring was a good way to learn the material. Seven of the eight students in the focus group said they did not think it was effective. The one student who thought is was a good idea stated, “If the students who are ahead, if they “get” the problems and they know how to do it, then I think it could work. It depends on how well they understand it.”

Distractions in the learning environment. I asked the students about the level of distraction in the room. Most said that the noise in the room was definitely more than in a traditional classroom but they were able to either block out the noise mentally or by listening to music on their iPads. I observed students using earbuds or headsets to watch videos and listen to music while using the online tutorials. I asked students why they thought the flipped mastery classroom was noisier than other classrooms they had experienced. Loren said, “Well, sometimes it’s loud because some people don’t do what they are supposed to be doing. They just play on their iPad and talk and stuff.” I asked Loren if the people doing the talking were ahead of everyone else in the class. She said, “No, they are behind.”

Types of problems. As the semester progressed, Ms. Smith was beginning to incorporate more problems of increasing complexity into her flipped mastery classroom. In her interview, she stated that she had recently attended a conference on preparing students for the QualityCore® EOC assessment. She realized the need to incorporate more level three questions into the curriculum because the majority of questions her students worked were procedural, requiring only memorization to solve. I asked students in Class B how they felt about working more complex problems, such as word problems. The common complaint students expressed was their inability to form a strategic plan for solving the word problem. Tina said, “For me, I prefer the step 1, step 2 problems. I don’t like word problems because I get confused as to where to start.” The majority of students indicated that they would be more interested in working word problems if there was a real-world connection involving such things as sports or another extracurricular activity.

Satisfaction with the flipped mastery classroom. The researcher sought to investigate the lived experiences of the teacher and students in the flipped mastery classroom and to determine what aspects of flipped mastery students liked, disliked, or would change if given the opportunity.

Students from both the individual and focus group interviews were consistent in what they liked, and disliked about the flipped mastery classroom. Students liked the fact that they could retake quizzes and unit tests to get a better grade, but understood that while they were taking advantage of this "second chance," they were getting farther and farther behind.

Donna said:

> I like the new version better. You go at your own pace and you keep on until you get everything out of it you possibly can get. And, you're not lost while they are going on to chapter nine while you are still confused about chapter six.

Students were able to articulate the purpose for changing to a more individualized instructional model. Zack, who participated in the focus group interview, summed up why he thought Ms. Smith made the switch:

> Well, the whole reason she went to the mastery class is for one, people have different speeds so they can stay a little bit longer on and not get left behind while everyone else is doing different stuff. If we were all in the regular class some of us would be way behind and not know anything and getting bad grades and stuff and others would be really far ahead and waiting for everybody else.

Mark agreed, "It's like pretty much impossible to come out with a bad grade, anything below an eighty." Almost immediately, another student in the group interjected, "Unless you get to the end of the year and you are not done!"

The exchange between these two students is representative of the conundrum communicated to me by almost every student interviewed from Class B (flipped mastery). Students liked having the opportunity to work at their own pace, retaking tests and improving their grade. The main thing they liked about the flipped mastery class was that they didn't feel rushed or stressed. But as the semester progressed, more and more students began to realize that while they had been taking their time achieving mastery on the first few lessons, they were falling farther and farther behind. This inversely proportional relationship, between time spent trying to master and progress moving through the curriculum, eventually would become the central complaint among students in the flipped mastery group. Students, who were interviewed early in the research period, were somewhat aware that they were falling behind but were relatively unconcerned. By the end of the semester, however, the time crunch would dominate all interview discussions.

Peter was interviewed early in the semester. He stated that the flipped mastery classroom was working for him. He said, "It's more laid back and you get it at your own pace. We are not rushed on tests. That's what I like about it." I asked Peter if he was aware of any students falling behind. He said, "Not really. Everyone is about the same."

Oscar was interviewed around the middle of the research period. He said he was a little behind but believed he could catch up easily. He expressed his satisfaction, but concern, with the flipped mastery class by saying:

> To comprehend math, the flipped mastery would be the best, but there is a problem with time. You have a limit. I'm not sure how to explain it, but we have exams next week and I think there are some people who are way behind because there is nothing to push them forward. For me, it is the best way to learn the content but for other people, they might need someone standing over them showing them what to do. I think they need motivation.

Perceived teacher support. Another concern students had about the flipped mastery classroom was the amount of perceived support they received from their teacher. In almost every interview, students were consistent in that they would like to see an increase in the amount of one-on-one assistance they received from the teacher. This was surprising to both the researcher and the classroom teacher. Ms. Smith felt she spent a substantial amount of time assisting students and direct classroom observation confirmed this. During our last interview I told Ms. Smith about the students' concerns that they were not receiving enough one-on-one assistance from her. She responded, "Oh dear God! [laughing] That is all I do!" I further explained that students told me that they felt she [Ms. Smith] was so busy helping everyone else on so many different topics that she didn't have time to come over and help them exactly when they needed it and stay with them until they understood how to work the problem. She explained,

> You know, I've thought about almost making appointments but I've got like 24 in there and I have to make myself aware of personalities. For instance, my loud student calling MS. SMITH, MS. SMITH, COME HELP ME! They are like an alarm or siren going off! And the personalities that are quiet, they may see me busy and may not holler my name out. So, I've had to make myself consciously aware of those personalities and kids that are quiet individuals.

Students in the focus group interview spoke extensively about their frustration trying to get one-on-one assistance. Tessa said,

> I do not like this! Because like whenever you're wanting help but your teacher is too busy going off to all the other people and forgets about you and you're sitting there trying to get help and she don't come to you.

Cheryl said,

> Since Ms. Smith has so many kids in one classroom it would be easier if there were more than one teacher to ask questions and go into detail. If I had Ms. Smith answer more of my questions fully and better then maybe I could master it faster but with so many people in a classroom it is kind of hard to stay on one student.

Reiterating what Robert described in his interview, " It [Khan Academy] takes a leaf away if you ask for a hint so if you don't understand it, it doesn't help you at all. So everyone is constantly like, Ms. Smith, Ms. Smith, Ms. Smith!" Robert believed that because Khan Academy punished the students for asking for a hint, the students were electing to ask for the teacher's assistance every time they needed a hint and that was leading to an increased number of questions and consequently an increased number of questions not being addressed.

Emerging awareness of responsibility. Some of the students I interviewed were starting to make the connection between extra efforts on their part and not getting behind in their progress. Cheryl agreed that it is very easy in the flipped mastery class to get behind. She explained:

> Even if you do a lot of lessons and quizzes, you can't learn them too fast because you don't know how to do them correctly. Like the people with the polynomials test and how it is taking forever to learn it and master it because it is like really hard. And people might not be able to master it so that is why they can't pass the test. To pass the polynomials test I had to really work at it and spend like a whole day trying to learn that stuff during the weekend! With the regular classroom, and with the Flipped Active classroom, you have a schedule to do, like do the lessons every day and you couldn't really get behind but with the Flipped Mastery it is really easy to get behind schedule.

By the end of the course, some students were beginning to take responsibility for their learning. The focus group interview for the flipped mastery group took place during the last few weeks of the semester. Almost all of the students were adamant in their disapproval for the mastery component of the class because they were all several weeks behind with time running out. I asked the interviewees why they thought they were so far behind. Zack suggested, "Well, most people would hate me for this, but, she doesn't enforce us to do the work enough." Lucy added,

> We have more responsibility on our own instead of her telling us to do it right then, we do it when we want to do it. So it's kinda our fault for being behind but we don't get into trouble for being behind, we just kinda suffer at the end.

Sue may have said it best with her epiphany on the effect mastery had on traditional student and teacher roles. She said,

> When you are by yourself, you have to do a lot of work by yourself. I mean the teacher is there to help you but you have to get yourself caught up. It's not the teacher's responsibility to make sure you are on track; it is your responsibility. In other classes, it is

> the teacher's responsibility to make sure everyone is somewhat in the same area but when it is your responsibility it is more difficult because it is very easy to get time passing and you just don't know you're getting behind.

Classroom observations confirmed what the students discussed in their interviews. Some students would come into class and immediately start working while others spent the majority of class time socializing or playing games on their iPad. Ms. Smith would routinely remind students to be mindful of time and progress, but ultimately, the responsibility for learning was shifted from the teacher to the student.

Perceived effectiveness of mastery learning. In her interview, Ms. Smith expressed that the Flipped Mastery students would outscore all other groups on end-of-course assessments even though some of the students in the flipped mastery class would not get to spend equal time on all of the content.

She said:

> I am going to force them to take tests. All they are going to get is a shortened time. Depending on where they are, they are going to run through the videos, practice as much as they can, and almost cram for those particular units.

However, students in the focus group had different expectations for how they would do on the end-of-course assessment. Kurt said, "If you are not far enough ahead and you are just trying to cram it all in the last few weeks of school, you are going to fail that test because you won't know how to work it." June said,

> The thing about the regular classes, even if you fail that test you kind of know some of the material but you continue at that same pace you are going to know everything that is going to be on the test. You at least go through it. Like with the mastery class, if you don't get to it, you don't know anything!

Within-case Analysis for Class C

Within-case analysis of Class C provided detailed information about the lived experiences of teachers and students in the Traditional Lecture/homework classroom. The goal of the within-case report was to provide a comprehensive description of the Traditional Lecture/homework classroom, enabling the reader to feel as though they have been an active participant, thereby determining whether the findings can be generalized to their own unique situation (Baxter & Jack, 2008).

Introduction and Participants

Ms. Jones taught in the learning environment denoted as Class C (traditional lecture/homework). She was in her first year as a classroom teacher. She had no prior experience in flipped instruction and utilized traditional lecture/homework instructional practices exclusively.

Students in Class C were provided with iPads for use at school and at home. Students were not required to use technology to complete assignments or assessments. All students had access to Internet resources while at school through the school's Wi-Fi network. Some, but not all, students had Wi-Fi access at home.

Ms. Jones began each class with an introduction or review of previous mathematics lessons. She worked a mathematics problem on the board and required students to copy down the problem verbatim. She did not allow talking or discussion during her lecture, but did stop periodically to answer questions and address concerns. Immediately after working a problem, Ms. Jones wrote a similar problem on the board and required students to work on the problem silently and independently as she moved about the classroom answering individual questions. The remainder of class was dedicated to working more practice problems, including homework problems. Ms. Jones allowed time in class to work on homework problems with the understanding that any problems not completed must be completed at home. Students sat in straight rows, working problems independently, with little or no peer discussion or collaboration. Students took tests weekly and advanced to the next topic regardless of mastery.

During her interview, Ms. Jones explained why she utilized traditional instructional strategies:

> Probably because that is the way I was taught and it is also the way I like to learn. I know there are a lot of things I could do different and I will next year. It is hard to change mid-year. I feel more successful this semester than I did last semester, a lot more successful! I do plan on using more technology but I don't think I will move too far from what I'm doing. I know some of the other math teachers are using flipped instruction but I'm not sure how their flipped instruction works and how much direct instruction they use or don't use but I still want to use it (direct) and I still think it is necessary a lot of the time. I am open to change but this is my first year and I'm trying to keep my head above water.

I observed Ms. Jones' classroom on several occasions. During every observation, the students were very quietly sitting in straight rows. Ms. Jones was always at the front of the room working problems with little interaction from the students. Immediately after working a problem, Ms. Jones would write a similar problem on the board and have students work the problem individually at their desks. During this time, she would move about the room answering questions of individual students. She allowed no talking in class and became quite agitated when student chatter rose to an audible level. Ms. Jones described a typical day in her class and how she introduced new material to the students:

> We start out with the start up and I try to introduce the topic we are going to be talking about and how it relates to something we have already studied. We are doing radical expressions right now and that goes back to factoring. Trying to help them with that and basically then just dive into the lesson.

Ms. Jones explained that the "start up" was a review of previously taught material and she began every class with this type review. She continued,

> Usually we will spend about a day and half on a topic, so about 30 -45 minutes of instruction and then they have the rest of that class time to work example problems. If they are not struggling, then the next day we will just move on. We try to review five or six problems right after we get started, like after the "start up" we will try and review

> from the day before. If they are getting it we will move on and if not we will stay there as long as we need to until they are getting it.

Direct observation confirmed this instructional routine. Ms. Jones appeared to be very structured in her approach and did not deviate from this routine on any observation. I asked her about the kind of homework she assigned and was surprised to hear her say:

> We don't have much homework because I can't get them to do it. The ones that do it, I hate for them to do it and do it wrong. If I give them ten problems and they do it wrong ten times the same way, when they get their test they are going to do it the way they did it those ten times. So when I'm walking around class I can correct them and I've just found that to be a lot easier. I hate for homework to kill their grade when they know how to do it but because they won't do it outside of class.

She confirmed that the only practice that the students in Class C received was during the 90-minute instructional block. She said, "They are doing a lot of work, it is just all done in class." I asked her if the students were allowed to use the iPads. She said that the new textbooks were loaded on the iPad but she had not made any assignments from that resource. The students received their entire math content directly from the teacher in the form of lecture and demonstration. Ms. Jones did say that she had attempted to use the Khan Academy practice website with her students but stated that they didn't like it. She said,

> A couple of them were upset that they didn't get all three leaves, or that sort of thing. I feel like that since that is not the way we have been doing it, they have gotten used to the one way. When we tried to change it, I feel like they just shut down on me.

In addition to the teacher interview, the researcher conducted ten individual student interviews and one focus group student interview in Class C. The structured interview questions were designed to gain a better understanding of what it is like to teach or learn in a traditional learning environment. Table 7 provides a summary of all student participants, including their particular learning style strengths and the type of interview in which they participated. Note that three students participated in both individual and focus group interviews. An unexpected situation occurred on the day of the individual interviews. When I arrived to conduct my first set of individual interviews, no students other than the eight who had completed the focus group interview had returned their Parental Informed Consent form. Three students who had participated in the focus group interview were asked to interview individually. Table 7 displays the Class C participant information including each student's learning style strengths and the type of interview in which they participated.

Table 7

Class C Interview Participant Information

Participant (Pseudonym)	Age	Gender	Ethnicity	Learning Style Profile				Interview Type
				A/R	Sn/I	Vs/Vb	Sq/G	
Sarah	16	F	A	MA	MSn	MVs	MSq	G
Emily	16	F	A	-	-	-	-	G
Robin	14	F	A	B	B	MVs	MSq	I-G
Roy	15	M	C	B	B	MVs	B	G
Gavin	15	M	C	SA	SSn	MVs	B	I-G
Stephanie	15	F	C	MA	MSn	SVs	SSq	G
Beth	15	F	C	SA	SI	B	B	I-G
Ally	14	F	C	MA	B	SVs	SG	I-G
Carson	15	M	C	B	B	SVs	MSq	I
Lindsey	15	F	C	SA	B	SVs	MG	I
Vicky	17	F	C	B	SSn	SVs	MSq	I
Joe	15	M	C	B	SSn	SVs	MSq	I
Amanda	14	F	C	MR	MSn	B	B	I
Jack	15	M	C	B	MSn	B	B	I

Note: C = Caucasian, A = African American, H = Hispanic, I = Individual, G = Group
For each learning style dimension, students are categorized as moderate (M), strong (S), or balanced (B). The first letter in the code represents the category, followed by the learning style dimension. Three students participated in both individual and focus group interviews. There was no learning profile data available for one student, (-).

Interview

After checking in and receiving my visitor's badge from the office, I made my way down to Ms. Jones' classroom. It was seven forty-five in the morning and already students were coming into her classroom. One thing I noticed right away was a huge pile of sports bags piled haphazardly near the door of the classroom. I observed several girls, obviously not students in her class, drop off one of these bags and leave. I soon realized that Ms. Jones, like many untenured teachers, wore multiple hats. In addition to her teaching duties, Ms. Jones was also the softball coach, hence the pile of sports bags stored in her room by her players.

Ms. Jones was polite and soft-spoken and asked if I would wait until she finished her start up review activity before I removed interviewees from the classroom. This afforded me the opportunity to conduct an impromptu classroom observation. Although a first year teacher, Ms. Jones taught as though she had many years of experience. Without fanfare, she launched immediately into her review of problems from the previous week. Her students were awake and quiet, if not attentive.

The review took less than 15 minutes and it was time for me to escort my first interviewee to the assistant principal's office. But then, there was a problem. Ms. Jones informed me that, other than the students who had participated in the focus group interview, none of the other students had returned the Parental Informed Consent form. The window of time for conducting interviews was closing so I had no other choice than to ask three of the students who had participated in the focus group interview to consent to participating in an individual interview. I chose three students who were not overly vocal during the focus group interview to participate in the individual interviews. Luckily, they were much more open and informative in an individual interview setting. The following themes were derived from the interview data and are presented by research question.

Themes Presented by Research Question Three

The researcher wanted to investigate student perceptions about whether the traditional way of delivering content was effective in helping students understand algebra concepts and problem solving. The following themes were derived from the ten individual student interviews and from the student focus group interview. Themes focused on content delivery, the learning environment, types of problems, and student satisfaction with the traditional instructional model.

Content delivery. Like most traditional classrooms, Class C was characterized by teacher-centered, direct instructional methods. The flow of information was unidirectional, from the teacher to the student. Lecture and guided practice were the primary instructional strategies. Student-teacher interaction took the form of whole class instruction and individual tutoring. Without exception, students in both the individual and focus group interviews liked the traditional format and felt that it was the best method for learning the material. Students with prior experience in a Flipped instruction learning environment stated adamantly that they preferred the traditional learning environment.

When asked how their teacher delivered instruction, students described the teacher presenting concepts and working problems from the front of the room as students sat in their desks taking detailed notes. Part of the daily routine was to begin each day with a review of previous material. Vicky described the review activity referred to as “start up”:

> We will walk in when the bell rings and she will have something on the board. She will have five questions on the board. We will work out the problems we did the week prior. Then she will come back and work all the problems on the board. She will ask us questions like, “What would you do next?” and we would say, “Well, you reduce this and carry that over, or put it in a box or whatever.”

After the review, Ms. Jones would introduce new material. Jack described the process:

> She writes a problem up there and she lets us see the problem as she works it out. She takes us through each step. After she works through a couple of them she lets us do some examples and if we can't get them right, she will go over the parts we don't understand. And just let's us ask questions.

The remainder of class time was devoted to working more problems. Observational data confirmed this instructional routine and there is no evidence to suggest that Ms. Jones deviated from the pattern.

No homework. The interview process revealed a surprising discovery: Ms. Jones assigned no homework. To clarify, Ms. Jones believed that students who did not have anyone at home to tutor them were likely to either not do the homework, or repeatedly reinforce incorrect problem-solving methods. Accordingly, she made class time available for students to practice all of their math problems during class so she would be available to assist them during class. Exactly what percentage of class time that was allocated for homework was unclear. Ally said, "If we do have homework she will most times let us work it in class. Sometimes at the end of class she will give us five or ten problems to go over and we will work on it the next day but we just do it in class." Beth estimated the amount of time spent in class on homework was about twenty-five percent. I asked another student what would happen if she didn't get those five or ten problems done in class. Robin said, "She would tell us to do them for homework." It seemed to be the consensus among the students that they did not have homework but several students admitted that they did, in fact, work problems at home whenever they failed to get their work finished at school or in preparation for a test.

Quiet and orderly learning environment. Ms. Jones believed in a quiet, orderly classroom. I asked her if she ever allowed students to work collaboratively in small groups. She said:

> Definitely, I did a Skittles project with probability last semester and they liked it but I'm big on staying in your seat and staying quiet. I've gotten a lot better about letting them talk if it is about math but even if they get off subject a little bit, as long as they are communicating, it is ok. At first, it just drove me crazy. I'm a quiet person and I don't like the chaos and stuff. I've gotten a lot better about that and I'm definitely open to doing more group stuff in the future.

Gavin described another group project he did in Ms. Jones' traditional class:

> Sometimes she gives us a problem every nine weeks and we get to work in groups on that. We will go to the computer lab and do something. The last one we had was about integers, I think. It was all about numbers and we had to do a slideshow about that.

Students in the traditional class appreciated the structured, quiet learning environment. Most students described Ms. Jones' class as extremely quiet most of the time and a good environment in which to learn. A few said it depended on the day. Vicky said, "It is quiet to an extent. It just depends on the day and who is in a good mood and who is not. Sometimes people will be listening to music or they will be talking." Observational data confirmed that the learning environment was extremely structured, if not engaging. While students were quiet, many appeared to be passively enduring their time in class with no evident expression of interest.

Types of problems. Ms. Jones said approximately 80% of the problems her students work are procedural in nature. She describes them as, "Working toward the test, type problems." She said that percentage would be higher if it wasn't for one unit on probability. I asked her if she anticipated her students have difficulties working the open-ended type problems on the new end-of-course assessment. She said:

> I think most students are going to have issues. Because in math classes we teach this is how you do it and why you do it and it is hard to change that mentality. It is hard to change their opinion when they see words in math class. They just shut down just like they do when they see fractions. They freak out and they don't think the can do it so a lot of it is the mentality they have. I think that if we can get inside their head that they an do it then they will have a better chance of doing it.

Vicky described how word problems are different than procedural problems. She said,

> Word problems are harder. Well, it's like a train is going so fast and you have to figure out this, or so many tacos were sold this day and so many were given this day and I'm like, "OK ,What do you want me to find?" Another problem is like, "Find out what Y is" and I'm like, "OK". I mean, I don't care what Y means!

Students in the traditional class did express an interest in working word problems with a real-world connection. Most felt that questions with a real-world connection would be more relevant and more interesting. Gavin said, "Just so I won't get bored so the problems might have something to do with the outside world." Most students said they would prefer working with a group of other students when working difficult word problems.

Satisfaction with the traditional classroom. The majority of students interviewed individually, eight of ten, liked the traditional instructional format and stated that the method the teacher used to deliver content was effective in helping them learn algebra concepts. Gavin said he was comfortable with the way Ms. Jones taught and the manner in which the information was presented. He said, "I have a real good understanding of what she teaches." Jack felt he learned well in a traditional classroom. He said, "I like how she gets up there and shows every single step".

Prior experience with flipped instruction. The general consensus in Class C was that traditional instructional methods were better than learning math from a video. All of the students in Class C had knowledge of the flipped algebra classes at their school and several of the students had personal experience in a Flipped instruction classroom. All were adamant in their defense of the traditional instructional approach. Jack was in a different Algebra I class the previous semester but a scheduling change required he transfer to Ms. Jones class. Jack was happy with his transfer to a traditional classroom:

> Yeah, we were the people that got flipped. But then, I joined the football team and I was placed in Ms. Jones' class. I wanted Ms. Jones' though because I had Ms. Alias, a pseudonym, and my grade was dropping because, I don't know, I didn't like the way she teached. But then I go to Ms. Jones' class and I brought my grade up.

Sarah, who had been in Ms. Smith's flipped class the previous semester, dominated the focus group discussion. She said:

> I've had Ms. Smith's class and the way she teaches I don't understand. Because she will just put it on paper and expect for you to just know it already because of 8th or 7th or 6th grade. So being in Ms. Jones' class and she showing us step-by-step, I understand more and know I am a visual learner more.

Dissatisfaction with traditional classroom. Several students, including those students who said they liked the way the traditional class was taught, said they wished there was more opportunity to work with their peers on practice problems and group projects. Lindsey, a shy girl reluctant to ask questions in open class, stated that there were times when she would have liked to work in groups on practice problems. She explained why, "Then you would have different people with different ideas and some people might know how to do it and they can teach you." Vicky found the class uninteresting and thought projects might add some student interest:

> If she would do more projects she would have more people interested in the class. No one would be sitting there so bored so they listen to music or get their phone out or whatever. If we're doing something like a project and she would assign you to a group. Work the project and get a grade on the project, it would push more people to try instead of just sitting there wanting to take a nap.

Summary of Findings of Lived Experiences of Teachers and Students

Chapter V sought to address research question three and presented the findings from the within-case analysis of Class A (flipped active), Class B (flipped mastery), and Class C (traditional lecture/homework) learning environments. The within-case analysis included a description of each learning environment as well as a description of the teachers and students who participated in the interview process. Several themes emerged from the analysis; a) content delivery, b) advantages/disadvantages of digitized curriculum, c) learning environment, d) types of problems, and e) level of satisfaction. A comparison of the themes will be presented in the cross-case analysis presented in chapter seven.

CHAPTER VI:

WITHIN-CASE ANALYSIS OF LEARNING STYLE PREFERENCE FOR LEARNING ENVIRONMENT

Introduction

This chapter addresses research question four by investigating the effect of learning style on students' preference for learning environment. The within-case analysis of learning style preference for learning environment includes a description of learning style dimensions as described by Felder and Soloman (n.d.), the accommodations for learning styles found in each of the three learning environments, and the preferences of the students for learning style accommodations in each of the three cases.

According to Lage et al. (2000), learning style preferences can have a significant effect on student satisfaction, engagement, and achievement in any learning situation. Classes that utilize a variety of teaching styles are more likely to increase student performance (p. 31). The researcher examined student interview data in four learning style dimensions as measured by the Soloman and Felder Index of Learning Styles (ILS) Questionnaire. The online version of the questionnaire was administered to students in Class A, Class B, and Class C on January 28th, 2013. Permission to use the ILS for research purposes is granted on the Felder and Solomon (n.d.) website.

Research Question Four

How do students' learning style affect preferences for learning environment?

Student Learning Styles

Analysis of each student's learning style profile was accomplished using the criteria established by Felder and Soloman (n.d.). The ILS online questionnaire reported learning profiles using four scales of learning dimensions: active-reflective (A-R), sensing-intuitive (Sn-I), visual-verbal (Vs-Vb), and sequential-global (Sq-G). The questionnaire contained 44 items; 11 items per scale. Consequently, the maximum score for any scale of each of the four dimensions was 11. Students scored along a scale between each of the learning dimensions (i.e. active – reflective), with some learners being balanced between the two extremes. The Felder and Solomon (n.d) criteria for classification of learning style preference divides the student's score for each learning style dimension into three possible categories: a) strong preference (9-11), b) moderate preference (5-7), and c) balanced preference (1-3). Where a student lies along this continuum may affect their preference for certain classroom activities (Felder & Soloman, n.d.). Figure 7 illustrates a sample student learning style profile report.

```
Results for: lkj

ACT                      X                                         REF
     11   9    7    5    3    1    1    3    5    7    9   11
                              <-- -->

SEN                           X                                    INT
     11   9    7    5    3    1    1    3    5    7    9   11
                              <-- -->

VIS       X                                                        VRB
     11   9    7    5    3    1    1    3    5    7    9   11
                              <-- -->

SEQ                           X                                    GLO
     11   9    7    5    3    1    1    3    5    7    9   11
                              <-- -->
```

Figure 7. Sample student learning style profile.

The sample student profile in Figure 7 would be interpreted for the student as having preferences for: moderate active learning, balanced sensing-intuitive learning, strong visual learning, and balanced sequential-global learning.

Class Accommodation of Learning Styles

Each of the three learning environments varied in their instructional approach as well as in their accommodation for students' learning preferences. This section describes the characteristics of each learning environment as it related to the four learning dimensions.

Active Learning Preference

Students with active learning preferences prefer discussing, explaining, and applying information as they are learning new information (Felder & Soloman, n.d.). Students in the Class A (flipped active) learning environment spent two or three days each week in class working in face-to-face collaborative groups. In these collaborative groups, students discussed, explained, and applied problem-solving strategies with their peers. Groups of students also presented their solutions to mathematics problems to the class for whole group discussion.

Students in Class B (flipped mastery) experienced a learning environment designed to individualize the learning experience. Students decided how they learned best; independently, in pairs, or in collaborative groups, and were free to change their grouping arrangement to suit their situational learning need. Students in Class B worked toward mastery of the content and assumed the responsibility for how, when, where, and with whom they worked.

Students in Class C (traditional lecture/homework) experienced a learning environment that was heavily dependent on the teacher. Students in Class C spent all of their class time alternating between lecture and independent problem solving. Peer tutoring and group collaboration were not part of the daily routine.

Reflective Learning Preference

Students with reflective learning preferences prefer thinking about new information before attempting to apply it. Students in Class A (Flipped Active) watched teacher-created videos, took notes and wrote down questions as they did so. Receiving new information in this medium allowed students time for thoughtful reflection of the problem solving process and application of concepts. The video medium also provided students with the option to rewind and review mathematics concepts. In addition, Ms. Smith routinely began class with what she called a start up, or review of previously covered material. The start up provided students with an opportunity to think about how mathematics problems were worked and reflect on how previously worked problems related to current problems.

Students in Class B (flipped mastery) had the option of working independently and adjusting the pace of learning to match their ability. Students were free to review video lessons on the learning management system and/or practice problems using the online tutorials. Individualized pacing was an important characteristic of the mastery classroom and allowed students more time to reflect on their problem solving strategies in order to make thoughtful adjustments in their attempts to achieve mastery. Students in Class B did not begin each class with a start up review.

Students in Class C (traditional lecture/homework) experienced daily reviews of previously covered material. This review provided students with an opportunity to think about how the problems were worked and how the previously worked problems related to current problems. Ms. Jones provided many verbal cues to help students think through the problem-solving process and solicited questions during her lectures.

Sensing Learning Preference

Students who prefer learning factual information by well-established methods and dislike surprises are referred to as sensors (Felder & Soloman, n.d.). Due to the procedural nature of teaching algebra problems, the characteristics of all three learning environments heavily favored students with strong sensing learning preferences. Regardless of whether the information was presented face-to-face or via video, the mathematics lessons were presented using logical, predictable methods. Both teachers made a conscious effort to consistently align instruction with curricular materials and in-class practice in order to avoid student confusion and frustration.

According to Ms. Smith and Ms. Jones, new mathematics standards are requiring students to work more complex level problems, primarily in the form of word problems. Word problems are frustrating for sensors because of their perception that there is no set procedure for solving them.

Intuitive Learning Preference

Students who prefer innovation and dislike repetition and rote memorization are referred to as intuitors. Intuitors work faster than sensors and tend to grasp new concepts quicker. They also tend to make more mistakes (Felder & Soloman, n.d.). The learning environments of Class A (flipped active) and Class B (flipped mastery) provided some opportunity for students to move through the lessons at a faster pace through the use of technology. Students could fast-forward through the videos, which may have permitted them to apply some innovative learning strategies to improve their understanding. Students in Class C (traditional lecture/homework) did not have the option of manipulating the sequence or pacing of the curriculum.

A learning environment that includes project-based instructional approaches and problems with real-world connections are more favorable for intuitors. Ms. Smith, in the flipped active and flipped mastery classes, attempted to introduce innovation into the curriculum through project-based activities, but this effort was not sustainable because of time limitations and limited experience using the project-based instructional strategy. She did increase the number of word problems she assigned after attending a professional development workshop on the new math curriculum standards.

The daily and weekly routine for students in Class C was the same throughout the study with heavy emphasis on repetition and little opportunity to use an innovative approach. In fact, conformity was strongly encouraged.

Visual Learning Preference

Students with a visual learning preference prefer information presented using visuals such as pictures, diagrams, or graphs (Felder and Solomon, n.d.). For students in Class A (flipped active) and Class B (flipped mastery) the presentation of the mathematics information and problem-solving process was the same, regardless of the medium. In class, students observed the teacher working problems on the board and listened to her as she explained the process. On the teacher-created videos, students viewed the teacher's pen strokes and listened to the teacher's explanation of how to work the problem. The lectures, videos, and online tutorials presented information in the same manner, only varying in the medium, which used no visual stimuli other than graphs when the problem involved graphing. As previously mentioned, the videos used by students in Class A and Class B were created by multiple teachers working at the school. The videos created by Ms. Smith for Class A and Class B contained more images, drawings and highlighting than the videos created by other teachers working at the school. Even so, the majority of all videos were created using only pen strokes and narration.

Students in Class C (traditional lecture/homework) received all information directly from the classroom teacher. They had access to an online textbook, accessible using the iPad, but the teacher did not require its use. The problems were worked on the board with no visuals other than a graph when the problem called for the use of graphing.

Verbal Learning Preference

Students who prefer to receive new information in written or audible explanations are referred to as verbal learners. According to Felder and Soloman (n.d.), auditory learners can benefit greatly from collaborative learning environments by explaining and listening to the explanations of their peers.

Students in Class A and Class B were afforded the opportunity to engage in peer discussion. Each week, students in Class A were required to work in pairs and in small groups. Students in Class B had the option to work in collaborative pairs or groups whenever they needed, as long as they were not being assessed.

Students in Class A (flipped active) and Class B (flipped mastery) received their instruction primarily from the teacher-created videos. All of the videos were carefully scripted to present the information concisely so it would fit into the condensed time frame of 10-15 minutes for each lesson.

Students in Class C (traditional lecture/homework) received all their information directly from the classroom teacher (Ms. Jones) in the form of written and verbal information. Ms. Jones spoke in a monotone voice and used precise language. She repeated main ideas and emphasized key points for students to remember. Ms. Jones did not allow students to discuss problem-solving strategies with their peers during class because of the potential for off-task and disruptive behavior.

Sequential Learning Preference

Sequential learners prefer learning in linear steps, with each step following logically from the previous one. According to Felder and Soloman (n.d.), sequential learners tend to do well in classes where the information is presented in some logical order.

Students in Class A, Class B, and Class C experienced a linear curriculum. All problems, whether presented live, via video, or using an online tutorial was presented in linear steps. Such is the nature of algebra instruction.

Global Learning Preference

Students who need to see the big idea before understanding the details may find themselves struggling in a learning environment where facts, procedures, and details are stressed more heavily than the real world connection between the information and the student. Global learners need to see how new information fits into what they already know (Felder & Soloman, n.d.).

Global students in Class A (flipped active) and Class B (flipped mastery) have the option to watch all the videos in a particular unit to get an overall idea of how the information fits together. Because the videos are pre-recorded and posted in advance, students have a level of access to the information that students in more traditional classes do not. To accommodate students with a global learning preference, teachers must be diligent in posting videos well in advance of their viewing due date. Students in the Class C (traditional lecture/homework) learning environment did not have this option.

Teachers can also assist students in tying new material to previously learned information. In her videos, Ms. Smith (Class A & Class B) routinely included pneumonic devices or learning strategies to help students relate the material to prior knowledge.

Students in Class C (traditional lecture/homework) did not have the option of looking ahead due to the fact that Ms. Jones was the source of all new information. In her interview, Ms. Jones (Class C) stated that with the system-wide implementation of the iPad and the movement toward a more digitized curriculum, all Algebra I students were provided access to an online textbook but she did not require its use. Nor were students issued a printed textbook. Ms. Jones began each class with a review and stated that she made a conscious effort to relate math problems to prior knowledge whenever possible.

Learning Style Preferences

Learning Style Themes for Class A

This section examines student individual and focus group interview data from Class A (flipped active) against the dimensions of each learning domain. The researcher analyzed the interview data to look for evidence that students' learning style had an effect on student preference for learning environment. Also included is a frequency distribution of the number of students in each learning style dimension. Table 8 displays the learning style categorization of the students in Class A.

Table 8

Frequency of Learning Style Preferences in Class A

Dimension		Students per Scoring Category		
		Balanced 1-3	Moderate 5-7	Strong 9-11
Active/Reflective	Active	5	8	1
	Reflective	4	1	1
Sensing/Intuitive	Sensing	2	9	1
	Intuitive	6	1	1
Visual/Verbal	Visual	4	9	4
	Verbal	3	0	0
Sequential/Global	Sequential	7	6	1
	Global	5	1	0

Active vs. reflective. Almost half of the students (45%) in Class A were balanced between active and reflective learning preferences. The rest of the class consisted of 40% moderate active, 5 % strong active, 5% moderate reflective, and 5% strong reflective.

The researcher examined the interview data to determine which students preferred the flipped active learning environment. The researcher used purposeful sampling to choose students for individual interviews that would represent the learning style makeup of the class. Of the nine students in Class A that were interviewed individually, four had learning style profiles indicating that they were balanced learners, three were moderate active, one was a moderate reflective learner, and one was a strong reflective learner.

Nancy is a balanced learner. When asked whether she preferred to work her mathematics problems alone or with others, she replied, "I don't mind either one. I think they both help." Quintin was another student with balanced preferences for active-reflective learning. Quintin was observed on several occasions sitting with the same group of three students. While they were sitting together, the group appeared to be working independently. Quintin said he liked to work independently most of the time but admitted there were times when he liked working with a group. He said, "When working a difficult problem, I prefer a larger group. Everyone has a different way of explaining about how to work a problem and it is easier to compare your answers."

Martha was the only strong reflective learner in Class A. She stated that she preferred to work alone and described the flipped active classroom as chaotic. She said, "When you are with a partner, you don't get to choose your partner, you're just partnered randomly and that partner is trying to talk to someone across the classroom so they are not paying attention."

Sensing vs. intuitive. Eight of the 20 students (40%) in Class A were balanced between sensing and intuitive learning preferences. The rest of the class consisted of 45% moderate sensing, 5 % strong sensing, and 5% moderate intuitive, and 5% strong intuitive.

Of the nine students in Class A that were interviewed individually, three had learning style profiles indicating that they were balanced between sensing and intuitive, three were moderate sensing, one was moderate intuitive, one was strong sensing, and one was strong intuitive. The researcher examined the interview data to determine how students felt about the method by which they learned to work their problems and kinds of problems they were being asked to work.

Most of the students who were interviewed agreed that the video lessons were short, concise, and analogous to the information they would receive during a typical lecture. However, several students complained that the content on the video did not exactly match what was reinforced in class or what was tested. Sensors are more likely to resent being tested on material not explicitly covered in class (Felder & Soloman, n.d.).

During one of my classroom observations a particularly interesting event occurred in the flipped active classroom. Ms. Smith was reviewing a quiz from the previous day. The students were frustrated over one of the problems on the quiz. The problem was a word problem involving, but not specifically stating, the use of the quadratic equation. Students were complaining that they had never worked a problem like that before and Ms. Smith was trying to reassure them that although the exact problem had not been on the video, the procedure for solving the problem had been the focus of the video. The students perceived they were being tested on material not previously covered and were observably upset.

Visual vs. verbal. Eight of the 20 students (35%) in Class A were balanced between visual and verbal learning preferences. The rest of the class consisted of 45% moderate visual and 20% strong visual. There were no moderate verbal or strong verbal learners in Class A.

Of the nine students in Class A that were interviewed individually, three had learning style profiles indicating that they were balanced between visual and verbal, four were moderate visual and two were strong visual learners. The researcher examined the interview data to determine how students felt about the content of the video lessons and how the material was presented.

Students in Class A compared the video lessons to the teacher writing on the board. The majority of students had no preference over which teacher created the videos, stating that they were pretty much the same. While several students stated that they found the video format helpful, no student referred to any visual element of the videos that helped them learn the material. Gail said,

> I like it better than regular math where you are just looking in a book.
>
> We go to the website that she made and just click on the video. She tells us about everything. It is like the book. She gives us detailed examples. I mean, sometimes we kids don't listen to the video, we just write it down. It is better when you are in class with the teacher and you learn it with her but sometime the video helps you.

Paul described the videos, "There are really just our homework and nothing really special. It's just someone talking and you have to write stuff down."

Sequential vs. global. Twelve of the 20 students (60%) in Class A were balanced between sequential and global learning preferences. The rest of the class consisted of 30% moderate sequential, 5 % strong sequential, and 5% moderate global. There were no strong global learners in Class A.

Of the nine students in Class A that were interviewed individually, five had learning style profiles indicating that they were balanced between sequential and global, two were moderate sequential, one was moderate global, and one was strong sequential. The researcher examined the interview data to determine whether students felt the video and practice they received in the flipped active classroom matched the way they preferred to learn.

All of the students except one stated that they felt they learned their mathematics lessons as well or better using the videos and practice tutorials than in traditional math classes. Students who had difficulty with learning from the video reported that the video lessons did not always match up with the online tutorials or with assessments. Paul stated that he was becoming more accustomed to learning by video but complained that the videos were out of sequence and inconsistent:

> Yes, and the videos are not in order. Last semester I went to a tutor and I did my homework there too and she would look at the videos over and over and she would like say that the videos didn't make sense because they are not the same thing. It's just video after video of different things than we are working in class.

Learning Style Themes for Class B

This section examines student individual and focus group interview data from Class B (flipped mastery) against the dimensions of each learning domain. The researcher analyzed the interview data to look for evidence that students' learning style had an effect on student preference for learning environment. Also included is a frequency distribution of the number of students in each learning style dimension. Table 9 displays the learning style categorization of the students in Class B.

Table 9

Frequency of Learning Style Preferences in Class B

Dimension		Students per Scoring Category		
		Balanced 1-3	Moderate 5-7	Strong 9-11
Active/Reflective	Active	11	7	3
	Reflective	2	1	0
Sensing/Intuitive	Sensing	10	5	1
	Intuitive	4	2	2
Visual/Verbal	Visual	7	10	4
	Verbal	2	1	0
Sequential/Global	Sequential	10	7	1
	Global	5	1	0

Active vs. reflective. Over half of the students (54%) in Class B were balanced between active and reflective learning preferences. The rest of the class consisted of 29% moderate active, 12.5 % strong active, and less than 1% moderate reflective. There were no strong reflective learners in Class B.

The researcher examined the interview data to determine which students preferred the collaborative flipped mastery learning environment. Students in the flipped mastery class were able to choose whether they wanted to work independently or with peers. The researcher used purposeful sampling to choose students for individual interviews that would represent the learning style makeup of the class. Of the ten students who were interviewed individually, seven were balanced active-reflective learners, two were strong active learners, and one was moderate active.

Loren is a strong active learner. Most days, she can be found working problems at the dry erase board with the same three female students. Loren liked watching the videos but when it came to practicing her math problems, she preferred working with her small group of friends rather than relying on the online tutorials. She felt she was getting enough support from her peers and from her teacher. She said,

> Most of the time, the people I've been in groups with, we don't really talk that much. They will just say, "I don't know how to do it." and we will call Ms. Smith over there and she will teach us how to do it.

Tina is moderate active learner who prided herself as one of the better students in the Flipped Mastery classroom. She described how she helped her teacher by assisting other students who were not progressing as well as she. She said,

> If I'm done I will go back and teach the other people how to do it because people ask me how to do stuff in class and I will have to stop and help them because she can barely teach them because other people are coming up to her. People that are ahead teach people who are behind.

Sue is a balanced active/reflective learner. She stated that she can learn from the video lessons and the online tutorials but she preferred learning from a teacher in class. She said,

> I just work better when I'm by myself because I can concentrate better. When I'm around other people, I'm more likely to talk than work so I isolate myself so I can get stuff done and make sure I'm not getting too far behind.

Sensing vs. intuitive. Over half of the students (58%) in Class B were balanced between sensing and intuitive learning preferences. The rest of the class consisted of 21% moderate sensing, 4% strong sensing, 8% moderate intuitive, and 8% strong intuitive.

Of the ten students in Class B that were interviewed individually, seven had learning style profiles indicating that they were balanced between sensing and intuitive, one was moderate sensing and two were strong intuitive. The researcher examined the interview data to determine how students felt about the method by which they learned to work their problems and kinds of problems they were being asked to work.

Most of the students found the videos and online tutorials effective methods for learning math concepts. The aspect of the videos they liked most was that they made it possible for them to move at their own pace. Tina, a balanced sensor-intuitor, said, "I like the videos because I understand that they actually work things out in front of us and for the traditional classroom they go ahead even if you are not ready to go ahead." Not every student was a sold on the effectiveness of the videos. Luke, another balanced sensor-intuitor, said, "I like being taught by a teacher more than a video. I don't get it and I ask Ms. Smith for help but she is all over the place and stuff so sometimes I don't get help."

The difference in sensors and intuitors can also be seen in the type of problems students like to work. Oscar and Sue were the only students in Class B that stated that they liked working word problems. Both Oscar and Sue are strong intuitors. Sue said, "They're not too bad. They are just the same problems only worked differently." Oscar even found the word problems challenging. He said,

> My favorite part of math is the ability to break a problem down, simplify it, and build it back together. How a mechanic loves to take a car apart and put it back together. So word problems give me further freedom to do that so I enjoy word problems in that sense and if it is a real-world problem, I can already see the use in the math so I'm more willing to solve it. It is like a puzzle.

Visual vs. verbal. Nine of the 24 students (38%) in Class B were balanced between visual and verbal learning preferences. The rest of the class consisted of 42% moderate visual, 17% strong visual, and 4% moderate verbal. There were no strong verbal learners in Class B. Of the ten students in Class B that were interviewed individually, three had learning style profiles indicating that they were balanced between visual and verbal, four were moderate visual learners, one was a moderate verbal learner, and two were strong visual learners. The researcher examined the interview data to determine how students felt about the content and presentation of the video lessons and whether this medium appealed to visual or verbal learners.

Students in Class B said very little in their interviews that would indicate whether the videos and online tutorials favored visual or verbal learners. The majority of students stated that the videos were an effective medium for helping them understand how to work mathematics problems. Students had no preference for which teacher created the video. Students described the videos as essentially the same as watching a lecture and responded apathetically when questioned about the quality of the videos.

Sequential vs. global. Fifteen of the 24 students (63%) in Class B were balanced between sequential and global learning preferences. The rest of the class consisted of 29% moderate sequential, 4 % strong sequential, and 4% moderate global. There were no strong global learners in Class B.

Of the ten students in Class B that were interviewed individually, four had learning style profiles indicating that they were balanced between sequential and global, four were moderate sequential, one was moderate global, and one was strong sequential. The researcher examined the interview data to determine whether students felt the video and practice they received in the Flipped Active classroom matched the way they preferred to learn.

The teacher-created videos and online tutorials presented mathematics problems in sequential, linear steps. All of the students except two stated that they felt they learned their mathematics lessons as well or better using the videos and practice tutorials than in traditional math classes. Students who liked learning with the videos cited individualized pacing and control over when and where they learned as the two main advantages. The inability to ask questions was the main reason why some students preferred a live teacher to the video and online tutorials. Donna, a balanced sequential-global learner, stated that she has never liked math class before but was starting to like it more since being in the Flipped Mastery class. She said, “You can be independent and you don’t have to worry about being wrong.”

Learning Style Themes for Class C

This section examines student individual and focus group interview data from Class C (traditional lecture/homework) against the dimensions of each learning domain. The researcher analyzed the interview data to look for evidence that students’ learning style had an effect on student preference for learning environment. Also included is a frequency distribution of the number of students in each learning style dimension. Table 10 displays the learning style categorization of the students in Class C.

Table 10

Frequency of Learning Style Preferences in Class C

Dimension		Students per Scoring Category		
		Balanced 1-3	Moderate 5-7	Strong 9-11
Active/Reflective	Active	5	6	3
	Reflective	5	1	0
Sensing/Intuitive	Sensing	2	8	3
	Intuitive	5	1	1
Visual/Verbal	Visual	5	5	6
	Verbal	3	1	0
Sequential/Global	Sequential	8	4	1
	Global	5	1	1

Active vs. reflective. One half of the students (50%) in Class C were balanced between active and reflective learning preferences. The rest of the class consisted of 30% moderate active, 15% strong active, and 5% moderate reflective. There were no strong reflective learners in Class C.

The researcher used purposeful sampling to choose students for individual interviews that would represent the learning style makeup of the class. Of the ten students who were interviewed individually, five were balanced active-reflective learners, one was a moderate active learner, one was a moderate reflective learner, and three were strong active learners.

Students in the Traditional class were not allowed to choose whether they wanted to work independently or with peers. Consequently, Ms. Jones' traditional classroom utilized direct instructional strategies almost exclusively, with little or no group work. The researcher examined the interview data to determine whether students preferred the teacher-centered learning environment of the traditional classroom.

Lindsey is a strong active learner. Lindsey described math class as her least favorite. She said she found the problems confusing. I asked her if there was anything about the class that she would change if given the chance. She said, “More group work.” When I asked her what she would be doing in these groups, she responded, “Just working problems.” I continued to press Lindsey about her preference for working with a group rather than working alone. She explained, “In a group you would have different people with different ideas and some people might know how to do it and they can teach you.”

Robin is a soft-spoken, balanced active-reflective learner. She liked the way her class was taught. She said, “I can learn more actually watching a problem being worked out rather than just hearing it because I don’t usually catch on to it quickly”. Robin preferred a quiet learning environment and when asked what she would change, she replied:

> Take some people out of the classroom. Our class is full and I like just a few people in there. Some of them talk and I get distracted and start talking with them when I need to be paying attention.

Sensing vs. intuitive. Less than half of the students (35%) in Class C were balanced between sensing and intuitive learning preferences. The rest of the class consisted of 40% moderate sensing, 15% strong sensing, 5% moderate intuitive, and 5% strong intuitive.

Of the ten students in Class C that were interviewed individually, four had learning style profiles indicating that they were balanced between sensing and intuitive, two were moderate sensing, three were strong sensing, and one was strong intuitive. The researcher examined the interview data to determine how students felt about the method by which they learned to work their problems and kinds of problems they were being asked to work.

The majority of students in Class C liked the method by which Ms. Jones presented the material and stated that it was an effective instructional strategy. They liked the way Ms. Jones explained the problems in detail and offered lots of time in class to practice their problems.

Gavin is a strong sensor. He liked the traditional classroom and thought his teacher's methods were effective at helping him understand algebra concepts. He stated that he would change nothing about the class and felt like he was improving as a math student. He said:

> I've not always been the best at math. I always have to study a lot more for it than for everything else. I've actually started getting an understanding of it so I'm starting to like it a whole lot more.

Gavin also liked the way Ms. Jones taught word problems. He said, "If we ever do work a word problem she shows us the way she wants us to work it. If someone else shows us another way, she just has us do it the way she taught us so we don't get confused."

The only strong intuitor in Class C is Beth. She used the word, "indifferent", to describe how she felt about her algebra class. Intuitors like innovation and dislike repetition (Felder & Soloman, n.d.). When asked what she would change about her class, Beth said, "I would probably say, give us examples for the real world. I'm one of those people that likes to see what they are getting into."

Visual vs. verbal. Eight of the 20 students (40%) in Class C were balanced between visual and verbal learning preferences. The rest of the class consisted of 25% moderate visual, 30% strong visual, and 5% moderate verbal. There were no strong verbal learners in Class C. Of the ten students in Class C that were interviewed individually, three had learning style profiles indicating that they were balanced between visual and verbal, two were moderate visual learners, one was a moderate verbal learner, and four were strong visual learners. The researcher examined the interview data to determine how students felt about the content and presentation of the video lessons and whether this medium appealed to visual or verbal learners.

Ms. Jones' method of delivering new content was essentially demonstration with accompanying visual media such as graphs and illustrations. Jack is a balanced visual-verbal learner. Jack said that history was his favorite subject and that his history teacher taught much differently than Ms. Jones. Jack described his history class:

> History class is very interactive. I like the class because we watch a lot of videos and it helps me relate to the past and I just find it interesting. You find out how stuff happens and everything. I think I just find history a better interest than math.

I asked Jack if he thought it was important for a student to be interested in a class. He said, "I think it is really important because if you aren't interested you don't have any motivation. Like I want to do good in math but, I don't know, it doesn't drive me as much as history does."

Vicky is the only student in Class C that could be characterized as a moderate verbal learner. Like Jack, she also described math as her least favorite class. Vicky was extremely knowledgeable about how the class operated and expressed a desire for more group projects. She said, "Like we could do stuff that would interest us instead of just sitting in a desk and going over the same problems." Vicky felt like projects would add interest to the class. She said, "If we were doing something like a project and she would assign us to a group… work on a project and get a grade on the project and it would push more people to try."

Sequential vs. global. Thirteen of the 20 students (65%) in Class C were balanced between sequential and global learning preferences. The rest of the class consisted of 20% moderate sequential, 5 % strong sequential, and 5% moderate global, and 5% strong global.

Of the ten students in Class C that were interviewed individually, six had learning style profiles indicating that they were balanced between sequential and global, two were moderate sequential, one was moderate global, one was strong global. The researcher examined the interview data to determine whether students felt the instruction they received in the Traditional Lecture/homework learning environment matched the way they preferred to learn.

Joe is a moderate sequential learner. Joe was very knowledgeable of the instructional routine and said that he was comfortable with the way in which Ms. Jones conducted her class. He described the methods Ms. Jones used to work the math problems and stated that, most of the time, he successfully learned the material.

Ally is a global learner. When asked if she liked learning the way her traditional class was conducted, she said, “Kind of.” Ally said that she had never liked math class and wouldn’t be interested even if the math problems had a real-world connection.

Summary of Findings of Learning Style Preferences for Learning Environment

Chapter six presented the findings from the within-case analysis of the learning style preferences of students for learning environment. The within-case analysis included a description of the procedure for determining the learning style preferences of the students using the ILS online questionnaire. Also included was a detailed description of how Class A (flipped active), Class B (flipped mastery), and Class C (traditional lecture/homework) learning environments accommodated the various learning style dimensions. Finally, student individual and focus group interview data were examined against the dimensions of each learning domain. A comparison of each learning style domain will be presented in the cross-case analysis in chapter seven.

CHAPTER VII:

CROSS-CASE ANALYSIS OF LIVED EXPERIENCES AND LEARNING STYLES PREFERENCES

Introduction

The purpose of cross-case analysis is to provide the data necessary for theory building (Merriam, 1998). The within-case analysis data from Class A, Class B, and Class C were analyzed to better understand the similarities and differences between the three different learning environments as well as the effect the varying learning environments had on the lived experiences of the teachers and students. Cross-case analysis also provided insight toward understanding the role of learning style in determining student preference for learning environment.

Cross-case Analysis Themes Presented by Research Question Three

Cross-case analysis revealed several themes about the lived experiences of the teachers and students across the different learning environments. The instructional strategy used in each of the three cases distinctively altered the learning environment. This section will discuss student perceptions of each learning environment and how the learning environment affected student perceptions of effectiveness and satisfaction.

Content Delivery

Instructional methods varied greatly across the cases. The greatest contrast in the methods used to deliver mathematics content existed between the flipped instruction classes (Classes A and B) and the Traditional Lecture/homework class (Class C).

Comparison of content delivery across cases. Students in Class C received all of their instruction from the teacher during regular face-to-face class times. Oddly enough, students in Class C were not required to do work at home but were given time in class to complete all practice problems. Ms. Jones believed that her students would either fail to do the homework or would do it incorrectly. Students in Class C very much appreciated the structured, sequential method by which their teacher taught the course content and were appreciative that they had time in class to complete their homework.

Ms. Smith utilized technology to “flip” instruction in Class A (flipped active) and Class B (flipped mastery). Flipped instruction significantly altered the learning environments of these classes much more than simply reversing the location of where students receive content information. Students in both the Class A and Class B learning environments were pressed into a method of learning that was entirely unfamiliar. The lecture format they had experienced up to this point was reduced to video pen strokes and narration. Additionally, the voice on the recording was not always the voice of their teacher, but any number of Flipped instruction teachers at the school. There were technical challenges to be overcome as well. Accessing the video content required additional skill and effort. Students without high-speed Internet access at home had to either download the videos to their iPad while at school or wait and watch the videos during class.

Students stated that homework was much easier because they had only to watch the video lesson and take notes at home. Some students admitted to taking shortcuts and not watching the videos or fast-forward through to get the notes. In class, they experienced a student-centered learning environment with greater freedom to work collaboratively. Working practice problems in the classroom with assistance from the teacher and their peers was one of the things students in both flipped instruction classes liked best.

Students in the flipped instruction classrooms also appreciated the degree of control afforded them by the video lessons. Students stated that they often would rewind, replay, and review the videos to gain a better understanding of the math content or use the videos to make up missed work. They felt that the videos were an effective medium for teaching them how to work their math problems.

In terms of how content was delivered, there was one major difference between the two flipped instruction groups. Students in the flipped active classroom received new content via video recording and were required to watch the videos at home. They reinforced the math concepts during the face-to-face class time with the help of their peers and teacher. This is what Bergman and Sams (2012) referred to as the “traditional flip.. Students in the flipped mastery classroom watched the same teacher-created videos as students in the flipped active classroom with the exception that they had control over the when, where, and at what pace they watched the video lessons and practiced on the online tutorials. Many elected to watch the videos in class so they could ask questions of their teacher while viewing their lessons, something many students in Class A (flipped active) wished they could have done.

Use of technology in delivering content. While students in all classes had the same access to technology, utilization of the technology was only evident in the flipped instruction learning environments of Class A (flipped active) and Class B (flipped mastery). There was no evidence that students in Class C (traditional lecture/homework) used their school-issued iPads for instructional purposes. Students in Class A used their school-issued iPads to gain access to teacher-created videos and online tutorials from the teacher’s blog while students in Class B utilized technology to access not only the teacher-created videos and online tutorials, but assessments and other resources from the teacher's learning management system. In fact, technology played such a key instructional role in both the flipped active and flipped mastery classrooms, such that many aspects of these learning environments would not have been possible without it. Students in both flipped classrooms expressed satisfaction with the integration of technology into the learning environment and stated that they liked having 24/7 access to the instructional content.

Pacing of content delivery. The rate at which students moved through the curriculum also varied across learning environments. Both the flipped active classroom and the traditional classroom students advanced from unit to unit as a collective group while students in flipped Mastery classroom advanced through the curriculum individually after demonstrated mastery of the content. Student in the flipped active and traditional classrooms advanced through the curriculum regardless of mastery and received the grade they earned on their first attempt. Individualized instruction posed a dilemma for students in the flipped mastery classroom as they struggled to balance the advantage of retaking tests with the disadvantage of falling behind.

Active vs. Passive Learning Environments

Flipped instruction altered the learning environment of the flipped active and flipped mastery classrooms by utilizing the face-to-face instructional time for student-centered collaboration and active learning strategies. Students in the traditional classroom were not afforded the same opportunity to collaborate and discuss problem-solving strategies as students in the flipped instruction classrooms. While most of the students in the traditional class expressed satisfaction with the way their teacher conducted the class, several students expressed that they would like to see more group work and more project work to add interest to the class.

Noise level and distraction. The noise level also varied from case to case. Direct observation confirmed that the flipped Active classroom was by far the most noisy and most chaotic. Several students in both the flipped active and flipped mastery interviews discussed the noise level and how distracting it could be when trying to watch the videos or practice their math problems. While the active learning strategy produced a more chaotic and noisy learning environment, students in both flipped classrooms stated that the noise level was manageable and only disruptive if their friends interrupted them for social purposes.

Collaboration and discussion. The researcher observed numerous instances of students from the flipped active and flipped mastery classes sharing problem-solving strategies with their classmates. Students from these classes stated that collaborative sharing and peer tutoring was one of their favorite things about their classroom and they especially liked working in groups when challenged with a difficult math problem. Many stated that working in diverse groups of individuals of varying talents was a distinct advantage over working alone.

Types of problems. Flipped instruction also altered the learning environment of Class A (flipped active) and Class B (flipped mastery) by allowing the teacher more time to work with her students on word problems. Students in all three learning environments expressed a dislike for working problems with no set procedural method. Both teachers had begun assigning more high-level word problems after a recent professional development training where they were informed that more of these type questions would be on the end-of-course assessment.

Students found word problems to be confusing and frustrating and lacked the confidence and persistence to persevere through the problem-solving process. Most expressed their inability to form a beginning strategy as the most frustrating part of the experience. Students from all three groups stated that they did not feel they received enough instruction or practice on word problems to be comfortable working them on their own.

Because Ms. Smith (Class A & B) was able to move lecture to an asynchronous format through the use of digital video, she was able to use more class time to help students work through the more complex word problems. Students were not always aware of Ms. Smith's motivation for introducing word problems with a real-world connection. Students with strong sensing learning styles may become upset if they perceive they are being tested on content that had not been previously covered in class.

Ms. Smith (Class A & B) also attempted to incorporate projects dealing with real-world problems. When asked if they would be more interested in working word problems with a real-world connection, students from all three groups were unanimously and positively supportive of the idea. Students felt that interest in the topic was important to success. Ms. Smith felt that the flipped mastery approach would ultimately be more successful in increasing students' confidence and persistence levels than either the traditional or flipped active learning environments. Ms. Jones felt that all students were going to struggle with the more difficult word problems but recognized the need to add more of them to the curriculum.

Satisfaction Within the Learning Environments

Overall, students from all three learning environments were satisfied with method of instruction and learning environment. In each of the three cases, there were things about the learning environment that students liked and things that they wished they could change. Therefore, each case will be discussed separately.

Satisfaction within Class A. Of the students individually interviewed, six of nine students stated that they liked the way the Flipped Active class was taught and were satisfied learning math procedures from the teacher-created videos. Three of the nine students stated that they would prefer a live teacher to learning algebra content exclusively through teacher-created videos.

Students who expressed satisfaction with the learning environment stated they enjoyed the relaxed learning environment and collaborative aspect of the face-to-face time. They also stated that learning from teacher-created video lessons was as effective as learning from teacher lecture. However, students expressed their frustration with their inability to ask real-time questions while watching the teacher-created videos, even though they had the opportunity to ask their questions the next day in class. They felt they missed an important, just-in-time, aspect of the learning process by not being able to ask, and receive adequate answers to their questions immediately. Another frequently mentioned concern was that the teacher-created videos did not exactly align with the online tutorial or with classroom instruction. This was a source of confusion and frustration for many of the students who were interviewed in Class A.

Satisfaction within Class B. The majority of students in Class B (flipped mastery), seven of ten, indicated in their interviews that they liked the flipped mastery learning environment. Oscar stated adamantly that he felt the mastery approach was the most effective way to learn math. However, while he appreciated the “second chance” nature of mastery learning, he was also concerned about falling behind. Like Oscar, approximately seventy-percent of the students who were interviewed individually, indicated that they were satisfied with the flipped mastery learning environment. Students unanimously agreed that it was advantageous to retake tests until you scored at least eighty-percent, but in the same breath added that it is also extremely easy to fall behind. This was the main concern voiced by students in Class B and they voiced this concern repeatedly.

As the semester progressed, students became increasingly aware that the responsibility for learning and self-regulation had shifted from the teacher to the student and that progressing through the content was now their responsibility instead of the teacher's. In the words of one student:

> The teacher is there to help you but you have to get yourself caught up. It's not the teacher's responsibility to make sure you are on track, it is your responsibility. In other classes, it is the teacher's responsibility to make sure everyone is somewhat in the same area.

The researcher observed several instances of students in the flipped mastery classroom taking ownership and responsibility of the learning process. Students were observably engaged in the learning process and became personally invested in mastering the content. Students were observed celebrating their accomplishments and mourning their failures.

However, as the number of failed attempts toward mastery increased, so did the stress and frustration level of the students. Many were concerned that when time ran out, their grades were going to plummet. The consensus among the Class B focus group was that they were not going to do well on the end-of-course assessment because they were being forced through the units they did not master. As a result, student satisfaction in the class began to drop.

Satisfaction within Class C. Students in the traditional classroom expressed fewer complaints with the way their teacher delivered mathematics content and their learning environment than students in the flipped active and flipped mastery groups. Eight out of ten individually interviewed students stated that the method their teacher used to deliver content was effective in helping them learn algebra concepts. Several stated that their teacher did a good job of explaining how to work the problems. They articulated that they liked the quiet, orderly classroom environment, which helped them concentrate on their work.

Students in the traditional group expressed appreciation for the fact that all practice work was done during class rather than at home. During class, several students interacted with the teacher and appeared to work diligently on their problems while other students appeared to be disengaged and endured their time in class passively. During the focus group interview, several students were adamant in their preference for traditional instruction over flipped instruction. The most verbal students stated that they had prior experience in the flipped instruction classroom and preferred having a live teacher to work problems on the board and answer their questions. Overall, the students in the traditional lecture/homework group were satisfied with their learning environment. Only a couple students from the individual interviews expressed a desire for more group work and more project-based work, stating that projects would add more interest to the class.

Cross-case Themes Presented by Research Question Four

The researcher examined student interview data in four learning style dimensions to determine whether learning style played a role in student preference for learning environment. A cross-case analysis of learning style preferences was conducted to determine which learning environment is best suited to meet the needs of the majority of students in each case.

Active vs. Reflective

Active learners tend to retain and understand information best by discussing, applying, or explaining it to others as they are learning. Reflective learners prefer to think about it quietly before doing anything with the information (Felder & Soloman, n.d.). This criterion suggests that students with active learning styles prefer a more collaborative learning environment where they have the freedom to discuss and share problem-solving strategies with their peers. Table 11 provides a comparison of active-reflective learning style categories between the three cases.

Table 11

Cross-case Comparison of Active-Reflective Learning Style Categories

Cases	Student Percentages Across Learning Categories				
	Strong Active	Moderate Active	Balanced	Moderate Reflective	Strong Reflective
Class A	5	40	45	5	5
Class B	13	29	54	4	0
Class C	15	30	50	5	0

The percentage of students preferring active learning strategies was greater than students preferring reflective learning strategies in each of the three cases. In each of the cases, the greatest percentage of students had learning preferences that were balanced between active and reflective learning. Additionally, the learning style preference of students in all three cases was heavily skewed toward balanced and active learning.

The learning environments of Class A (flipped active) and Class B (flipped mastery) supported student-centered, collaboration where students were encouraged, and often required, to work together in pairs or small groups. This was not the case with Class C (traditional lecture/homework). According to the student interviews, Class C only utilized collaborative work when the teacher was absent and left work with a substitute teacher. The majority of students in all three classes indicated in their interviews that they preferred to work math problems with another person or in small groups.

Sensing vs. Intuitive

Sensors like learning facts and solving problems by well-established methods and dislike complications and surprises. Intuitors dislike rote memorization and seek innovative methods for learning (Felder & Soloman, n.d.). This is especially important when aligning instruction to learning styles. This criterion suggests that students who are strong sensors prefer learning environments with a great deal of uniformity and consistency. Table 12 provides a comparison of sensing-intuitive learning style categories between the three cases.

Table 12

Cross-case Comparison of Sensing-Intuitive Learning Style Categories

Cases	Student Percentages Across Learning Categories				
	Strong Sensing	Moderate Sensing	Balanced	Moderate Intuitive	Strong Intuitive
Class A	5	45	40	5	5
Class B	4	21	58	8	8
Class C	15	40	35	5	5

The percentage of students preferring sensing learning strategies was greater than students preferring intuitive learning strategies in each of the three cases. Class A (flipped Active) and Class C (traditional lecture/homework) had the largest percentage of students with moderate to strong sensing learning styles. Class B (flipped mastery) had the largest percentage of students with balanced sensing-intuitive learning styles. The learning style preference of students in all three cases was heavily skewed toward balanced/sensing learning styles.

When analyzing the interview data, the percentage of students who indicated that they were satisfied with the way their teacher instructed the class revealed that the class with the greatest percentage of sensors, Class C (traditional lecture/homework), was also the class with the greatest percentage of satisfied students at 80%. The majority of students in Class C reported that they were extremely satisfied with the instructional methods utilized by Ms. Jones and felt that they were effectively learning the mathematics content.

The next highest satisfaction percentage was Class B (flipped active) at 70%. The majority of students in Class B (flipped mastery) were comfortable using the teacher-created videos and online tutorials to learn mathematics concepts.

The group least satisfied with classroom instruction was Class A (flipped active) with a 67% satisfaction percentage. Students in Class A repeatedly mentioned that the teacher-created videos were not perfectly aligned to the classroom instruction or assessments. With 50% of Class A being moderate to strong sensors, a misalignment of video content could potentially be a source of frustration.

Visual vs. Verbal

According to Felder and Soloman (n.d.), visual learners remember best what they see in pictures, diagrams, video, and demonstrations whereas verbal learners get more from the written and spoken word. Table 13 provides a comparison of visual-verbal learning style categories between the three cases.

Table 13

Cross-case Comparison of Visual-Verbal Learning Style Categories

Cases	Student Percentages Across Learning Categories				
	Strong Visual	Moderate Visual	Balanced	Moderate Verbal	Strong Verbal
Class A	20	45	35	0	0
Class B	17	42	38	4	0
Class C	30	25	40	5	0

The majority of students in all three cases preferred visual rather than verbal learning methods. The researcher analyzed the within-case data for similarities and differences between the three cases for instructional strategies incorporating media appealing to visual learners.

Students in all three cases failed to describe anything particularly visual or interesting about the instructional methods and materials. Even though Class A (flipped active) and Class B (flipped mastery) utilized video media to deliver their instructional content, students stated that the videos were analogous to watching the teacher write on the board and they had no preference for which teacher created the videos. Many of the students who said they preferred a live teacher to the video were not able to articulate a particular reason, just that they wanted more than a video of the teacher's pen and narration. Students in Class C (traditional lecture/homework) described instruction in their classroom as just "working problems" and did not describe any visually stimulating aspects of instruction.

Table 13 also illustrates that a large number of students from Classes A, B, and C are balanced between their visual and verbal preferences for learning. Students who are balanced between visual and verbal learning preferences can learn equally well in both dimensions. Therefore, balanced visual/verbal learners can benefit from learning environments that accommodate for the verbal learning style. According to Felder and Soloman (n.d.), students with verbal learning preferences may benefit from listening and explaining subject content in small groups. Students in Class A and Class B reported satisfaction with the collaborative learning activities they experienced in class. Several students stated that they found it helpful to discuss more difficult mathematics problems with their classmates.

Sequential vs. Global

Sequential learners prefer learning experiences that follows linear steps, with each step following logically from the previous one. Global learners need to see the big picture before focusing on the details (Felder & Soloman, n.d.). Table 14 provides a comparison of sequential-global learning style categories between the three cases.

Table 14

Cross-case Comparison of Sequential-Global Learning Style Categories

Cases	Student Percentages Across Learning Categories				
	Strong Sequential	Moderate Sequential	Balanced	Moderate Global	Strong Global
Class A	5	30	60	5	0
Class B	4	29	63	4	0
Class C	5	20	65	5	5

The majority of students in all three cases preferred balanced sequential-global learning experiences. This balanced sequential-global learning style is confirmed in the interview data with the majority of students indicating that they preferred working procedural problems to word problems, but also indicated that they would be more interested in working all types of problems that had a real-world connection.

Because of the nature of mathematics instruction, the instructional pedagogy of both teachers (Ms. Smith & Ms. Jones) was similar even though each had a different delivery method. Students in Class A (flipped active) complained that the teacher-created videos were sometimes misaligned with classroom practice and assessment, something not mentioned by Class B (flipped mastery), even though the two groups used the same resources. Students in Class C (traditional lecture/homework) were very satisfied with the instructional methods utilized by Ms. Jones but a couple students expressed a desire for more projects and group work to make the class more interesting.

Summary of Findings from Cross-case Analysis

Cross-case analysis revealed that the lived experiences of students in the different learning environments varied widely in terms of how the content was delivered and how students interacted during the face-to-face portion of class. Students in both flipped instruction classrooms (Class A and Class B) experienced a student-centered, active learning environment where they had the freedom to work collaboratively with peers. Students in the traditional classroom (Class C) experienced a much more structured learning environment with little opportunity to collaborate with classmates. In addition to the active learning environment, students in the flipped mastery classroom (Class B) experienced the joys and frustrations of self-regulated, mastery-based pacing where the advantage of retaking tests for a better grade had to be tempered with the constant threat of falling behind. The majority of students in all learning environments expressed satisfaction with the methodology of their class. More students in the Traditional class expressed satisfaction with the manner in which their teacher delivered new content than students in the flipped active or flipped mastery classrooms.

Cross-case analysis also revealed how learning style affected student preference for learning environment. The majority of students in all three cases indicated in their interviews that they preferred working math problems with another person or in small groups so they could actively discuss and explain problem solving procedures as they are learning new information.

Cross-case analysis also revealed that the majority of students in all three learning environments preferred learning new information using well-established methods and disliked being exposed to content not previously covered. This finding correlates with the fact that the learning style preference of students in all three cases was heavily skewed toward balanced/sensing learning styles. The majority of students in all three classes were satisfied with the methods their teachers used to deliver new information. Students in Class A complained that the content of the videos were sometimes misaligned with classroom practice and assessment and were upset when the teacher introduced word problems on assessments that they perceived to cover concepts unfamiliar to them.

Instructional methods and curricular materials in all three groups depended heavily on verbal rather than visual stimuli. There was an absence of interview data that would indicate whether students in the Flipped instruction classes found the videos to be visual stimulating. The majority of those students stated that the teacher-created videos were just pen strokes and narration. The majority of Flipped instruction students had no preference for which teacher created the video and did not describe one teacher's videos as more interesting or visual than the others.

The majority of students in all three groups were balanced sequential/global learners. Balanced sequential/global learners can learn equally well in learning environments that accommodate sequential or global learning strategies. Because math is subject normally taught sequentially, it was not surprising that students in all three learning environments expressed satisfaction with the sequential manner in which the information was presented.

Students in all classes expressed an interest in working more problems with real-world connections. Global learners have a need to discuss and reflect before arriving at their "ah ha!" moment and need to see the "big picture" before understanding the details. Because the majority of students in each of the three classes were balanced sequential/global learners, it is not surprising to find that they had an interest in working problems with real-world connections.

CHAPTER VIII:

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

Introduction

The proliferation of mobile technologies have led many innovative educators to place increased emphasis on providing individualized and personalized instruction through blended learning environments such as the flipped instruction classroom (Brown, 2013). Although the concept of flipped instruction is decades old, it is getting renewed attention as an instructional strategy for using mobile technology to move lecture to asynchronous home viewing, freeing up valuable class time for more active learning strategies and advanced problem-solving projects. This study investigated three unique learning environments, each characterized by a different instructional method: a) flipped instruction utilizing active learning strategies, b) flipped instruction utilizing mastery learning strategies, and c) traditional instruction utilizing lecture/homework learning strategies. Participants included 66 ninth grade Algebra I students and their Algebra I teachers.

Purpose and Design

The purpose of this study was to contribute to the empirical research on the effectiveness of flipped instruction as a pedagogical model for promoting active learning and mastery learning. More specifically, this study was conducted to investigate whether a particular learning environment had a significant effect on student mathematics self-efficacy and student mathematics achievement. The study also sought to understand the lived experiences of teachers and students in the three different learning environments and to understand what affect learning style had on students' preference for a particular learning environment.

This study utilized an explanatory mixed-methods research design. A one-way between groups MANCOVA was conducted to examine the main and interaction effects of the group means on student academic achievement and mathematical self-efficacy while controlling for prior ability. Qualitative methods were used to gain a deeper understanding of the lived experiences of the teachers and students in the three different learning environments and to understand what effect students' learning style had on preference for learning environment. The qualitative portion of the study utilized a multiple case study design that enabled the researcher to analyze interview and observation data to look for common themes across the cases, represented by the three different learning environments. Data collection included individual structured interviews, focus group structured interviews, and direct observation of the three learning environments.

Research Questions and Null Hypotheses

This explanatory mixed-methods study investigated four research questions. Research questions one and two, along with the associated null hypotheses, were investigated using quantitative methods. Research questions three and four were investigated using a qualitative multiple case study design.

> RQ1: How do students in classrooms utilizing flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and traditional Instruction with lecture-homework learning strategies, compare academically on mathematics achievement?
>
> Ho1: There is no statistically significant difference in the mean scores of students participating in classes utilizing varying instructional strategies with respect to mathematics achievement.

RQ2: How do students in classrooms utilizing flipped instruction and active learning strategies, flipped instruction and mastery learning strategies, and traditional Instruction with lecture-homework learning strategies, compare on mathematics self-efficacy?

Ho2: There is no statistically significant difference in the mean scores of students participating in classes utilizing varying instructional strategies with respect to mathematics self-efficacy.

RQ3: How do the lived experiences of students and teachers in the Flipped instruction with active learning strategies, flipped instruction with mastery learning strategies, and Traditional Instruction with lecture-homework learning strategies compare?

RQ4: How do students' learning style affect preferences for learning environment?

Significance of the Study

There is limited research investigating the effect flipped instruction has on the learning environment. There is also limited research on the effectiveness of flipped instruction in the secondary mathematics learning environment and the role it may play in student mathematics achievement or mathematics self-efficacy. Extant research has concentrated primarily on post-secondary classrooms with adult subjects (Armbruster et al., 2009; Mazur, 1991; Lage et al., 2000; Strayer, 2007; Teal, 2008). The findings of this study will inform educators at all levels about the advantages, disadvantages, and challenges of implementing a flipped, blended instructional approach at the secondary level. Findings from this study will also inform post-secondary, pre-service educators by providing information useful in making decisions about effective instructional strategies as they prepare the next generation of educators for the challenges of teaching in a dynamic, technological society.

Quantitative Findings

Quantitative Findings from Achievement Data

A one-way between groups multivariate analysis of covariance (MANCOVA) was utilized to determine the main effects and interaction effects of the three different learning environments on QualityCore® EOC assessment posttest scores after controlling for QualityCore® EOC pretest scores and Mathematics Self-efficacy pretest scores. QualityCore® EOC assessment posttest scores served as the dependent variable. Mathematics Self-efficacy pretest scores and QualityCore® EOC pretest scores served as the multiple covariates. Assumption testing was conducted with no violations.

Students in the Flipped Active group scored higher on the QualityCore® EOC assessment posttest ($M = 147.53$, $SD = 2.9$) than students in the Flipped Mastery ($M = 146.17$, $SD = 2.6$) and students in the Traditional group ($M = 142.33$, $SD = 2.3$). The mean QualityCore® Score of 147 indicated that students in the flipped active group scored at the ACT College Readiness Benchmark Level. The ACT College Readiness Benchmark Level is the minimum score that indicates a 50% chance of obtaining a B or higher grade, or a 75% chance of obtaining a C or higher grade in a first year college Algebra I course (ACT, 2010, p. 10). Students in the flipped mastery group scored 146.17, just below the ACT College Readiness Benchmark Level. Students in the Traditional group scored 142.33. A mean QualityCore® Score of 142 would correlate to a PLAN score range between 14 – 17, well below the ACT College Readiness Benchmark Level of 19 (ACT, 2010, p. 53).

Wilks' lambda was used to test significance of the main effects and interactions. There was a statistically significant difference between the groups on the combined dependent variables, $F(4, 112) = 11.025$, $p < .0005$; Wilks' $\Lambda = .566$; partial $\eta 2 = .247$. There was a statistically significant difference in QualityCore® EOC assessment posttest scores between the students from different learning environments, $F(2, 57) = 116.956$, $p < .05$; partial $\eta 2 = .383$. The value of .383 indicates that 38.3% of the variation was due to the independent variable, learning environment. According to the literature, an effect size of .383 can be considered large.

The large effect size correlates to the dramatic difference in QualityCore® Scores. Students in the flipped active learning environment scored at ACT College Readiness Benchmark Level. Students in the flipped mastery learning environment scored just below ACT College Readiness Benchmark Level. Students in the traditional lecture/homework learning environment scored well below the ACT College Readiness Benchmark Level.

Pairwise comparisons showed that there was a statistically significant difference between the Traditional group and the flipped active group on the QualityCore® EOC assessment posttest ($p < .05$). There was also a statistically significant difference between the traditional group and the flipped mastery group ($p < .05$). There was no statistically significant difference between the flipped active group and the flipped mastery group ($p > .05$). Null hypothesis one is rejected with significant differences existing between the traditional group and both the flipped active and flipped mastery groups. Achievement scores on the QualityCore® EOC assessment posttest were significantly less in the traditional group when controlling for prior ability.

These findings are consistent with the research literature, which suggests that active learning strategies are more effective at promoting increased student achievement than passive traditional instructional methods (Armbruster et al., 2009; Michael, 2006; Prince, 2004, Zappe et al., 2009). These findings are also consistent with research findings stating that mastery learning strategies are more effective at promoting increased academic achievement than traditional instructional methods (Bloom, 1968; Fulton, 2012; Miles, 2010). A search of the literature revealed no studies comparing active learning strategies with mastery learning strategies with traditional instructional methods in terms of student academic achievement.

The flipped active learning environment scored at the ACT College Readiness Benchmark Level on QualityCore® Scores. The flipped mastery learning environment scored less than one point away from the ACT College Readiness Benchmark Level on QualityCore® Scores. These findings, combined with an effect size of .383, are compelling evidence for the effectiveness of flipped instruction at promoting increased academic achievement while controlling for prior ability.

Quantitative Findings from Self-efficacy Data

A one-way between groups multivariate analysis of covariance (MANCOVA) was utilized to determine the main effects and interaction effects of the three different learning environments on Mathematical Self-efficacy Scale-Revised (MSES-R) posttest scores after controlling for QualityCore® EOC pretest scores and MSES-R pretest scores. MSES-R posttest scores served as the dependent variable. Mathematics Self-efficacy pretest scores and QualityCore® EOC pretest scores served as the multiple covariates. Assumption testing was conducted with no violations.

Students in the flipped mastery group scored higher on the MSES-R posttest ($M = 66.8$, $SD = 8.8$) than students in the flipped active group ($M = 64.1$, $SD = 11.2$) and students in the traditional group ($M = 55.05$, $SD = 12.4$). There was a statistically significant difference between the groups on the combined dependent variables, $F (4, 112) = 11.025$, $p < .0005$; Wilks' $\Lambda = .566$; partial $\eta 2 = .247$. There was a statistically significant difference in MSES-R posttest scores between the students from different learning environments, $F (2, 57) = 563.142$, $p<.05$; partial $\eta 2 = .128$. The effect size in this case is .128, indicating that 12.8% of the variation is due to the independent variable, learning environment. According to the literature, an effect size of .128 can be considered small.

Pairwise comparisons showed that there was a statistically significant difference between the Traditional group and the flipped mastery group on the MSES-R posttest ($p < .05$). There was no statistically significant difference between the traditional group and the flipped active group ($p > .05$). There was no statistically significant difference between the flipped active group and the flipped mastery group ($p > .05$).

The null hypothesis is rejected with significant differences existing between the traditional group and the flipped mastery group. MSES-R scores were significantly less in the traditional group when controlling for prior ability.

It can be stated that student mathematics self-efficacy in the flipped mastery group increased significantly compared to student mathematics self-efficacy in the traditional group. This finding is important in light of extant research stating that positive mathematics self-efficacy is a strong predictor of mathematics academic achievement. Multiple studies have shown that students with strong self-efficacy in mathematics correlate to greater academic achievement in mathematics (Bevel, 2010; Fast et al., 2010; Pajares & Miller, 1995; Peters, 2009). This study found that groups with the highest self-efficacy mean scores also had the highest academic mean scores.

Qualitative Findings

Qualitative Findings of Lived Experiences of Teachers and Students

Cross-case analysis revealed several interesting themes about the lived experiences of the teachers and students across the different learning environments. The following section discusses each theme from the perspective of each learning environment represented by the three different cases.

Effect of content delivery in flipped active. Ms. Smith utilized teacher-created video lessons to reverse the location of lecture and homework in the flipped active classroom. Her primary purpose was to move lecture onto an asynchronous video format and use the limited face-to-face time for active learning strategies such as peer-to-peer discussion and problem solving. This reversal of location of content delivery also had the effect of changing the teacher's primary instructional role to facilitation of the learning process. Much of the responsibility for learning was shifted from the teacher to the student, placing the responsible for obtaining the content information prior to class on the student.

Students in the flipped active learning environment appreciated the convenience and flexibility of the video lessons with the majority of students agreeing that watching the videos was analogous to taking notes during lecture. Students liked using the mobile technology supplied by the school to view the teacher-created videos and practice math problems. Several students stated that the videos and online tutorials were easier to understand than the traditional textbook. This finding is consistent with the findings in the research literature that the majority of students were receptive to learning through teacher-created video, believing that the ability to play, pause, rewind, and fast-forward the videos was beneficial to their ability to learn the material and understand the concepts (Gannod, 2007; Toto & Nguyen, 2009; Zappe et al., 2009).

Students had no preference for which teacher created the video, however, several students complained that the videos did not always align perfectly to in-class practice or to assessments. It was beyond the scope of this study to examine all of the video lessons for consistency, but the probability exists that multiple video creators would create sufficient variability among the videos to cause some confusion and frustration among the students.

The major complaint about the method of content delivery expressed by students in the Flipped Active classroom was the inability to ask questions while watching the video. This was consistent with findings by Gannod et al., (2008) who listed the inability of students to ask questions while watching the videos as one of the concerns in the flipped instruction learning environment. Gannod et al. (2008) suggested teachers create a protocol for having students write down their questions, along with the video timestamp, and present those questions for in-class review. Ms. Smith had implemented a protocol for addressing student questions, however, many students still felt that they were missing a vital component of the learning process by not receiving synchronous feedback from the teacher while watching the video lecture. Even though students were aware that they could ask questions the next day, they stated that they either forgot to ask their questions or felt their questions were not adequately addressed in subsequent class meetings.

In addition to obtaining content information from teacher-created videos, Ms. Smith also had her Flipped Active students practice mathematics problems using one of two online tutorials. Students had a choice of using the official online textbook with embedded tutorials or Khan Academy®, a free online tutorial. The majority of students liked using the online tutorial, Khan Academy®, over using the official textbook online tutorial. Printed textbooks were not used in the course.

While the majority of students found the videos and online tutorials helpful, several students expressed a desire for more review of the video content and more individual teacher assistance. Zappe et al. (2009) revealed a similar finding in a study of undergraduate engineering students enrolled in flipped active courses. Over seventy-five percent of students in the study felt that more time needed to be spent at the beginning of class on review of the video lessons prior to active learning strategies (Student Perceptions Section, para. 4) and that the classes should only be delivered in the flipped format about one-half of the time (para 2). Strayer (2007) also found that students in flipped instruction classes were less satisfied with how the structure of the class oriented them to the learning tasks.

Effect of content delivery in the flipped mastery. The major difference between the flipped mastery classroom and the flipped active classroom was the individualization of content delivery and the 80% proficiency requirement for advancement. Students in the flipped mastery classroom watched the same videos as students in the flipped active classroom and the majority agreed that watching the videos was equivalent to listening to a lecture. They enjoyed the technology-rich learning environment and liked the flexibility and convenience afforded by the video lessons and online tutorials.

The major concern for students in the flipped mastery classroom was the constant threat of falling behind, a natural consequence of individualized, mastery learning. Flipped mastery transfers the responsibility for learning the mathematics concepts from the teacher to the student. Some students were more aware of this modification to the learning environment than others. As the end of the semester approached, many of the students who had not adjusted their work ethic to match the rigors of the course became increasingly stressed and eventually frustrated. Student frustration in the Flipped instruction classroom was also observed in a study of undergraduate engineering students by doctoral student, Larry Bland (2006). He noted, “Frustration levels may be higher for some of the students as they are pushed to perform in a new environment” (Conclusion section, para. 2). While the majority of students took advantage of the mastery approach and used the extra time to improve their grades, others took a more leisurely approach and soon found themselves far behind where they should have been.

Effect of content delivery in the traditional. Ms. Jones stated that she taught her classes in the same manner in which she was taught. She utilized direct instruction to create a teacher-centered learning environment where students received all of their instruction during class, and exclusively from her. Technology played no instructional role in the class even though each student was issued a mobile device by the school. Students had an initial exposure to the online tutorial, Khan Academy, but found the format to be foreign and confusing. Ms. Jones suspended the use of the Khan Academy site until such a time that the students could become more comfortable with the format.

Surprisingly, students in the Traditional class were not assigned work at home but were given time in class to practice their math problems. The teacher's rationale was that if she assigned problems to work at home, the students would not have anyone at home to tutor them and they would either fail to do the work, or do it improperly.

All of the students interviewed in the traditional lecture/homework classroom were very satisfied with receiving their mathematics instruction directly from the classroom teacher and with working their practice problems in class, instead of at home. Many expressed that they liked having a "live" teacher to explain to them how to work the problems and answer their questions.

Summary of content delivery across the cases. Studies have shown that video can be as effective as traditional lecture for teaching math skills (Demetriadis & Pombortsis, 2007; Sorrells, 2009). However, students need to be able to ask clarifying questions and receive feedback in a timely manner. Lecture content that has been converted to video format has the advantage of anywhere, any time learning and can be a valuable resource for making up work and review. The students in Class A and Class B assessed the teacher-created lectures and demonstrations as equivalent to face-to-face lectures and demonstrations with the following caveats: a) video content was not always properly aligned to practice and assessment, b) video viewing did not allow for synchronous feedback, c) digital video is more readily accessible to some students than others based on the availability of broadband wireless Internet access.

Students in the flipped active and flipped mastery classes depended heavily on the Khan Academy practice site and preferred it to the online textbook. Some students used the hint feature to show them how to work the math problems but the majority of students in both flipped instruction classes viewed the hint feature as punitive and preferred to solicit the teacher's assistance, a practice which ultimately contributed to the perception of the students that they were not receiving enough individualized teacher assistance.

Students in the traditional class relied exclusively on the classroom teacher for access to all math content and information. Ms. Jones had experimented with using Khan Academy® with her students but suspended the practice after students became frustrated with the service. It is not known whether the students in Traditional class became frustrated because they found the hint feature to be punitive.

Students in the flipped mastery classroom did not have the same complaint about misalignment of the teacher-created videos with classroom practice and assessments as did the students in the flipped active classroom. They also had fewer complaints about the inability to ask questions while watching the video, explained in part by the fact that individualized pacing provided students with the option of watching the video during class where they could ask clarifying questions immediately. Both of these issues may be explained by the fact that students in the flipped mastery class were given the option to watch videos during class and ask clarifying questions. This just-in-time tutoring may explain why students in the flipped mastery class did not have the same complaints about the teacher-created videos as students in the flipped active class.

Finally, it became evident during the interviews that some of the students in the traditional lecture/homework classroom had prior experience in one of the flipped classes offered at the school. Because the study took place during the second semester, some students who were initially enrolled in a flipped class were reassigned into Ms. Jones' traditional class. The students reported scheduling conflicts as the reason for these transfers. Of interest, all of the students with prior experience in a flipped classroom adamantly stated that they preferred the traditional classroom to the flipped classroom. They explained that they preferred a live teacher to a video when learning how to work mathematics problems.

One possible explanation for several students preferring the traditional lecture/homework learning environment over the flipped instruction learning environment is that students who are accustomed to passive, teacher-directed learning environments are uncomfortable when the learning environment is altered, especially if that alteration forces them to work harder and be more responsible for the learning process.

Effect of in-class learning environment in Flipped Active. The in-class learning environment in the Flipped Active classroom was characterized by student-centered, active learning strategies. Students were observed working collaboratively using a wide variety of curricular materials and grouping arrangements. This was consistent with other flipped instruction studies where lecture was moved to homework, thereby freeing up valuable class time for active learning strategies (Alvarez, 2011; Bergmann & Sams, 2012; Gannod, 2007; Kennedy, 2012; Lage et al., 2000; Staker, 2011; Talbert, 2012).

Students in the flipped active classroom enjoyed the freedom and flexibility of the active learning environment. The majority of students, six of nine, stated in their interviews that one of the things they liked best about the format of their class was the freedom to seek assistance, and provide assistance to, and from, classmates. Active learning strategies have been shown to increase student engagement (Armbruster et al., 2009; Prince, 2004). Armbruster et al. (2009)

found significant increases in student course satisfaction scores when students were engaged in collaborative discussions that required application of subject content.

While the majority of students appreciated the relaxed, collaborative nature of the Flipped Active classroom, several students described the level of noise and distraction during class as excessive. According to students, the most disruptive behavior involved off-task students yelling across the room or calling their name. This disruptive behavior interfered with concentration and made it difficult for students to complete their assignments. Kendall (2009) conducted a mixed methods study of eighth grade Algebra I students to investigate where cooperative learning strategies had an effect on student on-off task engagement. She found that off-task behavior for cooperative learning activities decreased over time. The flipped active class was observably the noisiest with a large number of off-task students. This was also the first exposure to active learning strategies for the students in the flipped active class.

Effect of in-class learning environment in Flipped Mastery. Ms. Smith described the in-class learning environment of the flipped mastery classroom as organized chaos. She described her experience in the flipped mastery learning environment as the hardest, yet most rewarding of her teacher career. Ms. Smith was encouraged with level of maturity and responsibility she witnessed in her flipped mastery students, yet concerned that some of her students were not effective self-regulators. Bland (2006) recognized that flipped instruction transfers much of the responsibility for learning to the students but he was optimistic that even though some students were frustrated, learning was being enhanced and class time was being better utilized for more authentic and relevant material that would provide students with life skills that should transcend their schooling and career. This was Ms. Smith’s hope as well and classroom observation and interview data confirmed students increased awareness of self-regulation, self-responsibility, and ownership of the learning process.

If not completing a mastery test, students had the daily option of working independently, in pairs, or in small groups. The classroom was divided down the middle, with students testing on one side of the room and students watching videos and practicing problems on the other. Ms. Smith was a buzz of activity, answering questions, administering assessments, and opening up content on the learning management system.

A major concern among the students interviewed in the flipped mastery class was that they perceived that they did not receive enough individualized teacher assistance. Students complained that the teacher was just too busy to answer their questions and provide them with enough support for them to master the lessons. This finding conflicts with the research literature, which purports that students who are mastering the content do not need the teacher's assistance, therefore almost all of the teacher's in-class time is spent working with struggling learners (Bergmann & Sams, 2012; Cannod et al., 2011). Students working at different rates and on different topics created a difficult situation for the Flipped Mastery teacher when trying to address all of the students' questions in a timely manner. Ms. Smith felt she contributed a significant amount of classroom time to assisting individual students, even more than she had provided to students in traditional classes in the past. Classroom observation confirmed that she spent a large portion of class time assisting students.

The use of the online tutorial, Khan Academy®, may have inadvertently contributed to the students' perception that they were receiving less teacher assistance. The Khan Academy® practice site provided hints to the solutions to math problems upon request. However, it also retarded the students' progress toward mastery of the particular skill whenever they asked for assistance. The intended effect of the hint feature on the Khan Academy® practice site was to provide additional practice for a student that was struggling. However, many students perceived this feature as punitive, prompting them to opt for the teacher's assistance over the tutorial and thereby inadvertently created a situation where an even greater number of students found themselves competing for the teacher's limited attention. Consequently, the perception of many of the students in the flipped mastery classroom was that they did not receive enough individualized teacher assistance. Ms. Smith attempted to address this issue by utilizing peer tutors, but students in both the individual and focus group interviews stated that they did not feel that the peer tutors were able to adequately answer their questions.

Another aspect of the in-class learning environment is the noise level associated with student-centered instruction. Students believed the noise level in the flipped mastery classroom was higher than in their traditional classes but all of the students interviewed agreed that the noise level was manageable. They also stated that the main distraction came from friends soliciting off-task conversation. The majority of students were observed watching videos, practicing problems on Khan Academy® or attempting to master assessments and appeared to be on-task most of the time.

Effect of in-class learning environment in traditional lecture/homework. The in-class learning environment of Class C was the quintessential teacher-directed mathematics classroom with the teacher at the front of the room working problems and giving notes while the students sat quietly in straight rows, occasionally raising their hands to ask a question. Ms. Jones maintained an orderly learning environment and allowed no student-to-student interaction.

Students expressed satisfaction with the orderly, quiet learning environment with only two students suggesting that they might like to see more group or project work. Without exception, students in both the individual and focus group interviews liked the way their teacher instructed the class and felt that the traditional method was the best method for learning the mathematics concepts. The fact that students in the traditional lecture/homework group were just as satisfied with their learning environment as students in the flipped active and flipped mastery groups is supported by Roberts (2001), who found no significant difference in student satisfaction between students taught using active learning strategies and students taught using traditional learning strategies.

Summary of effect of in-class learning environment across cases. Students across the three learning environments expressed satisfaction with their in-class learning environments. Student in Class A (flipped active) and Class B (flipped mastery) appreciated the relaxed, collaborative aspect of the flipped instruction learning environment. They enjoyed working problems and sharing strategies with classmates but stated that the noise level could sometimes be a problem. Most had coping strategies to deal with the distractions of an active learning environment. Students in Class B (flipped mastery) were concerned that they did not receive enough individualized assistance from the teacher. The individualized pacing of the students presented challenges for the teacher in meeting the needs of each individual student. Additionally, features of the online tutorials may have contributed to students seeking additional assistance from the teacher instead of the tutorial. Students in Class C (traditional lecture/homework) appreciated the quiet, orderly learning environment characteristic of a teacher-centered classroom. Students felt that the sequential method of instruction was appropriate to the way they liked to learn Algebra I content.

Qualitative Findings of Student Learning Style Preferences

A cross-case analysis of learning style preferences was conducted to determine which learning environment is best suited to meet the needs of the majority of students in each case. The following section discusses student preferences for learning environment based on accommodations made in each of the three learning environments for the dimensions of each learning domain.

Class A. Characteristics of the flipped active learning environment were favorable to students who preferred active learning strategies. The format of the in-class learning environment provided students the opportunity to participate in a variety of social, collaborative experiences including peer discussion, small group discussion, and group presentation. Students in the Flipped Active learning environment appreciated the freedom they had to move about the classroom seeking and receiving support from classmates and their teacher. Many students described student-to-student interaction as the feature of the class they liked most.

The use of asynchronous video also made the flipped active learning environment appealing to learners with reflective learning preferences. Students were required to watch the teacher-created videos in advance of working practice problems in class, thereby providing students with the ability to rewind and review videos before discussing the algebra content with their classmates. The majority of students stated that the video format gave them a degree of control over the content that they found helpful in learning their algebra lessons.

The sequential nature of algebra instruction favored learners with sensing and sequential learning preferences. Students in the flipped active learning environment described the video lessons as synonymous to teacher lecture, indicating that the video lessons followed the same linear, well-established methods, as typically found in a live teacher lecture. In fact, when some videos deviated from the established norm and presented information that was perceived as misaligned with classroom practice and assessment, students were quick to complain. Strong intuitive and global students would find the presentation of the material, as well as the classroom pedagogy, challenging and possibly frustrating.

Surprisingly, the use of technology and multimedia to present algebra content did little to engage visual learners. Students were largely unimpressed with the videos, not preferring one teacher's videos to the others. One student described them as, "Nothing special, just math." However, the narration in the videos, as well as the in-class collaboration, did provide verbal students with the opportunity to hear algebra concepts being explained. Because students were encouraged, and often required, to work together in pairs or small groups, they had almost daily opportunities to learn verbally.

Class B. Because students in Class B utilized the same teacher-created videos and online tutorials as students in Class A, the characteristics of the flipped mastery learning environment were also favorable to students who preferred active learning strategies. Students worked independently as they attempted to master the algebra content and could choose to work individually or corporately, as the need fit the situation. Because of the independent pacing of the flipped mastery classroom, the learning environment made more accommodations for both the active and reflective learners. As previously mentioned, active learners had daily opportunities to discuss problem solving strategies with their peers but the videos and online tutorials afforded reflective learners the time they needed to process the information prior to discussing what they had learned with other students. The primary dilemma for students in the flipped mastery classroom was one of self-regulation. Social interaction during collaborative study sessions was a constant temptation to engage in off-task behavior, resulting in a lack of adequate progress for many students.

Like Class A (flipped active), the flipped mastery learning environment favored learners with sensing and sequential learning preferences. However, the individualization and personalization of the flipped mastery learning environment permitted more opportunity for innovative problem solving strategies and global learning. Students with strong global learning preferences need to get the “big picture” before the details and specifics make any sense. Because information was made available to the student in complete units, it was possible for global learners to gain a better understanding of the scope of the math information as they mastered the details, something unavailable to students in Class A and Class C.

Class C. The traditional ecture/homework learning environment did not favor active learning strategies because it did not allow for student discussion or collaboration. All interaction was teacher-to-student, with students assuming a passive learning role. Students with reflective learning styles would find the learning environment more conducive to thoughtful, independent problem solving processes. Like Class A and Class B, the nature of mathematics instruction favored the sensing and sequential learners. Ms. Jones’ style of teaching was very much appreciated by the majority of her students. Students perceived her methods to be effective and expressed statements of satisfaction for both the teacher’s instructional methods as well as the learning environment.

Technology played no instructional role in the traditional lecture/homework learning environment. Students did not use the online textbook, nor were they issued a printed textbook. All information came directly from their teacher, consisting of problems and explanations. This learning environment would favor verbal learners to visual learners.

Limitations of the Study

This study was limited to a small sample size and therefore the findings are not generalizable to the population as a whole. The primary reason for the small sample size is the relative scarcity of available learning environments utilizing all three learning environments. Additionally, a single teacher utilizing flipped active, flipped mastery, and traditional lecture/homework learning strategies with three different classes of students at a single location was not available.

Another limitation of the study was the positionality of the researcher. The researcher made every effort to remove personal bias and opinions about instructional strategies and pedagogical practices from the data collection and analysis process, but it is likely that some bias remain. The researcher has prior experience working in learning environments that promote active learning strategies and has worked extensively with classroom teachers on project-based instruction and instructional technology integration.

Conclusions

The findings of this study lead to four major conclusions: 1) active learning strategies are more effective at promoting academic achievement; 2) flipped active and flipped mastery are equally effective at promoting academic achievement; 3) mastery learning leads to increased mathematics self-efficacy; and 4) students are satisfied with all three learning environments.

Active Learning More Effective at Promoting Academic Achievement

The results of this study suggest that active learning strategies are more effective at promoting academic achievement than passive learning strategies. Students in the flipped active and flipped mastery groups experienced active learning strategies while the students in the traditional lecture/homework group experienced passive learning strategies. Students in the flipped active and flipped mastery groups significantly outscored students in the traditional group on mathematics achievement when controlling for prior ability. An effect size of .383, indicated that 38.3% of the variation in the scores could be attributed to the independent variable, learning environment.

The flipped active learning environment scored at the ACT College Readiness Benchmark Level on QualityCore® Scores. The flipped mastery learning environment scored less than one point away from the ACT College Readiness Benchmark Level on QualityCore® Scores. The traditional lecture/homework learning environment scored well below the ACT College Readiness Benchmark Level on QualityCore® Scores. These findings, combined with an effect size of .383, are compelling evidence for the effectiveness of flipped instruction at promoting increased academic achievement while controlling for prior ability.

It is unlikely that simply flipping the location where lecture and homework took place resulted in the significant academic achievement gains demonstrated by the flipped active and flipped mastery groups over the Traditional group. A more likely explanation of these achievement gains can be found in what was going on during the face-to-face portion of each learning environment.

In the flipped active and flipped mastery learning environments, lecture content was moved to asynchronous home viewing. Face-to-face class time was used for social learning through active learning strategies including peer-to-peer and small group discussion. Students in the flipped actives group were required to work collaboratively two days each week and students in the flipped mastery group were encouraged to discuss their solutions to assigned mathematics problems and compare problem-solving strategies. The classroom teacher, Ms. Smith, supported and encouraged students in the flipped active and flipped mastery learning environments to discuss, explain, and tutor each other toward attainment of mathematics goals. Since 90% of the students in the flipped active and 96% of the students in the flipped mastery classes were either strong active, moderate active, or balanced active/reflective learners, it follows that a learning environment that accommodated students' preferred learning style would result in greater gains in academic achievement.

Students in the traditional group did not have the same opportunity to work collaboratively with other students during the face-to-face portion of class. There was no homework assigned and all work was done during class. Additionally, there was no evidence that students in the traditional group sought collaboration with their classmates outside of class.

According to the research literature, active learning strategies are more effective than passive learning strategies. (Armbruster et al., 2009; Zappe et al., 2009; Lage et al., 2000; Bonwell & Eison, 1991). Learning strategies in both the flipped active and flipped mastery learning environments accommodated the active learning preferences of the majority of students in those classrooms.

Flipped Active and Flipped Mastery Equally Effective at Promoting Academic Achievement

The flipped active and flipped mastery learning environments are equally effective at promoting academic achievement. The results of the study found no significant difference between the flipped active group and flipped mastery group on academic achievement when controlling for prior ability. Numerous research studies comparing mastery learning strategies to traditional learning strategies suggest that mastery learning results in significant gains in achievement compared to traditional instructional methods.

One possible reason students in the flipped mastery class did not significantly outscore students in the flipped active class is time, or rather, insufficient time to master all assigned content. Because of repeated attempts toward mastery, many of the students in the flipped mastery class did not have adequate time on the last unit(s) in the Algebra I curriculum. As one student put it, “If you were in the regular class you might not pass a unit but you would have at least seen it.” Time simply ran out for many of the students in the flipped mastery class resulting in mean scores below the students in the flipped active class. Interestingly, there was no significant difference between the flipped mastery and flipped active groups on mathematics achievement even though many of the students in the flipped mastery class did not have adequate time to mastery all the information covered in the QualityCore® EOC posttest.

Mastery Learning Leads to Increased Mathematics Self-efficacy

Mastery learning strategies result in greater mathematics self-efficacy gains than traditional lecture/homework learning strategies. Students in the flipped mastery group significantly outscored students in the Traditional group on mathematics self-efficacy when controlling for prior ability. An effect size of .128, indicated that 12.8% of the variation could be attributed to the independent variable, learning environment. There was no significant difference between the flipped mastery and flipped active groups. There was no significant difference between the flipped active and traditional groups.

It can be stated that student mathematics self-efficacy in the flipped mastery group increased significantly compared to student mathematics self-efficacy in the Traditional group. This finding is important in light of extant research stating that positive mathematics self-efficacy is a strong predictor of mathematics academic achievement. Multiple studies have shown that students with strong self-efficacy in mathematics correlate to greater academic achievement in mathematics (Bevel, 2010; Fast et al., 2010; Pajares & Miller, 1995; Peters, 2009). This study found that groups with the highest self-efficacy mean scores also had the highest academic mean scores.

According to the Bandura's concept of reciprocal determinism, when a student experiences successful attainment of a task or goal, that student's self-efficacy increases. The increase in self-efficacy encourages that student to work harder and persevere longer. The implementation of flipped mastery strategies changed the learning environment by shifting the focus and responsibility of learning from the teacher to the student. This student-centered learning environment shifted the pacing of the curriculum and the accountability for obtaining the subject content to the individual while simultaneously raising the attainment bar to 80% mastery.

Raising the level of attainment to 80% mastery was challenging for most of the students, however, as they successfully mastered their tasks, they began to believe that it was possible to understand mathematics at a higher level. Each subsequent success raised students' mathematics self-efficacy. This was observed in the classroom, as emotional displays of celebration would erupt whenever a unit was mastered.

Flipped mastery learning strategies altered the learning environment of the students by providing opportunities to work at a pace that better matched the students' mathematics aptitude and encouraged ownership of the learning process through required mastery. As students experienced success in achieving mastery of the content, their personal beliefs (self-efficacy) about their ability to work mathematics problems increased. Students with higher mathematics self-efficacy continued to alter the learning environment by raising the expectations and degree of competition in the classroom. As their self-efficacy increased, the students worked harder toward attainment of content mastery and encouraged peers to do the same.

There was no significant difference between the mathematics self-efficacy scores of students in the flipped active group and the flipped mastery group. One possible reason for the no significance finding between the students in the flipped active group and the students in the flipped mastery group is that both groups experienced a change in the learning environment. Active learning strategies accommodated the learning styles of both active and verbal learners. The use of the digitalized curriculum accommodated the learning styles of reflective, intuitive, and global learners. These learning environment accommodations created opportunities for successful attainment of the mathematics curriculum and consequently, increased mathematics self-efficacy in both the flipped active and flipped mastery groups.

Because students in the traditional group did not experience changes in the learning environment that would shift the focus and responsibility of learning to the student, they did not experience increased self-efficacy scores as compared to the flipped mastery and flipped active groups. Students in the traditional group advanced through the curriculum regardless of mastery and both the pacing and responsibility for learning resided exclusively with the classroom teacher. If the students in this learning environment experienced repeated failures to attain mastery, their personal beliefs (self-efficacy) would also be affected. According to Bandura, unsuccessful attainment of a task or goal has the effect of lowering a student's self-efficacy and discourages them from working harder or persisting through difficult problems.

Students Satisfied with All Three Learning Environments

Overall, students in each learning environment expressed satisfaction with their particular learning environment and the method their teacher used to deliver mathematics content. Students in the Traditional group had fewer concerns and complaints about aspects of their learning environment than students in the flipped active and flipped mastery groups and expressed a generally more positive attitude.

Mark Twain was quoted as saying, “The only people who like change are wet babies.” That bit of folksy wisdom may explain why students in the Traditional group had fewer concerns and complaints with their learning environment and the way their teacher delivered mathematics content than students in the flipped active and flipped mastery groups.

Receiving mathematics instruction exclusively from teacher-created video and online tutorials dramatically altered the learning environments of the flipped active and flipped mastery classrooms. This change naturally resulted in some “push back” from the students in these learning environments. Issues with the teacher-created videos and online tutorials that were largely unknown to the classroom teacher, compounded the impact of the change. The resulting effect of these issues was student frustration with a) not being able to ask real-time questions, b) perceived misalignment of video content and in-class practice and assessment, and c) perception of insufficient individualized teacher assistance.

Another change in the learning environments of the flipped active and flipped mastery groups was the shift from teacher-directed to student-centered learning. Students in the flipped active and flipped mastery groups had the additional responsibility to watch and take notes on the video lectures prior to class. They were also responsible for practicing their mathematics problems using the online tutorial. By contrast, students in the traditional group received all of their instruction directly from their teacher and had no responsibility for practicing their mathematics problems outside of class. Ms. Jones (traditional) did not believe her students were capable of correctly working practice problems without out teacher assistance. Consequently, she made them do their homework problems during class.

Students in the flipped mastery group experienced an even greater level of responsibility. In addition to the responsibility for learning mathematics concepts from the videos and practicing the problems using the online tutorials, students in the flipped mastery group were responsible for self-regulation, self-pacing, and mastery of algebra content. This is a huge leap for students just one year removed from the protective and nurturing environment of middle school.

The fact that the satisfaction level of the students in the flipped active and flipped mastery groups was comparable with the satisfaction level of students in the Traditional group is both surprising and remarkable. Fourteen and 15 year old students are not likely to be appreciative of the extra work and additional responsibility placed on them, regardless of the potential gains in mathematics achievement.

Recommendations for Practice

Based on the findings of this study, I recommend that classroom teachers seeking to modify the learning environment of their classroom by implementing flipped instruction consider the following suggestions for instructional practice.

1. Classroom teachers should utilize flipped instruction to make more time during class for active learning strategies that include collaborative elements of discussion and student demonstration of conceptual understanding. Findings from this study showed that active learning strategies may increase student academic achievement while promoting important 21st century skills such as collaboration, communication, and

critical thinking. Equally important, classrooms utilizing active learning strategies may appeal to students with active, verbal, innovative, and global learning styles.

2. Classroom teachers should establish protocols to address students' concerns about receiving information primarily from video lessons and online tutorials. This study revealed that students who learn exclusively from video lessons and online tutorials are denied the ability to ask clarifying, real-time questions. Students either forgot to ask their questions in class or felt that their questions were not answered completely.
3. Classroom teachers should create their own video lectures whenever possible to reduce the likelihood of content misalignment. Classroom teachers are not only encouraged to create their own video lessons but periodically review the video lessons to ensure consistency between what is being taught on the videos with classroom instruction/assessments. This study revealed that students may experience frustration if the video content does not align perfectly with classroom practice and assessment.
4. Classroom teachers should ensure that digitized curricular materials support independent student learning. One of the primary goals of flipped instruction is to free the teacher from lecture so she can focus attention on the students who need the most assistance. In flipped mastery, this has the added benefit of allowing students who do not need assistance to advance through the curriculum unfettered. Teachers will only achieve this goal if the asynchronous learning materials they are making available to their students are of adequate quality and design; encouraging students to seek assistance from the technology and not from the teacher. Findings from this study revealed that the perceived punitive nature of the online tutorial added to the number

of students seeking teacher assistance. Consequently, the teacher was bombarded with numerous questions covering a plethora of topics, making it impossible for her to focus on the students who needed her assistance most. This created the perception that students were not receiving enough teacher assistance. To avoid this situation, teachers need to create and select curricular materials that are effective instructional tools and establish protocols to ensure that students use those instructional tools rather than relying on the classroom teacher.

5. Classroom teachers should implement the appropriate classroom management and formative assessment strategies to ensure that students remain on-task and productive while working collaboratively in the active learning component of the flipped classroom. This study revealed that students are not distracted by other students working productively but are distracted unruly and off-task behavior.
6. Classroom teachers who have experience using flipped instruction to promote active learning strategies should consider adding the mastery component to the flipped instruction blended learning model. Findings from this study revealed that mastery learning increases academic achievement, mathematics self-efficacy, student self-regulation, responsibility, and ownership of the learning process. Teachers utilizing the mastery component of flipped instruction should retain the “second chance” aspect of mastery learning, allowing students multiple opportunities to master subject content, but make modifications to the individualized pacing aspect of the instructional strategy to address the issue of “falling behind.” Teachers should establish hard deadlines for taking mastery assessments, at which time students would

receive their highest attempted score. This is most important for younger, more immature learners who have little experience in courses requiring self-regulation.

7. Classroom teachers should make accommodations to their classroom learning environments to address the needs of all students. The learning environments of this study adequately met the needs of sensing, sequential, reflective and verbal learners but all fell short of accommodating the visual, intuitive, and global learner. Teachers, especially math teachers, should incorporate more visual elements into their lessons, regardless of whether the method of presentation is video or face-to-face. Classroom teachers should also make accommodations for students to use more innovation in the acquisition of knowledge and organize curricular materials to emphasize the "big picture" for students with global learning preferences. Project-based instructional approaches may be one way to meet the needs of intuitors and global learners.

Recommendations for Future Research

Much of the extant research data on flipped instruction involves adult learners, usually in university science, engineering, or business courses. Based on the findings of this study, I recommend researchers consider the following for future investigations into flipped instruction.

1. Future research should investigate the effectiveness of flipped instruction for promoting academic achievement in the middle and high school learning environments. This study focused only on ninth grade participants. More data is needed to determine if age is a contributing factor for successful implementation of Flipped instruction strategies.

2. Future research should investigate the effectiveness of flipped instruction in subject areas other than Algebra I. Researchers should investigate whether one subject area is more amenable to Flipped instruction than others.
3. Future research should investigate the effectiveness of active learning and mastery learning in additional flipped instruction learning environments. This study investigated a flipped instructional approach to alter the learning environments of an Algebra I classroom to promote active learning strategies and another Algebra I classroom to promote mastery learning strategies. The results of this study suggested that providing more collaborative time during class has the effect of increasing student mathematical academic achievement. The study also suggested that mastery learning strategies have the effect of increasing mathematical self-efficacy in Algebra I students. Because of the small sample size, it would be difficult to generalize the findings of this study to the population in general. More data are needed to determine the effectiveness of active and mastery learning environments, specifically in the blended classroom. The data will inform educational experts making important instructional and pedagogical decisions concerning how to prepare the next generation of students to be college and career ready.
4. Future research should use quantitative methods to investigate whether learning style affects students' preference for learning environment. This study used qualitative methods to determine student preference for learning environment based on student interview data. More quantitative data are needed to develop a clearer picture of the role of learning style on student achievement and self-efficacy.

5. Future research should investigate the effectiveness of using visual elements in teacher-created videos. This study revealed that the teacher-created videos were primarily procedural with little use of images, diagrams, or other graphics. Researchers should investigate whether the incorporation of visual elements into the Flipped instruction videos has an effect on student mathematics achievement.

Summary

This study utilized an explanatory mixed-methods research design to investigate the effect of learning environment on student mathematics achievement and mathematics self-efficacy in a ninth grade Algebra I classroom. This study also sought to understand the lived experiences of teachers and students in the flipped active, flipped mastery, and traditional lecture/homework learning environments and to understand whether learning style preference affected preference for learning environment.

The study revealed that 1) students in the flipped active and flipped mastery learning environments scored significantly higher on mathematics achievement than students in the traditional lecture/homework learning environment, and 2) students in the flipped mastery learning environment scored significantly higher on mathematics self-efficacy than students in the Traditional Lecture/homework learning environment.

Students in both the flipped active and flipped mastery learning environments appreciated the level of control over the learning process but were dissatisfied by the inability to ask real-time questions. Students in the flipped mastery learning environment enjoyed working at an individualistic pace but struggled with falling behind.

Learning style did influence students' preference for learning environment. Students preferring active learning experiences expressed satisfaction with both the flipped active and flipped mastery learning environments. Students in the flipped active and flipped mastery learning environments perceived collaborative problem-solving more enjoyable and more effective than working alone. Actively discussing and explaining mathematics problems also had benefits for verbal learners in the flipped active and flipped mastery learning environments.

Students who preferred sequential, sensing, and verbal learning styles expressed the greatest satisfaction with the traditional learning environment but also expressed satisfaction with the flipped active and flipped mastery learning environments. This finding is possibly due to the sequential, orderly nature of mathematics instruction in general. There exists the potential for student accommodation of learning style in both the flipped active and flipped mastery learning environments. Students with innovative and global learning preferences could make their own accommodations through manipulation of the video lessons to modify the pacing and sequence of learning. This study revealed some students using innovative strategies to accommodate their global and intuitive learning styles.

REFERENCES

ACT. (2009a). The condition of college & career readiness: 2009. Iowa City, IA: ACT, Inc.

ACT. (2010b). The condition of college & career readiness: 2010. Iowa City, IA: ACT, Inc.

ACT. (2011c). The condition of college & career readiness: 2011. Iowa City, IA: ACT, Inc.

ACT. (2010). *QualityCore® technical manual*. Iowa City, IA: ACT, Inc.

ACT & The Education Trust. (2005). *On course for success: A close look at selected high school courses that prepare all students for college and work*. Iowa City, IA: Author.

Alabama State Department of Education. (2011). Alsde reports by site. Retrieved from http://www.alsde.edu/home/Reports/ReportsBySite.aspx

Alvarez, B. (2011). Flipping the classroom: Homework in class, lessons at home. Retrieved from http://neapriorityschools.org/successful-students/flipping-the-classroom-homework-in-class-lessons-at-home-2

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivational processes. *Journal of Educational Psychology*, *80* (3), 260-267.

Armbruster, P., Patel, M., Johnson, E., & Weiss, M. (2009). Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. *Life Sciences Education*, *8*, 203-213.

Bandura. A., (1977). Self efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (2006). Adolescent development from an agentic perspective. In F. Pajares & T. Urdan (Eds.), Self-efficacy beliefs of adolescents (pp. 1-43).

Barkley, B.W. (2010). The effects of blended online versus face-to-face learning environments on student outcomes for eighth grade algebra I students. (Doctoral dissertation). Retrieved from ProQuest. 3413019

Barone, C. A. (2003). Technology and the changing teaching and learning landscape: Meeting the needs of today's internet-defined students. *AAHE Bulletin*, *55*(9), Retrieved from http://www.aahea.org/articles/educause.htm

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544-559. Retrieved from http://www.nova.edu/ssss/QR/QR13-4/baxter.pdf

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Alexandria, VA: International Society for Technology in Education.

Berrett, D. (2012). How flipping the classroom can improve the traditional lecture. *Chronicle of Higher Education*, *58*, (25) 00095982

Betz, N.E. & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior*, *23*, 329-345.

Bevel, R. K. (2010). The effects of academic optimism on student achievement in Alabama. (Doctoral dissertation). Retrieved from ProQuest. 3409002

Bland, L. (2006). Applying flipped/inverted classroom model to engineering to life long learning. In Proceedings of the ASEE Annual Conference & Exposition. Chicago, Illinois.

Bloom, B. S. (1968). Learning for mastery. *Evaluation Comment*, *1*(2), 1-12. Retrieved from http://ruby.fgcu.edu/courses/ikohn/summer/PDFfiles/LearnMastery2.pdf

Bloom, B. S. (1984). The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher*, *13*(6). 4-16.

Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom. *ERIC Clearinghouse on Higher Education*, doi: ED340272

Brown, E. (2013). Schools increase access to mobile devices for learning. *Education Daily*, *46* (106), 1.

Bruner, J. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.

Bruner, J. (1985). Models of the learner. *Educational Researcher*, *14*(6), 5-8. Retrieved from http://www.jstor.org/stable/1174162

Bushweller, K. (2011). Navigating the path to personalized education. *Education Week*, *30*(25), 20-22. Retrieved from http://www.edweek.org/ew/articles/2011/03/17/25ileap.h30.html

Carlisle, M. C. (2010). In G. Lewandowski (Chair).Using Youtube to enhance student participation in an introductory Java course. Paper presented at 41st ACM Technical Symposium on Computer Science Education. doi: 10.1145/1734263.1734419

Center on Education Policy. (2007). Choices, changes, and challenges: Curriculum and instruction in the NCLB era. Washington, DC: Author.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, *39*(7), 3-7. Retrieved from http://www.aahea.org/articles/sevenprinciples1987.htm

Cohen, J. (1988). *Statistical power analysis for the behavior sciences.* Hillsdale, NJ: Erlbaum.

Condie, R., & Livingston, K. (2007). Blending online learning with traditional approaches: Changing practices. *British Journal of Educational Technology*, *38*(2), 337-348. doi: 10.1111/j.1467-8535.2006.00630.x

Cooperman, R. (2011). Mastery learning in the adult classroom. *T+D*, *65*(6), 52.

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* (3rd ed.). New Jersey: Prentice Hall.

Creswell, J.W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches.* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Crouch, C., Watkins, J., Fagen, A., & Mazur, E. (2007). Peer instruction: Engaging students one-on-one, all at once. In Research-Based Reform of University Physics (1). Retrieved from http://www.compadre.org/Repository/document/ServeFile.cfm?ID=4990&DocID=241

Cuban, L. (1993). Computer meets classroom: Classroom wins. *Teachers College Record. 95*(2). 185-210. Retrieved from http://www.tcrecord.org

Davis, M. R. (2011). Schools use digital tools to customize education. *Education Week*, *30*(25), 10-11. Retrieved from http://www.edweek.org/ew/articles/2011/03/17/25overview.h30.html

Demetriadis, S., & Pombortsis, A. (2007). E-Lectures for flexible learning: A study on their learning efficiency. *Journal of Educational Technology & Society*, *10*(2), 147-157.

Draper, R. J. (1997). Active learning in mathematics: Desktop teaching. *Mathematics Teacher*, *90*, 622.

Dziuban, C., Moskal, P., & Hartman, J. (2005). Higher education, blended learning and the generations: Knowledge is power—no more. In J. Bourne & J. C. Moore (Eds.), Elements of quality online education: Engaging communities. Needham, MA: Sloan Center for Online Education.

Elder, S. ILO, (2010). Global employment trends for youth august 2010: Special issue on the impact of the global economic crisis on youth. Retrieved from International Labour Office website: http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_elm/---trends/documents/publication/wcms_143349.pdf

Fast, L.A., Lewis, J.L., Bryant, M.J., Bocian, K.A., Cardulio, R.A., (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *Journal of Educational Psychology*, *102* (3), 729-740.

Felder, R.M., and Soloman, B.A. (n.d.). Index of learning styles. Retrieved from http://www.ncsu.edu/felder-public/ILSpage.html

Felder, R.M., and Soloman, B.A. (n.d.). Learning styles and strategies. Retrieved from http://www.ncsu.edu/felder-public/ILSdir/styles.htm

Felder, R.M., & Spurlin, J. (2005). Applications, reliability, and validity of the index of learning styles. *International Journal of Engineering Education*, *21*, (1) 102-112.

Fischer, G. F. (2011). School reform for 21st-century skills under the No Child Left Behind Act accountability system: Perceptions of superintendents. (Doctoral dissertation). Retrieved from ProQuest. 3452788

Fulton, K. (2012). The flipped classroom: Transforming education at Byron high school. *T H E Journal, 39*(3), 18.

Gannod, G. C. (2007). Work in progress: Using podcasting in an inverted classroom. Paper presented at Annual Frontiers in Education Conference, Milwaukee, WI.

Gannod, G. C., Burge, J. E., & Helmick, M. T. (2008). Using the inverted classroom to teach software engineering (Technical Report No. MU-SEAS-CSA-2007-001). Oxford, OH: Miami University.

Gribbons, B. & Herman, J. (1997). True and quasi-experimental designs. *Practical Assessment, Research & Evaluation*, *5*(14). Retrieved July 25, 2013 from http://PAREonline.net/getvn.asp?v=5&n=14

Gillham, B. (2000). *Case study research methods*. (4th ed., p. 11). New York, NY: Continuum.

Grey, A.C. (2009). No Child Left Behind in art education policy: A review of key recommendations for arts language revisions. *Arts Education Policy Review*, *111*(1), 8-15.

Guilfoyle, C. (2006). NCLB: Is there life beyond testing? *Educational Leadership*, *64*(3), 8-13.

Hergenhahn, B. R., & Olson, M. H. (2005). *An introduction to theories of learning*. Upper

Saddle River, NJ: Prentice Hall.

Horn, M. B., & Staker, H. (2011). *The rise of k-12 blended learning*. Mountain View, CA: Innosight Institution. Retrieved from http://www.innosightinstitute.org/media-room/publications/education-publications/the-rise-of-k-12-blended-learning

Hu, W. (2011, January 11). Math that moves: Schools embrace the ipad. *The New York Times*. Retrieved from http://www.nytimes.com/2011/01/05/education/05tablets.html?pagewanted=all

Kellogg, S. (2009, October). Developing online materials to facilitate an inverted classroom. Paper presented at Annual Frontiers in Education Conference, San Antonio, Tx.

Kaner, C., & Fiedler, R. (2005). Blended learning: A software testing course makeover. 11th Sloan-C International Conference on Asynchronous Learning Networks, Orlando, FL.

Keefe, J., & Jenkins, J. (2002). Personalized instruction. *Phi Delta Kappan*, *83*(6), 440-448. Retrieved from http://www.kappanmagazine.org/content/83/6/440.abstract

Kendall, M. H. (2009). A case study of the effects of classroom management of cooperative learning on students on-off task engagement in five high school mathematics classrooms. (Doctoral dissertation). Retrieved from ProQuest. 3462835

Kennedy, M. (2012). Left to their own devices. (2012). *American School & University*, *84*(9), 34.

Khan, S. (2012). Khan academy. Retrieved from www.khanacademy.org

Koller, D. (2011, December 6). Death knell for the lecture: Technology as a passport to personalized education. *The New York Times*. Retrieved from http://www.nytimes.com

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*, *31*(1), 30-43. Retrieved from http://www.journalofeconed.org

Lund, A. & Lund, M. (2012). One-way ANOVA using SPSS. Retrieved from https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php

Lyman, B. (2013, June 22). Alabama gets waiver from no child left behind. *Montgomery Advertiser*. Retrieved from http://www.montgomeryadvertiser.com/article/20130622/NEWS02/306210020/Alabama-gets-waiver-from-No-Child-Left-Behind

Marlowe, B. A., & Page, M. L. (2005).*Creating and sustaining the constructivist classroom*. Thousand Oaks, CA: Corwin Press.

Mazur, E. (1991). Can we teach computers to teach? *Computers in Physics*, *57*, 31-38. Retrieved from http://mazur.harvard.edu/sentFiles/Mazur_256459.pdf

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K., (2010). Office of Planning, Evaluation, and Policy Development. Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies. Retrieved from U.S. Department of Education website: www.ed.gov/about/offices/list/opepd/ppss/reports.html

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass.

Merriam, S.B. (2002). *Introduction to qualitative research*. San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2010). *Qualitative research in practice: Examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

Michael, J. (2006). Where's the evidence that active learning works? *Advances in Physiology Education*, *30*, 159-167. doi: 10.1152/advan.00053.2006

Miles, K.S. (2010). Mastery learning and academic achievement. (Doctoral dissertation). Retrieved from ProQuest. 3398236

Moos, R. H. (1973). Conceptualizations of human environments. *American Psychologist*, *28* (8), 652-665. doi:10.1037/h0035722

Moseley, B. (2012, May 25). Alabama Ahead Act signed by Governor Bentley. Retrieved from http://alreporter.com/archives/285-week-may-21-25/2183-alabama-ahead-act-signed-by-governor-bentley.html

National Commission on Excellence in Education (NCEE). (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: U.S. Department of Education.

National Governors Association Center for Best Practices, & Council of Chief State School Officers, (2010). *Common core states standards*. Washington, D.C.: National Governors Association Center for Best Practices, Council of Chief State School Officers. Retrieved from http://www.corestandards.org

No Child Left Behind Act of 2001, 20 U.S.C. 6301 (2002).

Noonoo, S. (2012). Flipped founders set the record straight. *T.H.E. Journal*, 1-4. Retrieved from http://thejournal.com/Articles/2012/06/20/Flipped-learning-founders-q-and-a.aspx?Page=1

Novak, G. (2006). Just in time teaching. Retrieved from http://jittdl.physics.iupui.edu/jitt/what.html

O'Brien, M.E. & Hart, S.J. (1999). Action learning: The link between academia and industry? *Educational Research*, *41*:1, 77-89 10.1080/0013188990410107

Obringer, S. J., Coffey, K. (2007). Cell phones in American high schools: A national survey. *The Journal of Technology Studies*, *31*(1), 41-47.

Pajares, F., & Kranzler, J. (1994). Self-efficacy, self-concept, and general mental ability in mathematical problem-solving. *Florida Educational Research Council Research Bulletin*, *26*, 8-32.

Pajares, F., & Miller, M. D. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology*, *42*, 190-198.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*. *66*(4). (pp. 543-578).

Pallant, J. (2007). *SPSS survival guide*. (3rd ed.). Berkshire, England: Open University Press.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. (3rd ed.). Thousand Oaks, CA: Sage.

Peters, M. (2009). The influence of classroom climate on students' mathematical self-efficacy and achievement: A multi-level analysis. (Doctoral dissertation). Retrieved from ProQuest. 3349646.

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223-231.

Roberts, P. (2001). The effects on community college student achievement and satisfaction using active versus passive teaching methodologies. (Doctoral dissertation). Retrieved from ProQuest. 3013896

Robinson, K. (2011). *Out of our minds: Learning to be creative*. (2nd ed.). West Sussex, United Kingdom: Capstone

Rozycki, W. (1999). Just in time teaching. *Research & Creative Activity*, *22*(1), Retrieved from http://www.indiana.edu/~rcapub/v22n1/p08.html

Ruhl, K., Hughes, C. & Schloss, P. (1987). Using the pause procedure to enhance lecture recall. *Teacher Education and Special Education*, *10*, 14-18.

Salpeter, J. (2003). 21st century skills: Will our students be prepared? *Technology & Learning*, *24*(3), 17-26.

Sezer, R. (2010). Pulling out all the stops. *Education*, *130*(3), 416-423.

Schunk, D.H. (1983). Progress self-monitoring: Effects on children's self-efficacy and achievement. *Journal of Experimental Education*, *51*, 89–93.

Schunk, D. H. & Meece, J.L. (2005). Self-efficacy development in adolescences. In F. Pajares & T. Urdan (Eds.), Self-efficacy beliefs of adolescents. 71-96.

Sorrells, R. D. (2009). Relationships between student achievement and use of power videos digital education videos. (Doctoral dissertation). Retrieved from ProQuest. 3411421

Speak Up National Findings. (2013). *Project tomorrow: From chalkboards to tablets*. Retrieved from http://www.tomorrow.org/speakup/speakup_reports.html

Stake, R. (2006). *Multiple case study analysis*. New York, NY: The Guilford Press.

Staker, H. (2011). *The rise of k-12 blended learning: Profiles of emerging models*. Mountain View, California: Innosight Institution. Retrieved from http://www.innosightinstitute.org/innosight/wp-content/uploads/2011/05/The-Rise-of-K-12-Blended-Learning.pdf

Stephens, W. (2013). Bring your own excitement. *Library Media Connection*, *31*(4), 12.

Strayer, J. (2007). The effects of the classroom flip on the learning environment: A comparison of learning activity in a tradtional classroom and a flip classroom that used an intelligent tutoring system. (Doctoral dissertation). Retreived from ProQuest. 3279789

Talbert, R. (2012). Inverted classroom. *Colleagues 9* (1). Retrieved from http://scholarworks.gvsu.edu/colleagues/vol9/iss1/7

Tabachnick, B., & Fidell, L. (2001). *Using multivariate statistics*. (4th ed.). Needham Heights, MA: Allyn & Bacon.

Teal, B. (2008). A comparative analysis of modes of instruction using student test scores in developmental mathematics. (Doctoral dissertation). Dissertation Abstracts International Section A, 69.

The Whitehouse, Office of the Press Secretary. (2011). State of the union address. Retrieved from http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address

Toto, R., & Nguyen, H. (2009, October). Flipping the work design in an industrial engineering course. Paper presented at *Annual Frontiers in Education Conference*, San Antonio, TX.

Trochim, W. M. K. (2006). Research methods knowledge base. Retrieved from http://www.socialresearchmethods.net/kb/intmult.php

U.S. Department of Education. Office of Educational Technology. (2000). The national technology education plan. e-learning: Putting a world-class education at the fingertips of all children. Washington, DC: U.S. Government Printing Office. Retrieved from http://www.ed.gov/about/offices/list/os/technology/reports/e-learning.pdf

U.S. Department of Education, Office of Educational Technology. (2010). National education technology plan: Transforming American education: Learning powered by technology. Retrieved from Education Publications Center website: http://www.ed.gov/sites/default/files/netp2010-execsumm.pdf

U.S. Department of Education, (2012). ESEA flexibility. Retrieved from http://www.ed.gov/esea/flexibility

Wang, F. & Reeves, T.C. (2003). Why do teachers need to use technology in their classrooms? Issues, problems, and solutions. *Computers in the Schools*, *20* (4), 49-65.

Walker high school. (2013). Retrieved from http://www.greatschools.org

Walter-Perez, N. and Dong, J. (2012). "Flipping the classroom: How to embed inquiry and design projects into a digital engineering lecture," in Proceedings of the *American Society for Engineering Education (ASEE) PSW Section Conference*. San Luis Obispo, CA.

Watson, J., (2008). *Blended learning: The convergence of online and face-to-face education*. Vienna, VA: North American Council for Online Learning.

Weltman, D., & Whiteside, M. (2010). Comparing the effectiveness of traditional and active learning methods in business statistics: Convergence to the mean. *Journal of Statistics Education, 18*(1), 1-13.

White, A. G. (2009). Ninth and tenth grade students' mathematical self-efficacy beliefs: The sources and relationships to teacher classroom interpersonal behaviors. (Doctoral dissertation). Retrieved from ProQuest. 3390654

Yin, R. K. (2009). *Case study research: Design and methods*. Thousand Oaks, CA: Sage Inc.

Zappe, S., Leicht, R., Messner, J., Litzinger, T., and Lee, H.W. (2009) "'Flipping' the classroom to explore active learning in a large undergraduate course," Proceedings, American Society for Engineering Education Annual Conference & Exhibition, Austin, TX.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Education Research Journal*, *29*(3), 663-676. doi: 10.3102/00028312029003663

Zimmerman, B. J., & Cleary, T. J. (2006). Adolescents' development of personal agency: The role of self-efficacy beliefs and self-regulatory skill. In F. Pajares & T. Urdan (Eds.), Self-efficacy beliefs of adolescents (pp. 45-69).

APPENDIX A

ACT QUALITYCORE® EOC ASSESSMENT

Name: Date:
Teacher: Class/Period:

1) Which expression is equivalent to
$2x + 3y - 5x^2 - 10y + 7x^2$?

A. $4x^2 - 7y$

B. $2x^2 + 2x - 7y$

C. $2x^2 - 5xy$

D. $2x + 13y + 12x^2$

2) Which expression is equivalent to $(x + 8)(x - 7)$?

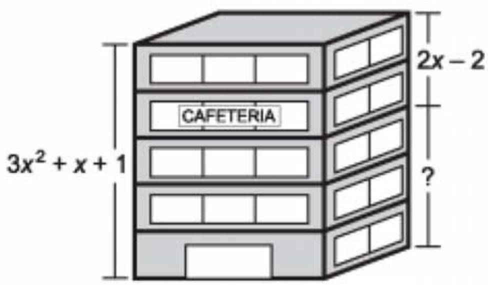
A. $(7 - x)(8 + x)$

B. $(8 + x)(7 - x)$

C. $-(7 - x)(x + 8)$

D. $-7x(x + 8)(x + 8)$

3) Kane made this model of an office building.



The expression $3x^2 + x + 1$ represents the total height of the building. The expression $2x - 2$ represents the distance between the top of the building and the floor of the cafeteria. How high is the floor of the cafeteria from the ground?

A. $3x^2 - x + 3$

B. $3x^2 - x - 1$

C. $3x^2 - 3x - 2$

D. $3x^2 + x - 3$

7) Evaluate this expression for $x = \frac{1}{2}$ and $y = \frac{1}{3}$:

$$x^2y - (x^2 - y^2) + xy^2$$

A. 0

B. $\frac{1}{23}$

C. $\frac{2}{35}$

D. $\frac{2}{9}$

8) In a class of x students, y% chose reading as their main hobby. Which expression represents the number of students who did not choose reading as their main hobby?

A. $x(1 - y)$

B. $\frac{xy}{100}$

C. $1 - \frac{xy}{100}$

D. $x(1 - \frac{y}{100})$

9) Which expression is equivalent to $(a + b)(x - y) - (a - b)(x + y)$?

A. $-2by$

B. $2b(x - y)$

C. $-2(ay - bx)$

D. $2(bx - ay) - by$

10) What is the product of $x + 2y + z$ and $2z^2 + 1$?

A. $x + 2y + 2z^3 + 1$

B. $2xz^2 + 4yz^2 + 2z^3 + 1$

C. $2xz^2 + 4yz^2 + 2z^3 + x + 2y + z$

D. $2xz^2 + 4yz^2 + 2z^2 + x + 2y + z$

17) These stem-and-leaf plots compare the number of tennis racquets targeted for production by a manufacturing unit in 8 weeks to the actual number produced.

	targeted
5	2 6 9
6	0 0 4 5 7

	actual
5	2 4 6
6	0 0 1 2 7

Based on the data, which statement is true about the actual number of racquets produced compared to the targeted number?

A. The median is higher.

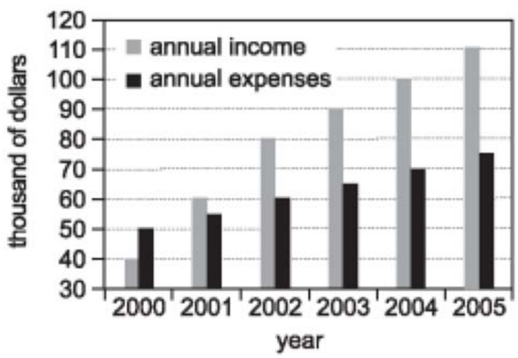
B. The range is lower.

C. The mean is lower.

D. The mode is higher.

18) This graph shows a company's income and expenses over a 6-year period.

Income and Expenses



Profit percentage is based on annual income. Use information from the graph to determine a reasonable approximation of the profit percentage the company made in 2006.

A. 150%

B. 145%

C. 50%

D. 33%

20) Clara joins small square pieces of cloth to make a border for a blanket. The number of pieces of cloth increases with the length of the border, as shown.

Which equation best describes the relationship between the number of square pieces, n, and the length of the border, b ?

A. $n = 2b - 1$

B. $n = 2^b - 1$

C. $n = b^2 + 1$

D. $n = b + 1$

21) Sam needs to completely factor the expression $3x^5 - 4x^2 + 7x^5 - x^2$. He factors the expression as shown.

Step 1	$3x^5 - 4x^2 + 7x^5 - x^2$
Step 2	$3x^5 - 7x^5 + 4x^2 - x^2$
Step 3	$-4x^{10} + 3x^4$
Step 4	$x^4\left(-4x^{\frac{5}{2}} + 3\right)$

A. Explain what Sam did incorrectly.

B. Completely factor the expression. Show your work algebraically.

Roster Report by Subscore

SCHOOL FINAL QUALITYCORE REPORT: Algebra I

Test Date: 12/2007-11/2009
Sub-district: Demo Sub-District
State: Demo State

QualityCore: Algebra I
District: Demo District

School: Demo School #1
Region: Demo Region

Export Report

Teacher/Group /Student	Student ID	Avg. Final QualityCore Score	Exploring Expressions, Equations, and Functions in the First Degree	Exploring Other Nonlinear Equations and Functions	Exploring Quadratic Equations and Functions	Number Sense, Operation and Graph Skills	# of Students
Ortiz, Michelle							
Ortiz Alg I School 1 Period One							
Baldwin, Michael		165	27	11	10	15	1
Chang, Sharon		155	13	11	13	10	1
Cortez, Lorna		164	26	11	11	14	1
Nguyen, Hiep		160	18	12	14	12	1
Perez, Miguel		159	21	12	14	8	1
Smith, Edward		145	4	8	12	4	1
Tapahonso, Sheri		150	9	10	12	7	1
Torrence, Shauna		171	27	12	14	15	1
Group Average		**159**	**18**	**11**	**13**	**11**	**8**
Overall Group Average		**159**	**18**	**11**	**13**	**11**	**8**
Chu, Amy							
Chu Alg I School 1 S1							
Baldwin, Michael		153	26	8	9	0	1
Chang, Sharon		169	25	12	14	16	1
Cortez, Lorna		150	11	6	4	16	1
Nguyen, Hiep		158	20	9	13	11	1
Perez, Miguel		149	18	5	7	5	1
Smith, Edward		167	25	11	13	16	1
Tapahonso, Sheri		162	19	12	14	14	1
Torrence, Shauna		148	12	8	5	9	1
Group Average		**157**	**20**	**9**	**10**	**11**	**8**

APPENDIX B

MATHEMATICS SELF-EFFICACY SCALE-REVISED (MSES-R) QUESTIONNAIRE

Mathematics Self-Efficacy Scale-Revised

This is a survey designed to measure how confident you feel about your ability to solve math word problems. The survey is anonymous so please do not place your name or any identifying marks on the paper.

Example: Each adult needed 5 yards of shoelace for the trip to California and each child needed 3 yards. A certain family with seven children needed 71 yards of shoelace. How many adults were in the family?

1	2	3	4	5

Not at all Confident ---Completely Confident

IMPORTANT: PLEASE DO NOT ATTEMPT TO SOLVE THE PROBLEMS.

Please indicate how confident you are that you can solve the math problem by circling the appropriate number in the scale.

1. In a certain triangle, the shortest side is 6 inches. The longest side is twice as long as the shortest side, and the third side is 3.4 inches shorter than the longest side. What is the sum of the three sides in inches? 1 2 3 4 5

2. About how many times larger than 614,360 is 30,668,000? 1 2 3 4 5

3. There are three numbers. The second is twice the first and the first is one-third of the other number. Their sum is 48. Find the largest number. 1 2 3 4 5

4. Five points are on a line. T is next to G. K is next to H. C is next to T. H is next to G. Determine the positions of the points along the line. 1 2 3 4 5

5. If y = 9 + x/5, find x when y = 10. 1 2 3 4 5

6. A baseball player got two hits for three times at bat. This could be represented by 2/3. Which decimal would most closely represent this? 1 2 3 4 5

7. If P = M + N, then which of the following will be true? 1 2 3 4 5
   a. N = P – M b. P - N = M c. N + M = P

8. The hands of a clock form an obtuse angle at ____ o'clock. 1 2 3 4 5

9. Bridget buys a packet containing 9-cent and 13-cent stamps for $2.65. If there are 25 stamps in the packet, how many are 13-cent stamps? 1 2 3 4 5

10. On a certain map, 7/8 inch represents 200 miles. How far apart are two towns whose distance apart on the map is 3 1/2 inches? 1 2 3 4 5

11. Fred's bill for some household supplies was $13.64. If he paid for the items with a $20 bill, how much change should he receive? 1 2 3 4 5

12. Some people suggest that the following formula be used to determine the average weight for boys between the ages of 1 and 7: 1 2 3 4 5

W = 17 + 5A where W is the weight in pounds and A is the boy's age in years.

According to this formula, for each year older a boy gets, should his weight become more or less, and by how much?

13. Five spelling tests are to be given to Mary's class. Each test has a value of 25 points. Mary's average for the first four tests is 15. What is the highest possible average she can have on all five tests? 1 2 3 4 5

14. 3 4/5 - 1/2 = _____ 1 2 3 4 5

15. In an auditorium, the chairs are usually arranged so that there are x rows and y seats in a row. For a popular speaker, an extra row is added, and an extra seat is added to every row. Thus, there are x + 1 rows and y + 1 seats in each row, and there will be (x + 1) and (y + 1) seats in the auditorium. Multiply (x + 1) (y + 1). 1 2 3 4 5

16. A ferris wheel measures 80 feet in circumference. The distance on the circle between two of the seats is 10 feet. Find the measure in degrees of the central angle SOT whose rays support the two seats. 1 2 3 4 5

17. Set up the problem to be done to find the number asked for in the expression "six less than twice 4 5/6"? 1 2 3 4 5

18. The two triangles shown on the right are similar. Thus, the corresponding sides are proportional, and AC / BD = XZ / YZ If AC = 1.7, BC = 2, and XZ = 5.1, find YZ. 1 2 3 4 5

APPENDIX C

LEARNING STYLES AND THE INDEX OF LEARNING STYLES QUESTIONNAIRE (ILS)

Index of Learning Styles Questionnaire

Directions

Student Code provided by Researcher

For each of the 44 questions below select either "a" or "b" to indicate your answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently. When you are finished selecting answers to each question please select the submit button at the end of the form.

1. I understand something better after I
   - **(a)** try it out.
   - **(b)** think it through.
2. I would rather be considered
   - **(a)** realistic.
   - **(b)** innovative.
3. When I think about what I did yesterday, I am most likely to get
   - **(a)** a picture.
   - **(b)** words.
4. I tend to
   - **(a)** understand details of a subject but may be fuzzy about its overall structure.
   - **(b)** understand the overall structure but may be fuzzy about details.
5. When I am learning something new, it helps me to
   - **(a)** talk about it.
   - **(b)** think about it.
6. If I were a teacher, I would rather teach a course
   - **(a)** that deals with facts and real life situations.
   - **(b)** that deals with ideas and theories.
7. I prefer to get new information in
   - **(a)** pictures, diagrams, graphs, or maps.
   - **(b)** written directions or verbal information.

8. Once I understand

(a) all the parts, I understand the whole thing.

(b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to

   (a) jump in and contribute ideas.

   (b) sit back and listen.

10. I find it easier

    (a) to learn facts.

    (b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to

    (a) look over the pictures and charts carefully.

    (b) focus on the written text.

12. When I solve math problems

    (a) I usually work my way to the solutions one step at a time.

    (b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken

    (a) I have usually gotten to know many of the students.

    (b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer

    (a) something that teaches me new facts or tells me how to do something.

    (b) something that gives me new ideas to think about.

15. I like teachers

    (a) who put a lot of diagrams on the board.

    (b) who spend a lot of time explaining.

16. When I'm analyzing a story or a novel

    (a) I think of the incidents and try to put them together to figure out the themes.

    (b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to

    (a) start working on the solution immediately.

    (b) try to fully understand the problem first.

18. I prefer the idea of

☐ **(a)** certainty.

☐ **(b)** theory.

19. I remember best

☐ **(a)** what I see.

☐ **(b)** what I hear.

20. It is more important to me that an instructor

☐ **(a)** lay out the material in clear sequential steps.

☐ **(b)** give me an overall picture and relate the material to other subjects.

21. I prefer to study

☐ **(a)** in a study group.

☐ **(b)** alone.

22. I am more likely to be considered

☐ **(a)** careful about the details of my work.

☐ **(b)** creative about how to do my work.

23. When I get directions to a new place, I prefer

☐ **(a)** a map.

☐ **(b)** written instructions.

24. I learn

☐ **(a)** at a fairly regular pace. If I study hard, I'll "get it."

☐ **(b)** in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first

☐ **(a)** try things out.

☐ **(b)** think about how I'm going to do it.

26. When I am reading for enjoyment, I like writers to

☐ **(a)** clearly say what they mean.

☐ **(b)** say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember

☐ **(a)** the picture.

☐ **(b)** what the instructor said about it.

28. When considering a body of information, I am more likely to

☐ **(a)** focus on details and miss the big picture.

☐ **(b)** try to understand the big picture before getting into the details.

29. I more easily remember

☐ **(a)** something I have done.

☐ **(b)** something I have thought a lot about.

30. When I have to perform a task, I prefer to

☐ **(a)** master one way of doing it.

☐ **(b)** come up with new ways of doing it.

31. When someone is showing me data, I prefer

☐ **(a)** charts or graphs.

☐ **(b)** text summarizing the results.

32. When writing a paper, I am more likely to

☐ **(a)** work on (think about or write) the beginning of the paper and progress forward.

☐ **(b)** work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to

☐ **(a)** have "group brainstorming" where everyone contributes ideas.

☐ **(b)** brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone

☐ **(a)** sensible.

☐ **(b)** imaginative.

35. When I meet people at a party, I am more likely to remember

☐ **(a)** what they looked like.

☐ **(b)** what they said about themselves.

36. When I am learning a new subject, I prefer to

☐ **(a)** stay focused on that subject, learning as much about it as I can.

☐ **(b)** try to make connections between that subject and related subjects.

37. I am more likely to be considered

☐ **(a)** outgoing.

☐ **(b)** reserved.

38. I prefer courses that emphasize

☐ **(a)** concrete material (facts, data).

☐ **(b)** abstract material (concepts, theories).

39. For entertainment, I would rather
    - **(a)** watch television.
    - **(b)** read a book.
40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
    - **(a)** somewhat helpful to me.
    - **(b)** very helpful to me.
41. The idea of doing homework in groups, with one grade for the entire group,
    - **(a)** appeals to me.
    - **(b)** does not appeal to me.
42. When I am doing long calculations,
    - **(a)** I tend to repeat all my steps and check my work carefully.
    - **(b)** I find checking my work tiresome and have to force myself to do it.
43. I tend to picture places I have been
    - **(a)** easily and fairly accurately.
    - **(b)** with difficulty and without much detail.
44. When solving problems in a group, I would be more likely to
    - **(a)** think of the steps in the solution process.
    - **(b)** think of possible consequences or applications of the solution in a wide range of areas.

When you have completed filling out the above form please click on the Submit button below. Your results will be returned to you. If you are not satisified with your answers above please click on Reset to clear the form.

Submit Reset

Sample Printout

Learning Styles Results

```
Results for: Barry Wiginton

ACT                                              X                 REF
     11   9   7   5   3   1   1   3   5   7   9   11
                         <-- -->

SEN                                          X                     INT
     11   9   7   5   3   1   1   3   5   7   9   11
                         <-- -->

VIS       X                                                        VRB
     11   9   7   5   3   1   1   3   5   7   9   11
                         <-- -->

SEQ                          X                                     GLO
     11   9   7   5   3   1   1   3   5   7   9   11
                         <-- -->
```

- If your score on a scale is 1-3, you are fairly well balanced on the two dimensions of that scale.
- If your score on a scale is 5-7, you have a moderate preference for one dimension of the scale and will learn more easily in a teaching environment which favors that dimension.
- If your score on a scale is 9-11, you have a very strong preference for one dimension of the scale. You may have real difficulty learning in an environment which does not support that preference.

APPENDIX D

PARENTAL INFORMED CONSENT

Parental Informed Consent

Dear Parents/Guardians:

It is requested that your child participate in a research study examining the effects of classroom learning environment on student achievement, student confidence when working mathematics problems, and student preference for learning environment based on learning styles. Mr. Barry Wiginton from The University of Alabama Instructional Leadership and Technology Studies is conducting the study. Your child was selected as a possible participant in this study because of his/her enrollment in a mathematics classroom utilizing either Flipped instruction methods or traditional instruction methods.

Participating students will complete two surveys at the beginning of the semester. The first survey is designed to assess their attitudes toward completing mathematics problems. The second survey is designed to assess their preference for different ways of learning. One survey is given on paper and the other is given online. All surveys will be anonymous and no student information will be written on the survey form or entered online. At the end of the semester, all participating students will retake the first survey to see if their attitudes toward working mathematics problems have changed. Students will take approximately 45 minutes to complete both surveys, which will be given on the same day to minimize loss of class time.

Students who choose not to participate in the study may read silently while the other students are completing the surveys. They will not be penalized in any way for not participating.

The researcher will be conducting several classroom observations throughout the semester. Twelve students from your child's class will be randomly selected to participate in individual interviews. Additionally, eight students from your child's class will be randomly selected to participate in a focus group interview. All interviews will be audio taped. During the interviews, the students will be asked questions about their experiences and opinions regarding classroom instruction. The researcher will be the only individual to have access to the audio recording. The files will be erased once the comments have been transcribed to paper. The paper notes will then be kept in a locked cabinet and destroyed once the study is over. Individual interviews will last approximately 15 minutes and the focus group interview will last approximately 60 minutes.

All information provided by you and your child will be confidential. Confidentiality will be maintained through several methods. The researcher is not an employee of Jasper City Schools and will serve as an outside observer to the study and will be the only one collecting survey data or conducting interviews. Additionally, students will not be asked to put their names on surveys or any other document collected in the study. Pseudonyms will be used throughout the study to protect the identity of all students. No individual survey data will be shared with school personnel, only group averages and comparative results of the study.

Your child's participation is completely voluntary. Your child may choose not to answer any questions that make him/her feel uncomfortable. Participation may be discontinued at any time.

Refusal to participate will involve no penalty or loss of benefits to which your child is otherwise entitled.

There are no known risks or discomforts associated with your child's participation in this study. It is reasonable to assume that your child could benefit from participation in this study as the information gained may be used to improve instruction in your child's school. Additionally, the learning styles survey is a valuable tool to help students develop effective learning and studying habits and strategies. However, I cannot guarantee that your child personally will receive any benefits from this research.

If you, or your child, have any questions about the study, you may contact Barry Wiginton at 256-320-3500. You may also contact Mr. Wiginton's University of Alabama advisor, Dr. Angela Benson at 205-348-7824. If you or your child have any questions about your rights as a research participant, please contact Ms. Tanta Myles, The University of Alabama Research Compliance Officer, by calling 205-348-8461, or toll free 877-820-3066.

I have read this permission form. I have had a chance to ask questions. I agree to allow my child to take part in the study. I understand that I will receive a copy of this permission for to keep.

________________________________	__________________________
Signature of Parents/Guardians	Printed Parents/Guardians Name
________________________________	__________________________
Printed Name of Child	Date
________________________________	__________________________
Signature of Primary Investigator	Date

Audio Taping Consent

As mentioned, the individual and focus group interviews will be audio recorded for research purposes to allow the researcher to accurately transcribe the participants' conversations. These recording files will be stored on a password-protected computer and available only to the researcher. The files will be kept for no more than 2 weeks and then destroyed after they have been transcribed.

I understand that part of my child's participation in this research study will be audio recorded and I give my permission to the researcher to record.

☐ Yes, my child's participation in the interview can be audio recorded.

☐ No, I do not want my child's participation in the interview to be audio recorded.

APPENDIX E

INFORMED CHILD ASSENT STATEMENT

Informed Child Assent Statement

Dear Student:

We would like you to be part of a research study examining the effects of classroom learning environment on student achievement, student confidence when working mathematics problems, and student preference for learning environment based on learning styles. Mr. Barry Wiginton from The University of Alabama Instructional Leadership and Technology Studies is conducting the study.

We are asking you to help because we do not know very much about how students your age feel about participating in a Flipped instruction classroom versus a traditional classroom and your opinion could be very helpful to your teachers and administrators to provide the best learning experience they can.

You will be asked to complete two surveys at the beginning of the semester. The first survey is designed to assess your attitude toward completing mathematics problems. The second survey is designed to assess your preference for different ways of learning. One survey is given on paper and the other is given online. All surveys will be anonymous and no student information will be written on the survey form or entered online. At the end of the semester, you will retake the first survey to see if your attitudes toward working mathematics problems have changed. It will take approximately 45 minutes to complete both surveys, which will be given on the same day to minimize loss of class time.

Mr. Wiginton will also be observing in your classroom several times during the semester. Additionally, he will randomly select 12 students from your class to participate in individual interviews and eight students from your class to participate in a focus group interview. All interviews will be audio taped. During the interviews, you will be asked questions about your experiences and opinions regarding classroom instruction. Mr. Wiginton will be the only individual to have access to the audio recording. The files will be erased once the comments have been transcribed to paper. The paper notes will then be kept in a locked cabinet and destroyed once the study is over. Individual interviews will last approximately 15 minutes and the focus group interview will last approximately 60 minutes.

You many choose whether you want to be part of the study. You will not receive anything for being part of this study. You many choose to stop participating at any time. Your grades and you or your parents' relationship with the school will not be affected whether or not you decide to participate.

If you have any questions about the study, you may contact Barry Wiginton at 256-320-3500. You may also contact Mr. Wiginton's University of Alabama advisor, Dr. Angela Benson at 205-348-7824. If you have any questions about your rights as a research participant, please contact Ms. Tanta Myles, The University of Alabama Research Compliance Officer, by calling 205-348-8461, or toll free 877-820-3066.

By signing this form, you agree that you have read the above and agree to participate.

______________________________ ______________________________
Assent of Minor (Participant's Signature Age

______________________________ ______________________________
Printed Name of Minor Date

______________________________ ______________________________
Signature of Primary Investigator Date

Audio Taping Consent

As mentioned, the individual and focus group interviews will be audio recorded for research purposes to allow the researcher to accurately transcribe the participants' conversations. These recording files will be stored on a password-protected computer and available only to the researcher. The files will be kept for no more than 2 weeks and then destroyed after they have been transcribed.

I understand that part of my participation in this research study will be audio recorded and I give my permission to the researcher to record.

☐ Yes, my participation in the interview can be audio recorded.

☐ No, I do not want my participation in the interview to be audio recorded.

APPENDIX F

FOCUS INTERVIEW PROTOCOL FOR STUDENTS

Focus Interview Protocol for Students

Welcome and Explanation of Purpose
The researcher will thank the interviewee(s) for their willingness to participate in the interview and explain their right to stop at any time if they feel uncomfortable. Next, the researcher will explain the purpose of the interview. The researcher will say, "Thank you for agreeing to participate in this interview. We hope to understand what it is like to be a student in your Algebra I classroom. Understand that the interview is going to be audio recorded but that recording is only for transcription and accuracy purposes. No one outside this room will hear our conversation".

After transcribing the audio recording, have the interviewee(s) read over the printed transcript and confirm that the information is correct. Have the interviewee(s) sign the transcript.

The interview will be guided by the following questions:

1) Tell me about a typical lesson in Algebra class. How does your teacher introduce new information and/or show you how to work math problems?
    a. Follow-up Question: Do you like learning new material this way?

Learning styles informed: Active/Reflective, Sensing/Intuitive, Visual/Verbal, Sequential/Global

2) Do you ever work with other students during class to solve problems or work on projects?
    a. Follow-up Question: When you work in groups, do you feel you learn the material as well as when you work alone?

Learning styles informed: Active/Reflective

3) When you study at home, do you prefer it to be quiet?
    a. Follow-up Question: In algebra class, do other students talking and discussing make it hard for you to learn?

Learning styles informed: Active/Reflective

4) Tell me about the kind of problems and assignments you have in Algebra class.
    a. Follow-up Question: How do you feel when the problem can be worked many different ways?
    b. Follow-up Question: Are you more interested in working problems that have a real-world connection? Why?

Learning styles informed: Sensing/Intuitive, Sequential/Global

5) Do you like Algebra class?
    a. Follow-up Question: Why or why not?
    b. Follow-up Question: If you could change anything about your class, what would that be and why?

Learning styles informed: Active/Reflective, Sensing/Intuitive, Visual/Verbal, Sequential/Global

APPENDIX G

FOCUS INTERVIEW PROTOCOL FOR TEACHERS

Focus Interview Protocol for Teachers

Welcome and Explanation of Purpose
The researcher will thank the interviewee(s) for their willingness to participate in the interview and explain their right to stop at any time if they feel uncomfortable. Next, the researcher will explain the purpose of the interview. The researcher will say, "Thank you for agreeing to participate in this interview. We hope to understand what it is like to be a teacher in your Algebra I classroom. Understand that the interview is going to be audio recorded but that recording is only for transcription and accuracy purposes. No one outside this room will hear our conversation".

After transcribing the audio recording, have the interviewee(s) read over the printed transcript and confirm that the information is correct. Have the interviewee(s) sign the transcript.

The interview will be guided by the following questions:

1) Tell me about a typical lesson in Algebra class. How do you introduce new information and/or show how to work math problems?
    a. Follow-up Question: How do the students respond to this type of instruction?
    b. Follow-up Question: Why did you choose this instructional method of alternative methods?

2) Do you ever place students into collaborative groups during class to solve problems or work on projects?
    a. Follow-up Question: How do the students respond to this type of instruction?

3) Tell me about the kind of mathematics problems you assign in Algebra class.
    a. Follow-up Question: What types of problems seem to give your students the most difficulty?
    b. Follow-up Question: Why do you feel they have trouble working these types of questions?

4) What are your perceptions of the instructional methods used by other instructors of mathematics at your school?

APPENDIX H

DIRECT OBSERVATIONAL FORM

Front of Classroom

(Circle One)
Class A Class B Class C

Date _____/_______/ 2013 Time _____: ______

ACTIVITY

Description/Purpose:____

What is the teacher doing? ____

What are the students doing? ____

Evidence of Engagement or Non-Engagement by Students
☐ On Task ☐ Off Task ☐ On-Topic ☐ Off-Topic

Evidence of Collaboration or Non-Collaboration by Students
☐Working as Team ☐ Working Individually ☐ Team Presentation ☐ Individual Presentation

Evidence of Lesson Plan Deviation by Teacher
☐Excludes planned activity ☐ Modifies planned activity ☐ Inserts unplanned activity

Observational Notes