THE FLIPPED CLASSROOM: ITS EFFECT ON STUDENT ACADEMIC ACHIEVEMENT
AND CRITICAL THINKING SKILLS IN HIGH SCHOOL MATHEMATICS

by

JoRanna Marita Saunders

Liberty University

A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

Liberty University
2014
THE FLIPPED CLASSROOM: ITS EFFECT ON STUDENT ACADEMIC ACHIEVEMENT, 
AND CRITICAL THINKING SKILLS IN HIGH SCHOOL MATHEMATICS 

by JoRanna Marita Saunders

A Dissertation Presented in Partial Fulfillment 
Of the Requirements for the Degree 
Doctor of Education

Liberty University 
2014

APPROVED BY:

Nathan Putney, Ed.D., Committee Chair

Marlene Carby, Ed.D., Committee Member

Michael Preuss, Ed.D., Committee Member

Scott B. Watson, Ph.D., Associate Dean, Advanced Programs
ABSTRACT

This study examined the effect of the flipped classroom on academic achievement in high school mathematics. The purpose of this study was twofold. The immediate purpose was to determine if there was a statistical difference in student academic achievement in two high school mathematics classrooms once the flipped classroom concept was implemented. This study also examined the effect of the flipped classroom on students’ critical thinking skills. This static-group comparison utilized a pretest-posttest non-equivalent control group design and two null hypotheses were tested. The flipped curriculum was not a significant factor in increasing student academic achievement or in increasing student critical thinking skills. Implications, recommendations, and suggestions for future research studies were discussed.

Keywords: flipped classroom, mathematics academic achievement in high school, student academic achievement in mathematics, student critical thinking skills in mathematics, teacher pedagogy, differentiation of instruction, technology in mathematics.
Dedication

I want to dedicate this work to my mother, Loranna Ladson, for believing in me before I could believe in myself and for instilling in me at an early age the value of education. You have influenced and supported me in my education endeavors and I would not be where I am today without your belief in my abilities. I will forever be indebted and grateful to you and appreciate you more than you will ever know.

I would like to give ALL the glory to God who makes the impossible possible and who has directed my every step throughout this journey and my entire life. For without Him, I am nothing. I would also like to thank my beloved family. To my dear husband Raoul, my rock, who, from the moment we met, always believed in me, patiently cheered me on throughout this process, and supported every dream I have pursued thus far. Thank you for loving me and for always encouraging me to never give up; because you love me I overcome. I will always be grateful for your kindness and I will always love you. To my beautiful children, Kia’Vonne, Raoul Jr., Ch’Vaun, Jamal, Christian, and Khendal, thank you for supporting me, being independent when necessary, making me laugh, reminding me not to take life so seriously, and encouraging me to pursue my dreams. I love you all.

Love bears all things, believes all things, hopes all things, endures all things. Love never fails. (1Corithians 13:7-8, ESV)
Acknowledgements

I would like to thank Dr. Nathan Putney for serving as my dissertation chair and mentor throughout the dissertation process. His positivity, prompt responses, and continued support encouraged me more than he knew. Thank You.

I would also like to thank Dr. Marlene Carby, Dr. Michael Preuss, and Dr. David Holder, my committee members and research consultant. They each provided moral support from the very beginning, which gave me the confidence to persevere. My dissertation chair, committee members, and research consultant remind me of a bible verse:

Therefore encourage one another and build one another up, just as in fact you are doing.

(1Thessalonians 5:11, ESV)
# Table of Contents

ABSTRACT ............................................................................................................................................. 3  
Dedication ............................................................................................................................................. 4  
Acknowledgements ............................................................................................................................. 5  
Table of Contents ............................................................................................................................... 6  
List of Tables ......................................................................................................................................... 10  
List of Figures ....................................................................................................................................... 11  
CHAPTER ONE: INTRODUCTION ....................................................................................................... 12  
Background ......................................................................................................................................... 12  
Problem Statement ............................................................................................................................. 15  
Purpose Statement ............................................................................................................................... 15  
Significance of the Study ..................................................................................................................... 15  
Research Questions & Hypotheses ....................................................................................................... 16  
Identification of Variables .................................................................................................................. 17  
Definitions .......................................................................................................................................... 17  
Research Summary ............................................................................................................................. 19  
CHAPTER TWO: REVIEW OF THE LITERATURE ................................................................................. 21  
Introduction ......................................................................................................................................... 21  
Theoretical Framework ......................................................................................................................... 21  
Vygotsky’s Social Constructivism Theory ......................................................................................... 21  
Bandura’s Social Learning Theory .................................................................................................... 23  
Social Learning ..................................................................................................................................... 25  
Connection of Theories to Learning ................................................................................................. 26
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question 1</td>
<td>74</td>
</tr>
<tr>
<td>Null Hypothesis (H₀₁)</td>
<td>74</td>
</tr>
<tr>
<td>Research Question 2</td>
<td>76</td>
</tr>
<tr>
<td>Null Hypothesis (H₀₂)</td>
<td>76</td>
</tr>
<tr>
<td>Summary</td>
<td>78</td>
</tr>
<tr>
<td>CHAPTER FIVE: DISCUSSION</td>
<td>80</td>
</tr>
<tr>
<td>Introduction</td>
<td>80</td>
</tr>
<tr>
<td>Purpose</td>
<td>80</td>
</tr>
<tr>
<td>Participants and Setting</td>
<td>81</td>
</tr>
<tr>
<td>Methods</td>
<td>82</td>
</tr>
<tr>
<td>Summary of Findings</td>
<td>82</td>
</tr>
<tr>
<td>Findings for Research Question 1</td>
<td>82</td>
</tr>
<tr>
<td>Findings for Research Question 2</td>
<td>83</td>
</tr>
<tr>
<td>Discussion</td>
<td>84</td>
</tr>
<tr>
<td>Conclusion</td>
<td>85</td>
</tr>
<tr>
<td>Implications</td>
<td>88</td>
</tr>
<tr>
<td>Implications for Practice</td>
<td>88</td>
</tr>
<tr>
<td>Implications for Research</td>
<td>89</td>
</tr>
<tr>
<td>Assumptions, Limitations, &amp; Weaknesses</td>
<td>92</td>
</tr>
<tr>
<td>Recommendations</td>
<td>95</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>97</td>
</tr>
<tr>
<td>Appendix A: Recruitment Form</td>
<td>110</td>
</tr>
<tr>
<td>Appendix B: Teacher Consent Form</td>
<td>111</td>
</tr>
</tbody>
</table>
Appendix C: Student Assent Form ................................................................. 114
Appendix D: Permission Letter ................................................................. 115
Appendix E: Instruments ................................................................. 116
Appendix F: Parent Consent Form ............................................................. 122
Appendix G: Parent Recruitment Form ....................................................... 125
Appendix H: School Board & University Approval ...................................... 126
List of Tables

Table 1: Demographic Data of Participating Classes ..............................................57
Table 2: Georgia Performance Standards for Mathematics III Curriculum ..................60
Table 3: Group Statistics for Student Posttest ........................................................71
Table 4: Independent Samples $t$-test for Student Posttest ........................................73
List of Figures

Figure 1: Histograms for student academic achievement posttest results by instructional format ............................................75

Figure 2: Histograms for student critical thinking skills posttest results by instructional format ..............................................77
CHAPTER ONE: INTRODUCTION

Background

In response to the National Council of Teachers of Mathematics publications (NCTM, 2005) and students’ bias towards mathematics, stakeholders in mathematics education have begun to create alternatives to traditional curricula to address students’ mathematics deficiencies (DeJarnette, 2012). Across the nation, revisions and alternatives to traditional curricula are being offered wherein technologies, facilitation, discovery learning, and student collaboration are being infused into curricula in an effort to boost student academic achievement in mathematics (Archambault, Wetzel, Foulger, & Williams, 2010). The major consensus has suggested that student collaboration, infusion of technology, and teacher facilitation all promote academic achievement in the secondary mathematics classroom (Kulkarni, 2012). These facets of the mathematics classroom appear to be the wave of the future and are inevitable if students are to become more than just functional in secondary level mathematics.

While many research studies suggested a complete overhaul of the public education system (Rycik, 2012), other research studies suggested that educators explore alternatives to the traditional classroom (Anderson, 2007). Educators are now implementing mixed curricula that include artificial intelligence software, multimedia assisted instruction, and even the inverted curriculum (Curriculum Review, 2012; Ritter, Anderson, Koedinger, & Corbett, 2007). The flipped classroom is a setting in which students are introduced to pre-recorded concepts (via the Internet, videos, or author audio-visual recordings) outside of the traditional instructional space (at home, in the library, or wherever the instructional material can be accessed) (Alvarez, 2012; Bergmann & Sams, 2012a; Fulton, 2012a). After students have watched the material, they are expected to come to class—usually the very next class meeting—and collaborate with their peers.
and teacher about the material. During this time they may clear up any misconceptions regarding the content they watched. Flipped classroom students are also expected to complete homework and discuss, explain, and extend the concepts they learned about from the pre-recorded material during class time. Thus, what the students have traditionally done at home becomes what the student does in class, and vice versa. The traditional nature of classwork and homework are “flipped.” Research on the implementation of the flipped classroom has suggested that this alternative classroom promotes student academic achievement as well as enhances student critical thinking skills (Brunsell & Horejsi, 2011; Fulton, 2012a). While implementing this alternative may not alleviate all the problems in mathematics education, its implementation may begin to provide solutions to increase academic achievement. Teacher pedagogy, educational technology, and differentiated instruction all play important roles in the implementation of the flipped classroom (Fulton, 2012a; Overmyer, 2012).

The pedagogical pattern of the teacher is very important to student academic achievement, and it can greatly impact the way a student views a particular subject and even education as a whole. Teachers are representatives of their topics. They are the face of education, and the way they present material can either make a student curious or discourage the student from pursuing the topic altogether, which can in turn influence the student to search for alternatives for future careers. Teacher pedagogy is critical to student academic progression since it can create pathways of learning that can positively impact student academic achievement, as well as student critical thinking skills (Caballero, 2010).

Technology plays an important role in everyday life. Older and younger individuals interact with and depend on digital technology on a regular basis. Checking text messages, reviewing online medical claims, updating social media, and even registering for college courses
can all be done on the latest hand-held device by simply touching its screen. Undoubtedly, technology has reshaped the way the world communicates. In fact, students that are currently enrolled in elementary, middle, and high schools have never lived in a world where digital technology did not exist (Lamanaukas, 2011). Computer technology is very familiar to current students and can be used as a stepping-stone to increase their academic performance and critical thinking skills. Students’ passions lie in technology, and digital media can have a positive impact on education (Louw, Muller, & Tredoux, 2008).

Giving students what they need is the initial step in reaching them academically. Differentiated instruction is a method used to customize teaching, which allows teachers to vary instruction and hone in on students’ strengths and weakness (Adams & Pierce, 2012). Once these strengths and weaknesses are identified, students can receive additional practice to remedy possible misconceptions about concepts or even begin to fill the gaps in their learning. When teachers use this approach, students can focus on their weaknesses, thus advancing student critical thinking skills as well as student academic achievement (Subban, 2006).

Even though the use of digital technology and the implementation of the differentiated instruction model provide educational benefits to students, these benefits inherently impact teachers and promote professional development. When teachers utilize computer technology, they are encouraged to stay current and also become students. Similarly, when a teacher incorporates the differentiated instruction model within the classroom, the teacher becomes a reflexive practitioner, which in turn promotes accountability. All in all, a teacher’s instructional efforts, the implementation of digital technology, and the incorporation of the differentiated instruction model in the flipped classroom should benefit the student as well as the teacher. These components encourage student academic achievement and improve student critical

**Problem Statement**

Due to prerequisite deficiencies (Hull & Seeley, 2010), students’ prior mathematics experiences and attitudes towards mathematics (Tulis & Ainley, 2011), and students’ lack of interest in and motivation to learn mathematics (Mahanta & Islam, 2012), research has indicated that mathematics students are not mastering the concepts necessary for math proficiency (Rock, Gregg, Ellis, & Gable, 2008; Schullery, Reck, & Schullery, 2011). If this trend continues, American students may not be able to effectively compete in the global economy (Rycik, 2012). To address this issue, this study sought to examine the effect of the flipped classroom on high school mathematics students’ academic achievement and their critical thinking skills.

**Purpose Statement**

The purpose of this study was to examine the effect of the flipped classroom on secondary mathematics education. In the flipped classroom, students watch instructional videos at home and expound on the concepts they learned from the instructional videos by discussing those concepts in the classroom with their peers and teacher, completing group projects, and getting individual assistance. This research study will assist educators and stakeholders in mathematics education in implementing alternatives to the traditional curriculum by advancing the understanding of their impact on student academic achievement and student critical thinking skills in the high school mathematics classroom.

**Significance of the Study**

Several studies have been conducted on the flipped classroom in education (Curriculum Review, 2012). Research studies previously conducted have focused on either elementary academic achievement (Fulton, 2012b) or content specific achievement in secondary education
(Brunsell & Horejsi, 2011). Few studies have been performed on the impact of the flipped classroom on student academic achievement and student critical thinking skills in the secondary mathematics classroom (Toppo, 2011). In order to add to the body of literature in mathematics education and to addresses students’ deficiencies in high school mathematics, an investigation needed to be conducted on whether this alternative curriculum will encourage greater achievement and improve critical thinking skills in the secondary mathematics classroom.

**Research Questions & Hypotheses**

The research questions for this study were as follows:

**RQ1**: Is there a difference in Mathematics III students’ mathematics academic achievement between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

**RQ2**: Is there a difference in Mathematics III students’ mathematics critical thinking skills between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

In the following, the term traditional represents the group that received no treatment, the control group. The term flipped will stand for the group that received the treatment, the experimental group.

The following were the null hypotheses:

**H₀₁**: There will not be a statistically significant difference in the mean posttest results in student academic achievement on the Mathematics III posttest (questions 1 through 29) between the control and experimental groups.

**H₀₂**: There will not be a statistically significant difference in the mean posttest results in student critical thinking skills on the Mathematics III posttest (questions 30 through 34) between the control and experimental groups.
Identification of Variables

The following variables were pertinent to this study: teacher pedagogy (an independent variable), two methods of instruction (traditional and flipped classroom instruction), academic achievement (a dependent variable), critical thinking skills (a dependent variable), and the posttest scores (a dependent variable).

Definitions

The following operational variables were used to describe terms identified in this study. They are defined as follows:

1. Carnegie Unit: Secondary-school units, each of which represents one year of work in a subject; the unit was developed in 1906 as a measure of the amount of time a student has studied a subject (Carnegie Foundation, 2013).

2. Flipped Classroom: An instructional setting in which students are introduced to concepts that are presented as pre-recorded vignettes (via the Internet, teacher made videos, or other audio visual recordings) outside of the traditional pattern (at home, in the library, or wherever the instructional material can be accessed). After students have watched the material, they are expected to come to class (usually the very next class meeting) and collaborate with peers and the teacher in discussing and applying the material (as well as clear up any misconceptions about the content). Flipped classroom students are also expected to complete homework, discuss, explain, and extend the concepts they learned from the pre-recorded material during class time. Thus, what the students have traditionally done at home becomes what the student does in class and vice versa. Hence, the traditional nature of classwork and homework are “flipped.” School becomes a place for talking, doing group projects, and getting individual help from teachers, and home
becomes a place for watching instructional videos (Springen, 2013).

3. *Georgia Performance Standards (GPS):* GPS is the Georgia specific set of educational standards developed by the Georgia Department of Education for the Georgia tax-funded elementary and secondary school system. The performance standards incorporate the content standards, which tell the teacher what a student is expected to know (i.e., what concepts he or she is expected to master) (Georgia Department of Education, 2013b).

4. *Southern Association of Colleges & Schools (SACS):* SACS is a regional accreditor that grants licensure to schools districts, colleges, and universities in the southern region of the United States. Its accreditation standards are accepted by the U.S. Department of Education and employed in authorization to provide educational services (Stillman College, 2013).

5. *Traditional Classroom:* An instructional setting in which students receive instruction from a teacher during class time, tend to be passive recipients of knowledge (Lave, 1988), and practice or other supplemental work is assigned to be completed by the student at home. For this research study, the control group received a prescribed pattern of traditional instruction. The instruction included the teacher introducing a concept by lecturing, the teacher giving examples of the introduced concept, and homework being assigned on the concept. Students completed homework independently at home, student work was graded for accuracy, returned to the student for brief reflection, and a new concept was introduced. This cycle was repeated over and over.

6. *Pedagogy:* The instructional skills and strategies teachers use to impart the specialized knowledge/content of their subject area(s) (National Board for Professional Teaching Standards, 2013).
7. *Statistically Significant:* Measuring the likelihood that events are truly correlated with an underlying reason (George Mason College, 2013). For this study, events were considered statistically significant if the difference between the group means were 95% or more.

8. *Mathematics III:* This is the third course in a sequence of courses designed to provide students with a rigorous program of study in mathematics. It considers exponential and logarithmic functions, matrices, polynomial functions of higher degree, conic sections, and normal distributions. This course is part of a sequence of mathematics classes and follows the successful completion of Mathematics II (Georgia Department of Education, 2013b).

**Research Summary**

This study utilized a static-group comparison non-equivalent group design and data were analyzed using SPSS software. The type of statistical test used in this study was the independent \( t \)-test to assess students’ posttest data. The independent \( t \)-test was chosen to analyze the control and treatment students’ data for three reasons. The main reason the independent \( t \)-test design was chosen was because it provides an inferential statistic that will determine if a statistically significant difference exists between the means of two unrelated groups (the control and treatment groups) (Laerd Statistics, 2013a). Secondly, the independent \( t \)-test design was chosen since the population for the control and experimental groups was less than 30 and the number of students in each group differed (Experimental Biosciences, 2013). Another reason the independent \( t \)-test design was chosen was because an independent \( t \)-test can be used in groups that lack random assignment (Psychology Australia, 2013).

The study utilized one assessment instrument to determine if a statistically significant difference existed between the control and treatment groups’ academic achievement as well as
the control and treatment groups’ critical thinking skills. Likewise, two different independent $t$-tests were utilized to determine if a statistically significant difference existed between the control and treatment groups’ academic achievement as well as the control and treatment groups’ critical thinking skills.

For the study, the students were assigned to either the control or treatment group based on the class they were in. The static-group comparison design for this study was chosen since the effects of the flipped classroom were examined but subject randomization was impossible. This design was also chosen for this study since it explored causality between the flipped classroom and the aforementioned variables and a true experimental design could not be used (Fortune & Hutson, 1984). The study was conducted during the fall semester of 2013 in two high school mathematics classrooms in Southeast Georgia. The control and treatment teachers both taught the same content for eight weeks. After implementation, data were analyzed and results were made available to stakeholders. Although the characteristics of this study included lack of random assignment, reliable results were still expected as treatment and control groups as well as pretest and posttest data were all employed (Gall, Gall, & Borg, 2007).
CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

This literature review highlights the theoretical underpinnings of the current study. An overview of recent studies regarding the flipped classroom is provided and topics related to the flipped classroom are reviewed. Vygotsky’s social constructivism theory and Bandura’s Social Learning Theory are discussed, as well as social learning in general. To further examine the flipped classroom, the literature review focuses on differentiated instruction, teacher pedagogy, and educational technology, which are major substructures of the inverted curriculum. Recent studies on the flipped classroom are also explored to examine this alternative curriculum and gauge its effectiveness.

Theoretical Framework

For this study, Vygotsky’s and Bandura’s theories were utilized to explain the relationship between the flipped classroom, mathematics academic achievement and improved students’ critical thinking skills in secondary mathematics classrooms. These theories suggested that when students learned through social interactions, in groups, or in collaboration with the teacher (facilitation), they retained the self-discovered knowledge and information apprehended with teacher assistance, and actually enjoyed learning mathematics (Sedig, 2008).

Vygotsky’s Social Constructivism Theory

Vygotsky suggested that students acquired knowledge through social interactions and through their culture to experience meaningful learning. When Vygotsky’s social constructivism theory was implemented in the mathematics classroom (via facilitation, collaboration, multiple representation, technology, etc.), students retained mathematical information longer and grasped the concepts regardless of the level of difficulty; in turn, student mathematics achievement was
maximized (Jones, Jones, & Vermette, 2010). The major theme of the social constructivism framework is that social exchanges or interactions play an essential role in cognitive development. “Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)” (Vygotsky, 1978, p. 57). In order for mathematics instruction to effectively take place, students’ interests and attitudes about mathematics must be considered. Instruction must be designed so that students effectively interact within the classroom and construct their own understanding (Alvarez, 2007; Berrett, 2012). Concepts from Vygotsky’s social constructivism theory are evident within the flipped classroom curriculum and consequently work well within this framework.

Vygotsky’s theory suggested that the facilitator incorporate effective scaffolding in lessons to assist learners in obtaining and retaining information (Lave, 1988; Vygotsky, 1978). The flipped classroom has provided alternative ways of scaffolding to support learners’ reasoning and problem solving skills. In the flipped curriculum, scaffolding is supported at a meta-cognitive level versus the traditional scaffolding that is present in the customary setting (Suh, 2010). The educator then provides the appropriate strategies to ensure precision of knowledge for content development. The inverted classroom educator supports learners’ content development by providing suitable activities at the correct level of difficulty and complexity. The educator provides the learning constructions necessary so that the student can complete the task with the proper amount of assistance, which will help the learner through the Zone of Proximal Development (Lewis, Perry, Friedkin, & Roth, 2011).

In the 1930s, Vygotsky introduced the Zone of Proximal Development as scaffolding (Wood, Bruner, & Ross, 1976). The Zone of Proximal Development is defined as the distance
between what learners comprehend within a task and the next level of learning that they can complete by themselves with a higher conceptual level of comprehension. Vygotsky suggested that scaffolding was the role of the facilitator who provides support structures to move the learner to the next level. The scaffolding learning strategy is evident in the flipped classroom since this mode of teaching requires the facilitator to provide students with meta-cognitive support and ensure exactness of student learning so that the students can become self-regulated and independent (Bergmann & Sams, 2012b; Johnson & Renner, 2012). Thus, Vygotsky’s social constructivism theory provided a framework for this alternative curriculum since components that frame the theory were evident in the flipped classroom. Effectively providing scaffolding for the learner, the educator as the facilitator, and the Zone of Proximal Development are all major components of Vygotsky’s social constructivism theory that are presented in the flipped classroom.

**Bandura’s Social Learning Theory**

Bandura’s Social Learning Theory provided another theoretical framework for the inverted classroom and also explained how learning occurs and is retained. Bandura’s theory suggested that a student, the student’s behavior, and the situation the student was in all exerted an influence on what the student’s next action would be (Bandura, 1977). According to this theory, learning occurs socially; students learn from their interactions with other students and adults. Abbott (2007) said:

Social learning theory talks about how both environmental and cognitive factors interact to influence human learning and behavior. It focuses on the learning that occurs within a social context. It considers that people learn from one another, including such concepts as observational learning, imitation, and modeling. (p. 25)
The premise of the Social Learning Theory is that people learn new information and new behaviors by observing others. Bandura believed that a learner’s behavior was the result of watching others, forming ideas of how new behaviors were supposed to be performed, and then mimicking that coded information into action. Observational learning (also called modeling) can be used to describe a wide variety of learners. Bandura’s Social Learning Theory explained the cognitive, environmental, and behavioral influences on human behavior (Bandura, 1977).

In order for observational learning to be effective, the learner must exhibit four conditions. These conditions include adequate attention, retention, reproduction, and motivation (Abbott, 2007). Once the first condition is met, the other conditions follow sequentially. The first condition, attention, sets the tone of the outcome. Since the other conditions rely heavily on attention, this stage will determine how effective the modeling can be. In terms of attention, the learner must give the appropriate focus to what is being modeled. Once the appropriate amount of attention is shown, the retention condition can be met and the learner can reproduce the actions and behaviors of the modeler. If the learner can successfully reproduce the modeled actions, the learner will likely become motivated about the experience and in turn, want to continually model appropriate actions to receive verbal praise, recognition, or for intrinsic reasons (Abbott, 2007).

In the flipped classroom, the Social Learning Theory is displayed continuously. The learner is presented with media in which a presenter models appropriate behavior. When the learner is attentive to instruction, retention, reproduction, and motivation will likely occur (Alvarez, 2012; Fulton, 2012a; Miller, 2011). Bandura’s Social Learning Theory provided a theoretical framework for the flipped classroom since effective modeling of concepts is presented (via online videos, teacher-made videos, or other media that students can watch). The
attentive student then retains and reproduces the concepts learned through solving practice problems and extends those concepts to real life applications. Although the inverted classroom may not provide solutions for each problem presented in the traditional instructional setting, it can begin to address and alleviate some of its issues. Student engagement, timely student feedback, and student collaborations are all addressed during flipped instruction, which could result in students retaining concepts longer and connecting those concepts to real life applications (Alvarez, 2012; Bergmann & Sams, 2012b; Berrett, 2012).

**Social Learning**

High school students cognitively reorganize concepts and skills learned earlier by mentally manipulating symbols. According to Miller (2011), “Older children, by observing a model, are expected to learn complex new skills quickly, with a minimum of verbal instruction” (p. 251). Social Learning Theory supported the need for multiple representations and peer collaboration in curricula. In the flipped classroom, multiple representations are delivered through technology (laptops, desktops, iPads, iPods, smartphones, etc.), other media devices that do not require Internet connection (vhs tapes, dvd discs, etc.), or by any other means that allows students to view prerecorded material and consequently visualize concepts by facilitating conceptual learning. Multiple representations are also present in this alternative instructional setting through the use of differentiated instruction and necessary collaborations. Peer collaborations allow students to share ideas, discuss misconceptions, and self-reflect; they are highly relevant to student learning (Fulton, 2012b). Such conditions are addressed in the flipped classroom by allowing students to use technological devices to enhance their learning experiences and discuss their ideas, have constructive debates, and voice their perspectives on particular concepts with other learners. Students’ interactions with technology and peer-to-peer
or peer-to-teacher collaborations can take place daily or as often as new material is introduced in the classroom (Fulton, 2012a).

According to Bandura (1987), adults also learn socially. Since adults learn socially, they should consider implementing social interactions within the classroom. These interactions between students can enrich learning experiences and present platforms for numerous rich discussions. However social interactions are just one way to foster learning. Educators must value the diversity of learning and implement various instructional formats and assessments to ensure that every student’s needs are met (Stanford & Reeves, 2009; Tomlinson, 2005).

**Connection of Theories to Learning**

Vygotsky’s and Bandura’s theories (Fulton, 2012a; Fulton, 2012b) explained the relationship between the flipped curriculum model and improved mathematics academic achievement in secondary mathematics classrooms. Since learning is a social experience, when the inverted curriculum was implemented in an instructional setting, students were socially stimulated with implemented technology when reviewing the technology in groups (teacher-to-student or student-to-student) (Churches, 2011), multiple representation (Sankey, Birch, & Gardiner, 2011), peer collaborations (Jones, Estell, & Alexander, 2008), and real life situations which forced them to use critical thinking skills to solve problems (Takaci & Budinski, 2011).

The flipped classroom addresses concepts mentioned in both theories by placing learning back into the hands of the students (Torkelson, 2012). When students are accountable for their learning, the teacher can become the facilitator who effectively scaffolds and assists students through the Zone of Proximal Development. Major facets of both theories suggested the positive impact of social learning on student academic development. The inverted classroom provides learners with opportunities to socially engage academically with peers, collaborate with teachers
at different cognitive levels, and interact with digital technologies on a continuous basis (Alvarez, 2012; Bergmann & Sams, 2012b).

**The Flipped Classroom**

The flipped classroom is a relatively new way of teaching that involves flipping the traditional approach of classroom instruction (Alvarez, 2012, Bergmann & Sams, 2012; Berrett, 2012; Brunsell & Horejsi, 2011). In traditional settings, students are expected to listen to lectures, read individually, and take notes while instruction occurs. To follow up, teachers quiz or test students on the introduced concepts to ensure they have understood the material. Students spend class time listening to lectures, and if time allows, they may get to work examples of the newly presented content (Bull & Kjell, 2013; Fulton, 2012b; Hull & Seeley, 2010). These traditional approaches to instruction are being revamped and alternate methods are being considered to keep students engaged and motivated about their learning (Berrett, 2012; Fulton, 2012a). The flipped classroom is one alternative to the traditional classroom setting. This instructional setting incorporates digital technology within each lesson, provides students with tailored and differentiated instruction, and causes the educator to take a facilitator’s approach in the classroom (Overmyer, 2012; Reeve, 2006; Steed, 2012).

Although the flipped mode of teaching has existed for several years, Bergmann and Sams (2012a) are credited with pioneering this alternate approach to the traditional class setting (Brunsell & Horejsi, 2011). After years of teaching traditionally, Bergman and Sams (2012a) wanted to see a change in their students’ dispositions and academic achievement. Daily, they saw students overwhelmed with homework from their courses, which influenced them to search for a method that could make students’ learning experiences more innovative and effective (Bergmann & Sams, 2012b). They decided to flip their teaching style, which allowed students to
take roles as active learners and allowed teachers to become facilitators rather than lecturers. When students take an active role in their learning by interacting with the teacher and discussing important content with peers as well as working collaboratively, they are indeed learning socially as Bandura’s and Vygotsky’s theories suggested (Abbott, 2007; Bandura, 1986; Vygotsky, 1978).

Within the flipped classroom, instructional tasks are reversed. Homework is completed in the classroom and lectures are viewed at home (Alvarez, 2012; Bergmann & Sams, 2012b; Berrett, 2012; Brunsell & Horejsi, 2011). The pre-recorded classroom lectures that students watch at home are presented digitally via teacher-made videos that are available either online or in DVD/VHS format. In response to the recorded instruction, students bring questions about the lectures to class. During class time, homework is discussed and possibly completed and then students use the remaining time for enrichment by applying the newly learned concepts to real-life application problems. If further clarity is needed, the learner can seek additional instruction by working with the instructor one-on-one or by collaborating with peers to better understand the concepts (Fulton, 2012b; Overmyer, 2012; Springen, 2013). When different students simultaneously participate in various activities such as enrichment or support, differentiation takes place and students have the opportunity to receive what they need (Anderson, 2007; Huebner, 2010; Long, 2011).

In an inverted instructional setting, differentiation of instruction is evident. When students do not understand what is happening in the presented material, they have the opportunity to rewind and review portions of the lessons they misunderstood or fast-forward through sections they have already mastered (Alvarez, 2012; Berrett, 2012; Fulton, 2012b). Unlike traditional instructional settings, students come to class armed with newly learned
concepts that provide a platform for lively class interactions, peer collaborations, and the opportunity to discuss misconceptions about the material. In the classroom, the teacher is able to guide students and give them the differentiated, individual, and meaningful feedback on their work right as they produce it. The inverted classroom becomes an interactive multi-learning environment that engages students directly in their education (Berrett, 2012; Horn, 2013). The flipped setting allows teachers to implement a differentiated learning approach while concurrently being effective facilitators (Fulton, 2012b; Steed, 2012).

In the inverted setting, the educator’s role is that of a facilitator versus the traditional classroom’s educator’s position as lecturer. To be an effective facilitator, the teacher must possess pedagogical skills to help students through multiple zones of learning (Abbott, 2012; Fulton, 2012b; Steed, 2012; Vygotsky, 1978). Effective facilitators often self-reflect on current best practices in pedagogy to ensure that students understand and retain presented information (Karl, Sheri, David, & Roger, 2005; Lewis, Perry, Friedskin, & Roth, 2012). In the flipped classroom, these self-reflection checks can be performed by getting feedback from students and colleagues about the pre-recorded instruction that was made or suggested by the educator (Archambault, Wetzel, Foulger, & Williams, 2010; Long, 2011).

As another means of self-reflection, the flipped curriculum approach can provide additional opportunities for educators to collaborate with colleagues who teach the same or similar content (Alvarez, 2012; Fulton, 2012a; Overmyer, 2012). This will allow teachers time to discuss effective strategies that are presented in the digital content used in their classes. One method of collaboration between educators is the sharing of lessons. Such collaboration could also serve as a source of professional development. When teachers exchange media, they can use or modify colleagues’ teaching strategies and techniques and discuss strengths and
weaknesses of their own media, which will help their classrooms to become more creative as well as provide alternate ways to present material to students (Karl et al., 2005; Lewis et al., 2012). The media used in the flipped classroom model serve as powerful instructional tools and allow teachers to create content, share resources, reflect and improve upon their own instructional practices, and implement digital technology within the classroom (Alvarez, 2012; Fulton, 2012a; Tucker, 2012).

Due to the incorporation of digital technologies in education, it is now crucial for teachers to connect with learners and for teachers to deliver innovative and memorable lessons (DeJarnette, 2012; Geer & Sweeney, 2012; Kajrekar, 2012; Pilgrim, Bledsoe, & Reily, 2012). Recent studies have suggested that computer and digital technology be implemented in the classroom to increase student academic achievement. In current educational conversations, the flipped classroom is widely discussed as an approach to incorporate technology as well as improve students’ grades and attitudes towards education (Kajrekar, 2012; Pilgrim et al., 2012). The use of digital technology is also appropriate for the new generation, and as educators seek to improve the ways they teach 21st century learners, the flipped curriculum provides a guide for a successful course of action (Fulton, 2012b; Subban, 2006).

When the flipped classroom was first introduced, teacher-made videos were the initial step to disseminate the content to students (Alvarez, 2012; Bergmann & Sams, 2012a). With the progression of online technology, online resources have started to replace videos and teachers are now creating digital media to instruct their students. Emerging computer and digital technologies have offered opportunities for even the most novice teacher to flip the classroom. Educators can now create interactive online videos that may enhance students’ learning experiences (DeJarnette, 2012; Geer & Sweeney, 2012). To begin using the flipped classroom,
educators should try flipping an individual lesson by searching for relevant videos online. The flipped model can be adapted to any subject and may soon be considered the norm in the 21st century classroom (Fulton, 2012b; Overmyer, 2012).

To alleviate the issues that have emerged from teacher-made videos, software companies have begun to develop flipped classroom resources and tools for schools. Companies with famous brands have also started to produce video software, which allows educators to connect with students outside the classroom so that students maintain interest (Curriculum Review, 2012). SOPHIA, an online social education platform that offers over 25,000 free academic tutorials, provides educators with free tools to help them flip their classrooms and includes a Flipped Classroom Certification (SOPHIA Learning LLC, 2013) once the educator has successfully done so. Currently, SOPHIA has partnered with Bill Nye the Science Guy to get teachers and students excited about learning with the Flipping for SOPHIA campaign. This campaign allows teachers and students to have 24/7 access to credible instructional content to enhance learning beyond the classroom (SOPHIA Learning LLC, 2013).

Other software resources such as Knowmia Teach (an iPad app) have provided instructors with numerous options for creating and incorporating media into their flipped classrooms. Knowmia Teach offers more than 8,000 video lessons for almost all major subject areas for middle and high school teachers. Once educators have access to Knowmia Teach’s app, they can begin learning how to create their own videos. While Knowmia Teach creation tools are free, users are required to grant Knowmia “a royalty-free, worldwide, transferable, sublicensable, irrevocable, perpetual license to use or incorporate into the Service any suggestions, enhancement requests, recommendations or other feedback that is provided to Knowmia relating to the operation of the Service,” (Knowmia, 2012). Knowmia’s subscribers
generate revenue to the creators of the app and teachers benefit by receiving a free tool that allows them to create and publish instructional videos and share the profits (Bull & Kjell, 2012).

Although the flipped classroom does not address all the limitations of the traditional classroom (pacing limitations, curricular issues, etc.), with the flipped model’s implementation, students move at their own pace and most of their individual needs are met through the flexibility the inverted curriculum offers. Research has indicated that when classrooms are flipped, student-to-student interactions and teacher-to-student interactions increased, student learning deepened, and academic achievement increased (Alvarez, 2012; Fulton, 2012b; Overmyer, 2012).

Various teachers across the U.S. have reported academic success in their flipped classrooms (Bergmann & Sams, 2012b; Fulton, 2012b; Overmyer, 2012). One middle school teacher suggested that students that participated in flipped curricula were more engaged and asked more thoughtful, in-depth questions (Fulton, 2012b). A Detroit-area school saw clear results after incorporating the flipped format into its curriculum; the failure rate was reduced by 14% in math and 30% in English (Fulton, 2012b). A teacher in Florida noted that flipping the class was a good instructional strategy since the instructional environment went from teacher centered to student centered (Curriculum Review, 2012). The flipped classroom has removed the educator from being the focus and has allowed the classroom to center on the students (Curriculum Review, 2012; Fulton, 2012a; Fulton, 2012b).

Like many districts, the Byron school district near Rochester, Minnesota, faced academic and financial challenges in the fall of 2009. The district’s funding was cut by 1.2 million dollars and stakeholders had no money for textbooks. Math teachers came up with an idea to create their own curriculum by providing teacher made media via video cassette, DVD, etc., to students and allowing homework to be completed in class after the introductory material was viewed at
home. The Byron teachers flipped their classrooms as a solution to decreased revenue and concluded that their inverted curriculum was beneficial to students, parents, and educators (Fulton, 2012b).

Colleges across the nation have been faced with high enrollment, low student engagement, and continued diminishing resources. To address some curricula issues, one higher education institution located in Michigan decided to reformat its business courses using the flipped/inverted classroom method. The inverted curriculum was introduced to determine if students were engaged and actually learned the foundation concepts when courses were presented in this format. In the redesigned courses, lectures were downloaded and viewed at home where students collaborated and interacted with peers while weekly in-class meetings reinforced individual learning and fostered deeper understanding of concepts (Schullery et al., 2011). This research concluded that from the beginning of implementation, the new format forced students to get more involved in their classroom learning.

To evaluate the program’s effectiveness, open-ended surveys were given to students in the reformatted course near the end of the semester. There were a total of 210 students that responded to the spring 2009 survey and 653 students that responded to the fall 2009 survey. The results showed that a clear majority of students favored the overall format, but 83% of respondents suggested improvement in the course design. Redesigning a delivery format is worthwhile if it promotes student engagement and student learning. This study was limited due to self-selected students completing the survey and because the audience for the study was agenda driven. Hence, inferences from this study should be made cautiously (Schullery et al., 2011).
Differentiated Instruction

Differentiated instruction is defined as a philosophy of teaching in which teachers accommodate students based on their particular interests and learning styles (Tomlinson, 2005). Contemporary classrooms have become extremely diverse. In order to reach students, many districts have incorporated the differentiated instruction approach throughout curricula.

Subban (2006) examined research studies from the past 25 years with regards to teacher pedagogy, student learning, motivation, and engagement to synthesize the underpinnings of the differentiated model. Subban’s study focused on various themes that were present in the literature. These derived themes supported the differentiated teaching model and included current research rationale to support the need for an alternative educational model, teaching to the middle, addressing differences, brain research, learning styles, multiple intelligences, responding to the needs of different learners, engaging students, and catering for interest, learning profile, and readiness. These themes all suggested that differentiated instruction was necessary to accommodate current learners in their academic pursuits. Subban’s examination of various studies (Hodge, 1997; Tomlinson, Moon, & Callahan, 1998; McAdamis, 2001; Affholder, 2003) suggested that teachers’ use of differentiated instruction positively impacted standardized test scores in mathematics, student academic achievement, teacher awareness of the need for differentiated instruction in the classroom, teacher self-efficacy, individual perception, and teachers’ adoption of a greater responsibility for student growth.

Hodge’s (1997) study investigated the use of differentiation on student scores on standardized tests, teacher perceptions of their ability to meet the needs of different learners, and parent expectations of student performance. Hodge gathered data from student participants using a posttest only design (a standardized test) after differentiation was implemented. This study
concluded that students who were prepared for testing using differentiation strategies showed an overall gain in their mathematics scores. These findings suggest that differentiated instruction had a positive impact on learning since teachers were aware of the different learning styles which allowed them to understand individual needs and assist with student development. Significant gains in test scores were reported after the student preferred learning style was incorporated into instruction.

Affholder (2003) conducted a study on the differentiation strategies utilized by teachers. The study was conducted as part of a professional development initiative for the school district and data was collected through pre and post surveys. During this study, teachers intensively implemented differentiated strategies into their classrooms to enhance self-efficacy in the hopes of becoming more effective educators. To test the effect of differentiation, survey results were examined and results of the study concluded that teachers who used the differentiated format adopted a greater responsibility for student growth and improved individual perception. Additionally, teachers who incorporated higher levels of differentiated strategies demonstrated a greater willingness to try new instructional approaches and also experienced higher levels of self-efficacy (Affholder, 2003).

A study of a Missouri school district’s implementation of differentiation was conducted by McAdamis (2001) over a period of five years. This differentiation proposal was implemented school wide and included workshops that aided teachers in professional development, intensive planning, and mentoring. Differentiation strategies were used in coaching, workshops, and study groups to provide teachers with continuous support and feedback over the five-year period and included a joint effort from all stakeholders (principal, district personnel, teachers, and other school officials). To evaluate the effectiveness of the differentiation initiative, standardized tests
and summative and formative assessments from students were gathered and analyzed. McAdamis’s (2003) study concluded that student test scores improved significantly following the implementation of the school wide differentiation initiative and that students were more motivated about learning. McAdamis’s (2003) study suggested that that the implementation of differentiation in an instructional setting could positively impact student academic achievement.

Adams and Pierce (2012) found that instructional leaders established more effective strategies when working with mathematics teachers that modeled ways to differentiate instruction. As part of a differentiation initiative, Adams and Pierce provided mathematics instructors with easy to implement teacher-made lessons for sixth through twelfth grade students. These lessons encouraged student engagement. Positive responses were received from students regarding the lessons, and the differentiation techniques presented throughout each lesson ensured that every student learning style was addressed (Adams & Pierce, 2012). Throughout this initiative, differentiation techniques and strategies had a positive impact on student retention of math concepts, student academic achievement, student social skills, and teacher efficacy.

Differentiation of instruction has allowed educators to implement structures to meet a variety of student learning abilities (Fulton, 2012a; Kobelin, 2009). These structures have included open-ended tasks, tiered tasks, and spiral type tasks. These structures have afforded students the opportunity to think critically, problem solve, and incorporate specific content algorithms via direct instruction. Differentiation provides educators with a choice on how to reach every student in the classroom while keeping instruction rigorous. As Vygotsky’s constructivism theory suggested, differentiation in the flipped instructional setting provides alternative ways of scaffolding to support learners’ reasoning and problem solving skills (Abbott, 2007; Vygotsky, 1978). Most students are motivated to learn when teachers present materials in
ways they understand (Anderson, 2007; Caballero, 2010). When students understand concepts presented by their teachers, they become accountable for their learning (Torkelson, 2012). When students hold themselves accountable for what they learn, a positive impact on their student academic achievement, student critical thinking skills, and self-efficacy will be obvious (Caballero, 2010; Fulton, 2012b; Kobelin, 2009).

Subban’s examination of the above studies provided a framework that supported various reasons why differentiated instruction was necessary to reach all students in the 21st century classroom. The 21st century classroom is one equipped with laptops, video players, audio equipment, etc., where students are actively engaged in the learning experience and engrossed in the content. Educators must be effective facilitators who use various modes of teaching to reach every student (Archambault et al., 2010).

In order for teachers to provide students with what they truly need, they must know the students’ interests, backgrounds, and readiness levels. In a differentiated setting, the learning is varied, social, and collaborative and students are valued for their strengths. In fact, reasons to differentiate instruction include teachers’ abilities to identify student strengths and weaknesses quickly, increased student academic achievement levels, increased student motivation, and increased student retention of learned material (Adams & Pierce, 2012; Kobelin, 2009; Tomlinson, 2005). Differentiation also forces the teacher to engage students by accommodating differences and likenesses. Several studies have indicated that differentiated classrooms yielded positive outcomes, with test scores improving significantly through the utilization of this model (Caballero, 2010; Miller, 2011; Sharma & Hannafin, 2007). The theoretical framework of Subban’s (2006) study was credited to Vygotsky’s grounded learning theory, and Subban suggested that time and resources were challenges that teachers faced when incorporating a
differentiation approach into their classrooms.

Students with disabilities often fall through the cracks of traditional classrooms. However all students have different learning styles, regardless of disabilities, and an educator’s philosophy should be considerate of such differences (Adams & Pierce, 2012; Periathiruvadi & Rinn, 2012). Stanford and Reeves (2009) suggested that students with diverse disabilities learned best when differentiated instruction was infused into the classroom. Although differentiated instruction has been around for years in the gifted education arena, regular education classrooms have begun to incorporate differentiation into their curricula (Huebner, 2010; Periathiruvadi & Rinn, 2012). Since the implementation of the Individuals with Disabilities Act of 2004, teachers have been forced to revisit the ways they introduce instruction and deliver content to all students (Anderson, 2007; Carnahan, Williamson, Hollingshead, & Israel, 2012). Some of these changes have included differentiating instruction to cater to the varying learning styles of students, implementing computer and digital technology into daily lessons to help learners retain information as well as make all topics interesting, taking on a facilitator’s role instead of the role of a lecturer, and using multiple representations to present concepts so that students can make real world connections (Sankey, Birch, & Gardiner, 2011; Sobel, 2013). Educators must aim to meet the content demands of the curriculum while supporting growth for each child (Sharma & Hannafin, 2007; Stanford & Reeves, 2009).

Today’s classroom learners are culturally, linguistically, and cognitively diverse. Students’ background information, learning preferences, and cognitive abilities must be known before effective teaching can take place. Teachers differentiate instruction by what students learn (the content), how students learn (the process), and the way students demonstrate their mastery (the product). While there is no one-size-fits-all differentiation model, the incorporation
of differentiation within the classroom encourages teachers to stay flexible, creative, and purposeful (Huebner, 2010). Many studies suggested that differentiated instruction, when implemented correctly, yielded positive results in a mixed-ability classroom (Anderson, 2007; Rock et al., 2008; Tomlinson, 2000).

In the near future the number of Hispanic, Asian, and African-American students in classrooms across the U.S. will likely increase (Caballero, 2010; Logan, 2011). In order for all students to be reached academically, teachers must implement differentiated instruction to ensure that students have access to high quality education while their individual needs are met (Anderson, 2007; Caballero, 2010 Logan, 2011). Logan (2011) suggested five major principles that educators must adapt in order to implement this format of instruction successfully into their classrooms. These principles included the notions that every child and teacher can learn, all children have the right to a high quality education, progress is expected for all, learners in the classroom have individual and similar needs, and computer and digital technology supports differentiated instruction (Logan, 2011).

Past research studies have demonstrated the need for teachers to differentiate instruction in their classrooms. Archambault, Wetzel, Foulger, and Williams (2010) suggested that in order for differentiated instruction to be effective, teachers must identify students’ personal strengths and weaknesses. Archambault et al. (2010) proposed that students’ strengths and weaknesses be identified through questionnaires, assessments, student collaborations, or by speaking with the student directly. Teachers must also identify their own strengths and talents in order to make this alternative instruction manageable (teachers may prefer online sites for instruction or specific workbooks, etc.) (Archambault et al., 2010; Logan, 2011; Long, 2011). Long (2011) encouraged teachers to build a library of resources that interest them in order to make instruction
exciting and doable for learners. Thomas & Williams (2010) advised teachers to realize that they
cannot implement an effective inverted curriculum instantaneously and that different lessons
may require different levels of support or alternative approaches to engage students.

Barriers exist in the differentiated model which include teachers’ perceptions, teachers’
time management, the lack of teachers’ availability to all students all of the time, and the impact
of differentiation on standardized testing (Logan, 2011). Even though barriers exist for this
model, studies have shown that this mode of instruction is effective. Logan (2011) noted that
student achievement (Tieso, 2005), peer collaboration and tutoring (Mastropieri, Scruggs, &
Norland, 2006), and instructional reading levels (Baumgartner, Lipowski, & Rush, 2003)
increased when differentiation was the instructional preference in the classroom. For the
aforementioned studies, teachers used differentiation strategies to cater to the needs of each
learner by allowing students to complete self-selected assignments (Tieso, 2005), incorporating
multiple representations (Baumgartner, Lipowski, & Rush, 2003), and providing prompt
individualized feedback (Mastropieri et al., 2006). Although the differentiation model is not
perfect for everyone, schools must adjust to the various developmental needs and levels of
students (Logan, 2011).

Teacher Pedagogy

A teacher’s pedagogy is the personal knowledge, beliefs, values, and attitudes regarding
how students learn and the incorporation of strategies that may enhance student learning (Long,
2011; Yost, 2006). Teacher pedagogy can affect teaching efficacy, and educators must reflect on
their pedagogy and efficacy to remain effective (Ediger, 2009; Piccolo, 2008). Research has
indicated that when teachers were given the chance to evaluate their pedagogy, they began to
genuinely reflect as learners and developed new ways to “know and do” (Hargreaves & Fink,
2008). Teachers who often reflected on their learning by themselves or with same-content colleagues tended to deliver diversified instruction, and as a result, student learning was maximized (Karl et al., 2005; Lewis et al., 2011).

Long (2011) advocates for professional communities to allow same-content educators to collaborate and engage in critical professional conversations. The need for teachers to discuss their work, share relevant problems, and reflect on school and individual practices is critical to true pedagogical reflection. Since teachers are ultimately responsible for their own pedagogical growth, professional learning is necessary to ensure that individual and school level learning occurs (Caballero, 2010; Clarke & Zagarell, 2012). Thus, self-reflection of educators is crucial to their teaching efficacy and pedagogy and can impact the way instruction is transmitted to learners. The inverted classroom can provide educators with the self-reflection needed by allowing them the opportunity to re-examine their created or chosen digital media. Educators can have colleagues in their content area view their digital media and provide genuine feedback. Once feedback is given, educators can revise their media as necessary to deliver a better product to their students. This approach to self-reflection could allow educators to become more effective practitioners, increase their personal teaching efficacy, and positively impact the way they facilitate student learning (Bull & Kjell, 2013; Long, 2011; Springen, 2013).

In 2010, Arizona State University’s College of Teacher Education offered a professional development project to its faculty. To transform teaching pedagogy, the faculty was assisted with integrating various web tools such as blogs, social networking, and webpages into their courses. After the workshop, the faculty was asked to reflect on the curriculum revision process and how these revisions would impact their pedagogy and student achievement. Homogenous sampling was utilized to conduct a qualitative analysis of the group reflections. The results
concluded that 50% of the faculty felt that their teaching became more collaborative by using technology. Eighty percent of the faculty believed that social networking tools had a positive impact on student achievement (Archambault et al., 2010). These findings were relevant to the current study since they illustrated possible ways that instructional technology could improve instruction and student academic achievement, keep learners interested in content, and provide educators with the means to collaborate by using the same technologies often used in the flipped classroom model. Additional studies are needed in this area, specifically ones that aid in the transforming of pedagogical practices, including those involved in the inverted curriculum.

Many have debated whether teachers’ knowledge of the content or their knowledge of how to transmit it is more important in the field of mathematics (Ediger, 2009; Karl et al., 2005). Research has confirmed that knowing the content and knowing how to teach the content are of equal importance and the mathematics teacher must be proficient in both to be effective (Long, 2011; Piccolo, 2008). The mathematics educator must deliver the content with high quality pedagogy since mathematics is a language that needs to be communicated clearly. Once the math educator masters the content and communicates the content unambiguously, student understanding and teacher efficacy should increase. Since the content in the flipped classroom is delivered through videos and other online sources, teachers can build high quality content and pedagogy into their courses and improve upon it year after year (Berrett, 2012; Bull & Kjell, 2013). Mathematics educators must possess positive attitudes towards math, accept research as a guide to teaching, seek positive relationships with parents by pushing their children to do well, and address deficient content of mathematics within self (Ediger, 2009; Miller, 2011), much of which can be accomplished using the inverted curriculum model.

Ediger (2009) believed that mathematics educators should be required to obtain at least a
master’s degree in their field to ensure deficiencies in content and pedagogy have been addressed. When educators are confident in the content they teach and in their abilities to instruct, they can begin to apply their content knowledge and pedagogical skills to application problems and real world examples through instruction. Students will then make relevant connections. Mathematics educators must know how to make mathematics interesting, fun, and applicable to the lives of their students so that its relevance is obvious. In the classroom, the mathematics teacher must have an environment conducive to teaching and learning, where all inquiry is welcomed, and where each student can become successful (Matsumura, Slater, & Crosson, 2008). Since the inverted curriculum provides students an outlet to collaborate with the instructor and other students, learners can discuss misconceptions, seek clarity, and extend their knowledge on the presented concepts openly and freely in this instructional setting (Torkelson, 2012; Tucker, 2012).

The need for more effective pedagogical strategies when teaching science, technology, engineering, and mathematics (STEM) courses has been stressed in numerous reports (Foster, K., Hamos, J. E., Bergin, K. B., McKenna, A. F., Millard, D., Perez, L., & Vander Putten, E. (2010); National Council of Teachers of Mathematics, 2005). The goal and focus was to increase the number of high school graduates prepared to major in STEM disciplines and to maintain the number of STEM majors who entered college and continued their course of study until the STEM degree was awarded. To achieve this goal, more rigorous curricula as well as more effective pedagogy used in STEM courses is necessary (Talley & Scherer, 2013).

In a recent study by Talley and Scherer (2013), learning and pedagogical techniques were used in conjunction with a hybrid of the flipped classroom to evaluate undergraduate psychology students’ knowledge of synaptic transmission, a multi-step physiological process of brain cell
As a class project, students were assigned the task to create their very own video that explained their knowledge of synaptic transmission. To prepare for the creation of their videos, the students participated in the flipped classroom techniques by viewing online video lectures from their instructor and by participating in several practice test sessions. Afterwards, the students recorded their own videos, which showed them teaching the newly learned concepts to an imaginary class. The students’ videos were then uploaded to Blackboard and were viewed by the instructor. In class, time was used to discuss common misconceptions that were revealed in the students’ videos. Talley and Scherer (2013) suggested that the self-explanation learning method coupled with the instructor’s pedagogical strategies employed higher level thinking and learning skills since students had to analyze, explain, interpret, and then summarize the material.

In fact, quantitative results between subjects with regards to student performance in the course were significantly higher ($t(79) = 2.22, p=.029, \text{Cohen’s } d = .5$) than the previous semester where different pedagogical methods were used. Results also indicated that student grades increased almost one letter grade from the previous semester. Further, the moderate effect size of the study suggested a relatively strong relationship between the difference in performance and the use of pedagogical strategies (Talley & Scherer, 2013). Students appreciated the flexibility of accessing the course material on various devices, especially their cell phones. Revamping pedagogical strategies and learning techniques has the potential to increase student retention not only in STEM courses, but in courses across all disciplines.

The days when teachers served as lecturers in the classroom are gone (Piccolo, 2008; White-Clark, DiCarlo, & Gilchriest, 2008). Stakeholders in mathematics have advocated that students become more responsible for their own learning (Miller, 2011; Smith, Sheppard,
Johnson, & Johnson, 2005). Strong teacher pedagogies that allow students to become more independent include cognitive collaborations, implementation of technologies, enhancements of critical thinking, timely feedback, and diversity. Diversity is implemented in the inverted classroom because students are encouraged to engage in multiple learning styles of their choosing (via digital or computer learning and teacher/student collaborations). Timely feedback is incorporated since the educator has more time to deliver one-on-one instruction to each student, and students become more independent overall by accepting responsibility for their learning. Students can decide if they need to view content again, if they need further discussion with peers for clarity, etc. Teacher collaborations are also critical to pedagogy since they allow the educator to self-reflect and examine their own practices (Smith et al., 2005). Teachers using the flipped model can continuously improve upon their content; educators can reflect on their flipped media by watching and tweaking annually, after each topic, or after each grading period (Lewis et al., 2011).

Educators must begin to shift from a teacher centered paradigm to a learner centered paradigm (Roehl, Reddy, & Shannon, 2013) as Bandura’s theory suggested, since learning occurs socially (Bandura, 1977; Bandura, 1986). Unlike the generation before them, the Millennial students, students born between 1982 and 2002, are less tolerant of lecture-style pedagogy since they have been reared on rapidly evolving technologies. Although educators complain about these students’ abilities to focus, Prensky (2001), a Millennial generation expert, suggested that students’ attention abilities have not changed but that their tolerances and needs have. Prensky suggested that educators adopt alternative pedagogical methods and strategies to reach and engage today’s learners.

Lectured-based teaching methods have been questioned and scrutinized for decades
Researchers and educators have come to realize the complexities of teaching and learning for understanding versus teaching and learning for rote memorization and knowledge retention (Caballero, 2010; Ritchhart, Church, & Morrison, 2011). Active learning is an alternative pedagogical strategy to lecture style learning. Active learning pedagogies focus on student activity as well as student engagement in the learning process. Active learning allows students to utilize higher-order thinking skills while they collaboratively employ analysis, synthesis, and evaluation strategies (Anderson, 2007; Bandura, 1977; Geer & Sweeney, 2012; Groff & Haas, 2008). In the flipped instructional setting, active learning pedagogies are incorporated by delivering innovative course material in comparison to the traditional lecture. Flipping the classroom also allows for numerous teaching methodologies to be incorporated, such as videotaping, creating videos, utilizing already made videos from sources such as TeacherTube and YouTube, and integrating content specific websites available through various professional organizations (Roehl, Reddy, & Shannon, 2013; SOPHIA, 2013). The time gained from the pedagogical shift from lecture to facilitation allows students to actively learn, have one-on-one time with their instructors for more personal engagement, and also provides a deeper understanding of the concept (Reeve, 2006; Jones et al., 2008).

With the traditional pedagogical approach, teachers may not be aware of student deficiencies until after a test has been given. Utilizing the flipped classroom, instructors have greater insight into student strengths and weaknesses as a result of increased teacher-to-student interactions (Fulton, 2012b; Roehl et al., 2013). The flipped classroom pedagogy also includes the ability for the course to continue in spite of teacher or student absences and allows the student to stay on track regardless of interaction with the instructor.

Educators are faced with demands from state and district leaders to reach every student in
spite of budget cuts, diminishing resources, and student dispositions towards learning (Clarke & Zagarell, 2012). Since educators now face increased demands for improving the learning experience as well as maintaining the focus of the Millennial learner, a shift from the traditional lecture-style pedagogy is necessary (Clarke & Zagarell, 2012; Roehl et al., 2013). The inverted curriculum pedagogy addresses educators’ concerns regarding implementation of technology, pedagogical strategies, and active learning. To increase student retention of knowledge, learning outcomes, and students’ depth of knowledge in specific content, the flipped classroom pedagogy must be considered by stakeholders in education (Alvarez, 2012; Bergmann & Sams, 2012b; Berrett, 2012).

**Educational Technology**

Classical education has undergone a paradigm shift due to the advent of digital technology. Computerized Technology has emerged quickly and educators are scrambling to take advantage of the technologies that are becoming available. Current education systems are inundated with conversations about the digital age and teachers must expose themselves to digital technology and master using it (Lamanauskas, 2011). Today’s youth are part of various social media groups (Facebook, twitter, etc.), yet educators fail to use interactive social tools to reach them. Lamanauskas (2011) stressed to educators that digital teaching has emerged and that it will strengthen student critical thinking skills and abilities, as well as increase student motivation. Difficulties in learning to use technology may be apparent for the teacher, but competence is necessary to make digital teaching and the student’s learning process more interesting, effective, and meaningful (O’Hara, Pritchard, Huang, & Pella, 2013).

The introduction of technology in the classroom has changed the teaching profession in its entirety. Today’s educators are required to be trained appropriately in the use of
technological tools to correctly implement technology in the classroom (Papic, 2011). Most secondary educators have responded to using technology in a positive way and have positive attitudes about its implementation within the classroom (Kulkarni, 2012). Alvarez’s (2012) and Fulton’s (2012b) studies focused on digital technology as an integral part of course delivery. Their findings concluded that in the flipped classroom setting, educators were excited about implementing the accompanying digital components into course curriculum.

In 2010, the U.S. Department of Education provided the nation with a national educational technology plan that suggested advanced technologies be applied to improve student learning through instructional use in a wide variety of settings (Pilgrim et al., 2012). Educators were encouraged to successfully integrate digital/computer technology into their classrooms so students could employ the use of tools such as iPads and iPhones into classroom activities (Brown-Martin, 2012). The mobility of such tools will allow students to engage in academic activities that may otherwise be inaccessible. These types of digital technologies offer an alternative way for educators to engage students in real world problem solving, deep critical thinking, and real-life applications. Educators must work beyond whiteboards and projectors to keep pace with ever-changing technology to support all students in classroom learning (Sobel, 2013).

Computer use in a society can revolutionize the future of education as well as empower the people in that society (Kajrekar, 2012). Even though computers are used in various ways in education, Kajrekar’s (2012) study grouped educational computer use into four categories. These categories included developmental tools, programmed instruction, simulating experiments, and productivity tools. Productivity tools (the Internet, word processing spreadsheets, and presentation software), as related to education, can be very effective and powerful in respect to
student learning, if implemented correctly. Digital technologies allow students to interact socially and collaborate about particular content (Brown-Martin, 2012; Carnahan et al., 2012).

Vygotsky’s social learning theory suggested that young students collaborated (Cicconi, 2013). Student collaborations in the classroom, coupled with the implementation of computer/digital technology, can lead to a powerful culture of social learning. When students are engaged with technology, they are empowered and take on a facilitators’ role regarding learning instead of remaining passive. Torkelson (2012) found that when technology was used appropriately within the classroom, effective long-term learning took place. With the incorporation of digital technology in the classroom, educators are preparing the world’s future workforce by fostering effective strategies within the students they teach. Tasks such as creating, evaluating, applying, and analyzing all come to life with technology as a greater enthusiasm for its learners is generated (Cicconi, 2014).

Technologies such as Voki (a web-based program that brings monologues to life), Vodcast (a web-based program that allows students to share educational videos), and VoiceThread (a web-based program where teachers upload files and students collaborate on those uploads) all offer children a live audience with whom they can share knowledge and gain insight. To examine the effectiveness of these web-based technologies, Cicconi (2014) evaluated feedback from educators that implemented such technologies into their curricula. The educators who implemented Voki reported that the program captured student attention with attractive graphics, promoted creativity, and encouraged collaborations while supporting teachers. When Vodcast was introduced in the instructional setting, the educators noticed that collaborations became student driven which provided in-depth content collaborations and authentic assessment. The educators who implemented VoiceThread suggested that after this web-based program was
incorporated in the class, students left with a better understanding of the concept (and math in general, although the concept was already introduced in the traditional classroom) as well as a better understanding of and an increased enthusiasm for math (Cicconi, 2014). Cicconi (2014) concluded that using technology to engage collaboration tended to deepen students’ understanding of math concepts while offering rigorous learning through relevant projects. Hence, digital technologies were found to create social environments for learners where they could be the disseminators of knowledge, thus encouraging the students to prepare and study the material and increasing content retention (Reeve 2006; Torkelson, 2012).

In the United States, there are few students pursuing STEM disciplines despite the numerous STEM programs that exist and are being offered at the middle and high school levels. Stakeholders of STEM initiatives have begun to take proactive measures by providing exposure to instructional technologies as early as elementary school; specifically, more advanced engineering, science, and math concepts have been implemented in the elementary classroom with digital technology (DeJarnette, 2012). Presumably, early exposure to technology will engage students as they are exposed to critical thinking, communication skills, and collaboration so that they may function in a globally competitive society as adults. In education, all American students must develop these skills, and these skills must be addressed at the federal level. Under the Obama administration, many programs in education were created to emphasize STEM fields (The White House, 2009). STEM fields focus on topics that are underrepresented in secondary schools. These programs will provide America’s youth with the technological skills that are needed to be competitive in the future (DeJarnette, 2012).

Today’s youth are often called digital natives since they have always lived in a world where digital technologies have existed. For most adolescents, the use of the Internet, cellular
phones, computers, and other common technologies are as natural as any other daily routine. Scholars have called for a revamping of the traditional lecture teaching style and for educators to present a more facilitative approach to learning, which incorporates some form of technology (Periathiruvadi & Rinn, 2012). Recent studies have pointed out that students learn to collaborate, negotiate, and explore multiple real-life scenarios and concepts through their use of digital media (Lamanauskas, 2011).

Geer and Sweeney (2012) suggested that the student’s voice be heard with regards to the 21st century pedagogical approaches to learning. Students think about learning differently since computer and digital technology emerged. Although other countries have already embraced the technological movement in education, the U.S. is still struggling to understand what the contemporary classroom that includes technology should look like (Geer & Sweeney, 2012). Teachers cannot deny the key role that digital and computer technology plays in relation to student play, learning, and interactions with others. Geer and Sweeney (2012) suggested that teachers explore and incorporate digital technology to allow their classroom to resemble a 21st century learning environment.

Gifted students reported positive perceptions about computer technology implemented throughout their learning (Periathiruvadi & Rinn, 2012). The current research on computer and digital technology in the gifted classroom has primarily focused on the impact of technology on critical thinking skills and rigor. Online learning has become a recent topic of interest in gifted forums and students have reportedly shared their views on this topic and reflected on their learning (Periathiruvadi & Rinn, 2012). Educators should not discourage the use of digital technology in the classroom but should instead encourage all students to have access to digital and computer technology since it has a strong influence on everyday life (Groff & Haas, 2008).
Integrating digital technology into curricula will build a stronger education for future learners and simultaneously increase critical thinking, logic, and reasoning skills in all areas of learning (Suh, 2010).

Students with significant disabilities can also benefit from the use of digital/computer technology throughout the classroom. Carnahan, Williamson, Hollingshead, and Israel (2012) emphatically suggested using digital technology to support a balanced literacy approach in special needs classrooms. The authors defined a literacy approach as instruction rooted in communication, reading, writing, speaking, and listening. This approach used adapted thematic instruction based on student interest and encouraged adapted reading materials in the form of e-books, interactive teacher made books, PowerPoint books, and online books. In the areas of writing and spelling, teachers may implement interactive graphic organizers to incorporate low and high computer/digital technology (work that is physically written—books, posters, tangible items, etc. and e-books, material presented via computers, iPads, tablets, etc.). All of this technology may increase students’ motivation, interest, and focus on the concepts to be learned. Even though these computer and digital technological resources are available, they are only effective when they are aligned to each learner’s needs via differentiated instruction and when the learner receives the appropriate support from the teacher via scaffolding (Sharma & Hannafin, 2007).

**Summary**

To address the problems currently in mathematics education, stakeholders are searching for and implementing varied curricula in hopes of boosting academic achievement. Many of these curricula involve some infusion of computer or digital technology to keep students alert, focused on the content, and on task. While many research studies have been conducted on
mathematics deficiencies in the nation’s public high schools (Adams & Pierce 2012; Anderson, 2007; Convissor, 2014), a small amount of literature is available on the flipped classroom and an even lesser amount has been devoted to mathematics exclusively.

The literature surrounding this topic is not new and has suggested that educators consider numerous facets of the curriculum while teaching concepts so that students not only remember what is being taught, but also think critically and deeply about what they have learned (Abbott, 2007; Lave, 1988). In turn, students will be able to apply these concepts to real-life application problems or complex situations (Piccolo, 2008; Stanford & Reeves, 2009). The use of differentiation in an educational setting has afforded educators the opportunity to reach students where they are academically (Miller, 2011; Takaci & Budinski, 2011). Differentiated instruction is not only useful in today’s classrooms, but is necessary so that all students’ learning styles can be addressed. In fact, teachers are now being evaluated on differentiation practices and are expected to teach children based on their specific needs (Anderson, 2007; Caballero, 2010).

Educators must also reflect on their own teaching styles and pedagogy (Caballero, 2010; Archambault et. al, 2010). In today’s teaching arena, educators are not only expected to assess their pedagogical style regularly, but must also make adjustments as necessary to ensure student learning is maximized (Adams & Pierce, 2012). Most school districts offer various professional development workshops to assist teachers with ongoing learning so that their skills are kept up to par (Long, 2011). The implementation of computer and digital technology should be considered by educators since the vast majority of students are engrossed in technologies or impacted by its uses daily. Students who are currently in primary and secondary schools have never lived in a world without computer and digital technology and are dependent upon its use (Groff & Haas, 2008; Kajrekar, 2012). Many public education institutions are trying to keep up with this trend
by offering their students iPads, tablets, laptops, and other electronic devices (Kajrekar, 2012; Long, 2011).

The way in which instruction is delivered has changed drastically in the past ten years (Fulton, 2012b; Lamanauskas, 2011). Students are no longer expected to remain quiet in classrooms or sit quietly at their desks while the teacher disseminates information. The current education system is shifting to an exploratory one where students are expected to explore given information, gather facts, and make conclusions based on information independently or in groups. The role of the teacher is no longer to be the “sage on the stage,” but has become one of facilitation and guidance (Reeve, 2006; Sharma & Hannafin, 2007).

To address students’ different needs, educators’ need for self-reflection, and the need to implement digital and computer technology, various curricula have been introduced in academia (Alvarez, 2012; Fulton, 2012b; Miller, 2011). Specifically, the flipped classroom is being discussed among stakeholders in hopes of addressing the ever-changing dynamics of classroom instruction (Berrett, 2012; Brunsell & Horejsi, 2011; Fulton, 2012a). In this study, the flipped classroom model was examined to determine its impact on student academic achievement and student critical thinking skills in the secondary mathematics classroom. This study will add to the body of literature in mathematics education while simultaneously attempting to address students’ deficiencies in high school mathematics. This teaching format allows computer and digital technology to be implemented in the classroom, encourages teachers to reflect on their pedagogy, allows students to think critically, and encourages richer class discussions. In turn, student academic achievement and critical thinking skills can be maximized (Bergmann & Sams, 2012a; Fulton, 2012b).
CHAPTER THREE: METHODS

Introduction

The purpose of this quantitative, static-group comparison design study was to examine the effect of the flipped classroom on student academic achievement (AA) and critical thinking skills (CTS) in high school mathematics. Other studies exist which reveal positive effects that non-traditional instruction has on student learning in educational settings; however, research is scant with regards to empirical studies which measure the benefits of the flipped curriculum on student learning in secondary mathematics. As a result, this study seeks to fill a gap in the literature by determining if flipped instruction has a positive effect on student AA and CTS in the mathematics classroom. The researcher used static-group comparison data to analyze the effects (if any) that the flipped curriculum may have on student AA and CTS in secondary mathematics. Chapter three will present the methodology, research design, research questions, participants, instrumentation, procedures, and data analysis for this research study.

Research Design

This quantitative study utilized a static-group comparison non-equivalent control group research design to determine the effect of the inverted classroom upon student AA and CTS in the secondary mathematics classroom. A static-group comparison non-equivalent control group research design was chosen since the effect of the flipped classroom on AA and CTS was being examined but subject randomization was not possible (Gall et al., 2007). Participants in the treatment group received flipped instruction while participants in the control group did not. For the purposes of this study, the dependent variables included student AA and CTS in the form of student posttest data. The independent variable, teacher pedagogy, was presented in the form of traditional or flipped instruction and was manipulated to determine if it caused a positive effect.
Questions & Hypotheses

The research questions for this study were as follows:

**RQ1**: Is there a difference in Mathematics III students’ mathematics academic achievement between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

**RQ2**: Is there a difference in Mathematics III students’ mathematics critical thinking skills between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

The following were the null hypotheses:

**H₀₁**: There will not be a statistically significant difference in the mean posttest results in student academic achievement on the Mathematics III posttest (questions 1 through 29) between the control and experimental groups.

**H₀₂**: There will not be a statistically significant difference in the mean posttest results in student critical thinking skills on the Mathematics III posttest (questions 30 through 34) between the control and experimental groups.

Participants

Participants were eleventh grade students who were enrolled in a Mathematics III course. The study included a sample of eleventh graders at a public high school in South East Georgia. The available population was the school’s 2015 graduating class which consisted of 468 students. The school’s total population was 1720 and included students in grades 9-12. The ethnic/racial composition of the school was as follows: 60% African American, 23% Caucasian,
12% Hispanic, and 5% other. Sixty one percent of the student body qualified for free/reduced lunch. The participants for this study included 58 eleventh grade students, 29 girls and 29 boys, who were enrolled in Mathematics III during the 2013-2014 school year. The control group had 30 students (15 boys and 15 girls) and the treatment group had 28 students (14 boys and 14 girls). The classes were similar in nature and each class consisted of all eleventh grade students.

The control and experimental classes that participated in the study were academically and demographically equivalent. The control group contained 22 students who were African American, 6 students who were Caucasian, and 2 students who were of Hispanic descent. The experimental group contained 21 students who were African American, 5 students who were Caucasian, and 2 students who were of Hispanic descent. Table 1 includes information about both classes’ demographic data. In both classes, all students had passed the prerequisite course, Mathematic II, with at least a 70%.

Table 1

Demographic Data of Participating Classes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>73%</td>
<td>75%</td>
</tr>
<tr>
<td>Caucasian</td>
<td>20%</td>
<td>18%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Eligible for Free/Reduced Lunch</td>
<td>72%</td>
<td>71%</td>
</tr>
</tbody>
</table>

Setting

The setting for the static-group comparison study was a high school in South East
Georgia. The school was SACS accredited and the curricular Math III courses were used for this study. The actual classes that participated in this study were chosen using the convenience sample method. The students became participants in this study if their class was chosen to participate. Students in both the experimental and control group earned credit of one Carnegie unit for the course. The classes that participated in the study were initially chosen based on availability (the accessible course sections at the grade level chosen for the study by the researcher) and from the available population.

Due to the implementation of Georgia’s new mathematics curriculum, Common Core Georgia Performance Standards (CCGPS), for first and second year high school mathematics students, and to eliminate any validity or reliability issues associated with the new curricula, the researcher chose Mathematics III, a third year mathematics course for the study which was taught in the school for the past six years. During the study, the researcher conducted herself as an observer who viewed and considered data. Although the researcher was employed at the high school at the time of the data analysis and she frequented the classrooms involved in the study, she did not participate in class discussions or discuss pedagogical strategies with teacher or student participants. The researcher conducted herself in this manner during the entire research study to maintain the fidelity of the experiment.

Before participating teachers implemented the traditional or flipped curriculum, all student participants took a pretest (to establish normality since student participants were not chosen at random for the study), and the researcher collected this the same day it was given. The following day, after the pretest was given, students within the control group received traditional instruction for nine weeks and students within the treatment group received flipped instruction for nine weeks. After the nine week implementation phase, student participants took a posttest
which was also collected by the researcher the day the posttest was given.

**Instrumentation**

The instruments utilized in this static-group comparison study were a pre- and posttest for student participants. The pre- and posttest administered to students were both researcher designed unit tests which were used in the researcher’s classroom the previous year. The pretest was version 1 of the polynomial unit test used the previous year and the posttest was version 2 of the polynomial unit test used the previous year. The pretest was used to examine normality between the control and experimental groups before treatment and the posttest was used to assess student academic achievement and critical thinking skills for the control and experimental groups after treatment in order to address the null hypotheses. The pre- and posttest contained material from Unit Two of the school’s Mathematics III curriculum. Unit Two of the Mathematics III curriculum addressed various concepts of polynomials which included: naming polynomials, identifying leading coefficients of polynomials, determining the degree of polynomials, and classifying polynomials as even, odd, or neither; identifying polynomials as symmetric to the y-axis, symmetric to the x-axis, symmetric to the origin or having no symmetry; dividing polynomials, evaluating polynomials, and describing the end behaviors of polynomials. An item analysis of each concept and the Georgia state standard each concept addressed for the pre- and posttest is presented in Table 2.
Table 2

*Georgia Performance Standards for Mathematics III Curriculum (Polynomials Unit)*

*(Georgia Department of Education, 2014)*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Concept</th>
<th>Question on Pre-and Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>MM3A1b</td>
<td>Naming polynomial</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>MM3A1b</td>
<td>Identifying leading coefficients of polynomials</td>
<td>5, 6, 7, 8</td>
</tr>
<tr>
<td>MM3A1b</td>
<td>Determining the degree of polynomials</td>
<td>9, 10, 11, 12</td>
</tr>
<tr>
<td>MM3A3a and MM3A3d</td>
<td>Evaluating polynomials (direct substitution)</td>
<td>13, 14, 15</td>
</tr>
<tr>
<td>MM3A1c</td>
<td>Classifying polynomials as even, odd, or neither</td>
<td>16, 17, 18, 19</td>
</tr>
<tr>
<td>MM3A1c</td>
<td>Identifying symmetries of polynomials</td>
<td>20, 21, 22, 23</td>
</tr>
<tr>
<td>MM3A3a and MM3A3d</td>
<td>Dividing polynomials</td>
<td>24, 25, 26, 27, 28, 29</td>
</tr>
<tr>
<td>MM3A3a and MM3A3d</td>
<td>Evaluating polynomials (synthetic substitution)</td>
<td>30, 31</td>
</tr>
<tr>
<td>MM3A1d</td>
<td>Graphing polynomials and describing end behaviors of polynomials.</td>
<td>32, 33, 34</td>
</tr>
</tbody>
</table>

**Reliability and Validity**

The pretest was an assessment consisting of a total of 34 questions. The test included 29 multiple choice questions, with four answer choices for each of the 29 questions. The remaining five questions required free responses. The 29 multiple choice items were used to gather normality data on the student academic achievement variable for the pretest and the five free response items were used to gather normality data on the student critical thinking skills variable.
for the pretest. Normality for the pretest variables (AA and CTS) were examined between groups to ensure that posttest data could be compared on these same variables. Reliability analyses for the pretest were computed using 62 previous students’ unit tests, which the researcher taught the prior academic school year. Reliability analysis for the pretest instrument produced a Cronbach’s alpha coefficient of .89 (for the 29 multiple choice questions) and .82 (for the five free response questions). The pretest items that were analyzed for reliability for this study were the exact same items that were used in the previous academic school year. Thus, the prior year students’ polynomials unit test (version 1) served as the pretest utilized in this study. Construct and content validity were embedded in the pretest instrument since the content to be tested were prerequisite content items mandated by the Georgia Department of Education (Georgia Department of Education, 2013b).

The researcher-designed posttest was used to measure student academic achievement as well as student critical thinking skills from the polynomial unit after treatment. The posttest was an instrument with a total of 34 questions: 29 were multiple choice (with four answer choices for each of the 29 questions) and the remaining five required free responses. The 29 multiple choice questions evaluated student academic achievement in respect to content taught during the period of the study, whereas the five remaining questions required a short response providing information about student critical thinking skills in respect to content taught during the period of the study. Reliability analyses for the posttest were computed using 65 previous students’ unit tests which the researcher taught the prior academic school year. Reliability analysis for the posttest instrument produced a Cronbach’s alpha coefficient of .85 (for the 29 multiple choice questions) and .80 (for the five free response questions). The posttest items which were analyzed for reliability for this study were the exact same items that were used in the previous academic
school year. Thus, the prior year students’ polynomials unit test (version 2) served as the posttest utilized in this study. Construct and content validity were embedded in the posttest instrument since the construct to be tested was the academic standards and content mandated by the Georgia Department of Education: “The construct tested is the academic content required by the statewide curriculum. With curriculum-based achievement tests, both types of validity are intertwined” (Georgia Department of Education, 2013b).

Cronbach’s alpha coefficient was used as a reliability estimate and measure of internal consistency for this study, since its coefficient is not affected by small samples and since the coefficient is widely used for composite scores in the educational, social science, and psychology arenas (Yurdugul, 2008). To avoid misuse of Cronbach’s alpha’s reliability coefficients and for construct and content validity to remain high, the researcher included all data from the teacher-designed pre- and posttest even though data varied between subjects. According to Tan (2009, p. 102), “Excluding some items from the scale to improve the internal consistency may severely cause a decrease in content and construct validity and such information is missing in most educational and psychological studies”. Data analysis was conducted in SPSS on the treatment and control groups’ pretest to examine normality. Data analysis was also conducted in SPSS to determine if there was a statistically significant difference between students’ posttest scores for the control and treatment groups to address research questions 1 and 2 utilized in this study. There was a span of nine weeks between pre- and posttest instrumentation.

To collect student data, a pretest was given to establish normality, the traditional or flipped instruction was implemented, and a posttest was administered to assess student AA and CTS to address research questions 1 and 2. In line with common practice, intact student groups were utilized. Regardless of grouping, everyone took a pretest and a posttest (Gall et al., 2007).
To begin the analyses of student pretest data, the researcher scored the pretest for every participant, entered the data in SPSS, and conducted normality analyses. To begin the analyses of student posttest data, the researcher scored the posttest for every participant and the student data were entered into SPSS for data analysis. SPSS performed two independent $t$-tests on the students’ posttests (one independent $t$-test for AA and another for CTS) to determine if a statistically significant difference existed in the mean posttest scores between the control and treatment groups as a result of the flipped instruction.

**Procedures**

Before data collection could begin, the researcher obtained local permission from the site administrators to conduct the study. After obtaining permission from the site administrator, the researcher obtained permission to conduct research in the school district from the district’s local board of education. After receiving approval from the local school board the researcher sought and received approval from Liberty University’s Institutional Review Board (IRB). After receiving IRB approval, the researcher issued recruitment forms to Mathematics III teachers at the study site. Once the teachers showed interest in the study and agreed to participate, the researcher secured permission from the teacher participants by obtaining voluntarily signed consent forms. The researcher also issued parent recruitment forms to each participating teacher to give to each of their students. Once parents agreed that their students could be part of the research study, parents signed a consent form and student participants signed voluntary assent forms. Since human subjects were used for this study, the IRB protocol included protection of human subjects and these standards were adhered to strictly.

The forms included for this study were one Teacher Recruitment Form (see Appendix A) and one Consent Form (see Appendix B) for each teacher who participated in the study, one
Assent Form for each student who participated in the study (see Appendix C), one Permission Letter to conduct research addressed to the Executive Director for the local School Board of Education (see Appendix D), Instruments (a pre- and posttest for each student who participated in this study) (see Appendix E), a Parent Permission letter addressed to parents whose students participated in the study (see Appendix F), and a Parent Recruitment Letter (see Appendix G). The researcher kept participating schools, classrooms, participants, and any other identifying information confidential by using pseudonyms throughout the study.

The treatment was implemented during Fall 2013 and was nine weeks in length. During this study, the control group received traditional instruction while the treatment group received instruction utilizing the flipped classroom model. In the traditional setting, students were taught concepts during the allotted class time and homework was assigned accordingly. In the flipped classroom, students received instruction at home (via teacher made videos, Internet, etc.) and completed homework in class. During class time students discussed the assigned topic with their instructor and classmates. Before implementing the flipped classroom, the researcher ensured that each student participant had access to the digital media necessary to incorporate flipped instruction.

The researcher ensured the flipped lesson’s availability by informing the flipped curriculum teacher that there was a media center “safety net” in place: each flipped lesson was available to students in the media center (the researcher downloaded each flipped lesson on every computer in the media center and showed the librarians how to retrieve each lesson for student participants if necessary) if students did not have access to the flipped instruction once they left the classroom. The media safety net was made available to student participants before school, during lunches, and after school. If these times were not convenient for students, the researcher
and flipped instructor agreed to accommodate students individually if access issues arose. After inquiring about the availability of Internet connection at home with his students, the flipped teacher ensured the researcher that every student had access to the flipped material after they left the classroom (each student had Internet access at home and a device which allowed them to view the inverted instruction) and that the media center’s safety net was not needed. As an added measure of fidelity, the researcher confirmed that students in the flipped classroom had access to the flipped material by frequenting the treatment classroom and witnessing engaging discussion amongst participating students and the flipped classroom teacher in reference to the viewed flipped instruction. To ensure that the study was progressing appropriately, the researcher made visits to the classrooms of the teachers who were involved in the study while instruction was taking place. These visits were the means the researcher employed to ensure that the traditional classroom instructor incorporated traditional methods of teaching and that the flipped classroom instructor actually flipped the treatment classroom. Although the researcher made visits to participating classrooms during the study, she did not verbally engage in classroom discussions, intervene with instructional strategies, or render pedagogical advice, comments or suggestions to student or teacher participants during the treatment phase of the research study.

The researcher disclosed the purpose of the study to all stakeholders, which included the school’s principal, the school district’s executive director, and the participating teachers. However, the researcher avoided disclosing information that would allow identification of the participants and class sections involved. The researcher respected the site and participants by causing minimal disruptions and by seeking to build relationships with the participating teachers that were characterized by trust. The researcher was committed to honestly reporting validity
and ethical issues, as well as reporting findings which were not favorable to the research study. The researcher shared the findings with participants and stakeholders, but as the results had the potential to impact the school system at large, the researcher only reported general and summary material.

The data for this study were collected at the beginning of the Fall 2013 semester from each participating classroom. The students completed a pretest at the beginning of the 2013 school year, treatment was implemented, and a posttest was given. Pretest raw scores were intended to establish normality between the control and experimental groups’ mathematics academic achievement and critical thinking skills levels at the beginning of the study. Posttest data were analyzed between groups to determine if there was a statistically significant difference in posttest means between the control and treatment groups.

**Data Analysis**

The purpose of this quantitative, static-group comparison study was to determine the possible effects of the inverted classroom on student AA and CTS in the secondary mathematics classroom. A static-group comparison design was chosen for this study, as it was developed to explore causality in situations where a true experiment design cannot be used (Bivens, 1999; Trochim, & Donnelly, 2006). Additionally, a static-group comparison design has two distinguishing characteristics: control and manipulation (Trochim, & Donnelly, 2006). In a static-group comparison design study, the control characteristic is the managing of extraneous sources or variables that may affect the study and can lead to invalid conclusions. The manipulation characteristic is the treatment or lack of treatment for a group of subjects (Bivens, 1999).

The researcher managed both the control and the manipulation characteristics for this
study. The researcher managed the control characteristic by trying to eliminate extraneous variables. Extraneous variables for this study included students’ access to technology during non-school hours, whether students actually watched the flipped material, and the flipped teacher implementation of the treatment. The way the researcher addressed these extraneous variables was discussed earlier in this chapter under the Procedures section. The researcher managed the manipulation characteristic by having control and treatment groups, wherein the control group received no treatment. For actual data collection, the researcher used a pretest and a posttest to collect the appropriate data. For this research study, the researcher collected, analyzed, and interpreted data on student academic achievement and student critical thinking skills.

Data from the pre- and posttest instruments mentioned above were analyzed using SPSS software. The pretest data for both student academic achievement and student critical thinking skills were examined for normality between the control and treatment groups. To determine normality between the groups, an independent $t$-test was utilized, wherein the significance level and confidence intervals were examined, Shapiro-Wilk’s coefficient was evaluated, and frequency distributions were created and examined in SPSS. The posttest data for both student academic achievement and student critical thinking skills were examined for differences in the groups’ mean between the control and treatment groups. To determine if there was a statistically significant difference in the mean posttest scores between the control and treatment groups, two independent $t$-tests were used to analyze student data: one independent $t$-test analyzed the academic achievement items and the other independent $t$-test analyzed the critical thinking skills items. For this study, the researcher used $p<0.05$ as the level of significance.

An independent $t$-test was chosen for the following reasons. First, the number of participants in each group was less than 30 and the two groups’ means were to be compared for
statistically significant differences. Research methodologists consider this analysis appropriate for comparing the means of two groups (Trochim & Donnelly, 2006). Second, all assumptions for an independent $t$-test were met. According to Elrod (2013), four conditions must be met to use an independent $t$-test. The first condition states that the study must contain bivariate independent data (A, B groups). Second, a continuous dependent variable must be present. Third, each observation of the independent variable must be independent of the dependent variable. Fourth, each group’s dependent variable must have a normal distribution. Although student participants were not randomly selected for this study, independent $t$-test results were still valid. When utilizing an independent or dependent $t$-test to evaluate data, randomization is not necessary (Elrod, 2013).
CHAPTER FOUR: RESULTS

Introduction

The main purpose of this study was to determine if there was a statistically significant difference in student academic achievement and critical thinking skills between Mathematics III students who received flipped instruction and students who did not. This chapter presents the results for this study related to the research questions and the null hypotheses identified in Chapter one, and concludes with a brief summary of the results.

For this static-group comparison design study, IBM SPSS version 21 was used for statistical analysis and the following research questions were used to guide the study:

Research Questions

RQ1: Is there a difference in Mathematics III students’ mathematics academic achievement between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

RQ2: Is there a difference in Mathematics III students’ mathematics critical thinking skills between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

Null Hypotheses

This research project explored the effect of the flipped classroom in mathematics education on student academic achievement and student critical thinking skills with the following null hypotheses:

H₀₁: There will not be a statistically significant difference in the mean posttest results in student academic achievement on the Mathematics III posttest (questions 1 through 29 on the posttest instrument) between the control and experimental groups.
**H₀₂:** There will not be a statistically significant difference in the mean posttest results in student critical thinking skills on the Mathematics III posttest (questions 30 through 34) between the control and experimental groups.

**Collection of Student Data**

The student data for this research project were collected through a student pretest and a student posttest. For the study, there were a total of 28 students included in the treatment group, 14 females and 14 males. There were a total of 30 students included in the control group, 15 females and 15 males. Once the pretest and posttest were given to the student participants in the study, the researcher immediately collected, organized, graded, and recorded all data for the study and kept the data locked in a file cabinet at the researcher’s personal residence. Since the researcher coded the data, the participants in this research study remained anonymous. Each student participant’s scores were entered into IBM’s SPSS Statistics, Version 21 software by the researcher.

**Test of Normality: Pretest**

Before treatment, the researcher employed a pretest to establish normality between the control and treatment groups. To conduct parametric tests, an examination of normality of data is an underlying assumption as well as a prerequisite (Laerd Statistics, 2013). There were a total of 29 academic achievement items on the pretest (questions 1-29) and a total of 5 critical thinking skills items on the pretest (questions 30-34). Each item on the pretest was worth a single point. If the student responded correctly to a question, they received a point. Thus, the maximum number of points a student could receive on the academic achievement items for the pretest was 29 and the maximum number of points a student could receive on the critical thinking skills items for the pretest was 5. After the pretest was given to every student
participant, the researcher graded each student’s pretest, and entered the data into IBM’s SPSS Statistics, Version 21 to examine normality.

**Independent t-test Summary**

To determine if there was a statistically significant difference in the mean posttest results in student academic achievement and critical thinking skills between the traditional and flipped classroom students, posttest data were compared. Table 3 includes the descriptive statistics of the posttest for the control and experimental groups. The descriptive statistics for the treatment classroom, instructional format 1, were as follows: A total of 28 student participants’ posttest scores, which assessed academic achievement, included a Mean of 19.68 and a Standard Deviation of 6.57; posttest scores which assessed critical thinking skills included a Mean of 3.36 and a Standard Deviation of 1.50.

The descriptive statistics for the control classroom, instructional format 2, were as follows: A total of 30 student participants’ posttest scores, which assessed academic achievement, included a Mean of 20.00 and a Standard Deviation of 4.58; posttest scores which assessed critical thinking skills included a Mean of 3.10 and a Standard Deviation of 1.69.

Table 3

*Group Descriptive Statistics for Posttest*

<table>
<thead>
<tr>
<th>Group Statistic</th>
<th>Instructional Format</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post AA</td>
<td>1</td>
<td>28</td>
<td>19.6786</td>
<td>6.56621</td>
<td>1.24090</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>20.0000</td>
<td>4.57881</td>
<td>.83597</td>
</tr>
<tr>
<td>Post CTS</td>
<td>1</td>
<td>28</td>
<td>3.3571</td>
<td>1.49603</td>
<td>.28272</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>3.1000</td>
<td>1.68870</td>
<td>.30831</td>
</tr>
</tbody>
</table>
When comparing data among groups, equal variances must be assumed (Elrod, 2013). To compare variances among the treatment and control groups’ posttest data, Levene’s Test for Equality of Variances was utilized. As seen in Table 4, equality of variances can be assumed (p > 0.05) for the student academic achievement items (p = 0.665) as well as for the critical thinking items (p = 0.239). Further, the Levene’s test is a homogeneity-of-variance test that depends less on the assumptions of normality than other tests. For each case to pass the Levene’s test, two assumptions must be met. The first assumption was that each sample under consideration must be independent, and the second assumption was that the populations under consideration were approximately normally distributed (Virginia Commonwealth University, 2014). To ensure that these assumptions were upheld, the researcher collected samples independently and frequency distributions were created to confirm that the populations were approximately normal (displayed in Figure 1 and Figure 2). Hence, these two groups can be compared (Elrod, 2013).

Table 4 includes statistical data from the treatment and control groups’ posttest. An independent $t$-test was conducted on both the AA and CTS variable for both groups. Table 4 shows the results for each $t$-test and reveals that there were no statistically significant differences between the treatment and control groups AA or CTS posttest scores when evaluated at a 0.05 significance level.
To address research question 1, the researcher compared the mean difference in posttest scores for the academic achievement items between the control and experimental groups. Student academic achievement posttest scores from the experimental group, the group that participated in the flipped classroom, were then compared to the student academic achievement posttest scores in the control group, which did not receive flipped instruction. An independent *t*-test was conducted.

To address research question 2, the researcher compared the mean difference in posttest scores for the critical thinking skills items between the control and experimental groups. Student critical thinking skills posttest scores from the experimental group, the group that participated in the flipped classroom, were then compared to the student critical thinking skills posttest scores in

<table>
<thead>
<tr>
<th></th>
<th>Independent Samples Test</th>
<th>Levene's Test for Equality of Variances</th>
<th></th>
<th>t-test for Equality of Means</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>t</td>
<td>df</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post AA</td>
<td>Equal variances assumed</td>
<td>1.420</td>
<td>.239</td>
<td>-.217</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td>- .215</td>
<td>47.886</td>
<td>.831</td>
<td>-.32143</td>
</tr>
<tr>
<td>Post CT</td>
<td>Equal variances assumed</td>
<td>.190</td>
<td>.665</td>
<td>.612</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td>.615</td>
<td>55.856</td>
<td>.541</td>
<td>.25714</td>
</tr>
</tbody>
</table>
the control group, which did not receive flipped instruction. An independent $t$-test was conducted. The comparison of these posttest scores reflected the effects (if any) that the flipped curriculum had upon student academic achievement and critical thinking in secondary mathematics.

**Research Questions and Hypotheses**

**Research Question 1**

Is there a difference in Mathematics III students’ mathematics academic achievement between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

**Null Hypothesis ($H_0$)**

There will not be a statistically significant difference in the mean posttest results in student academic achievement on the Mathematics III posttest (questions 1 through 29) between the control and experimental groups.

An independent samples $t$-test was conducted to determine if there was a statistically significant difference between the independent variable, teacher pedagogy, and the dependent variable, student academic achievement. Data from both classrooms were entered into SPSS, and a variable, instructional format 1 (flipped) or instructional format 2 (traditional), was added to identify groups. Student academic achievement posttest scores from the flipped classroom were compared to the student academic achievement posttest scores from the traditional classroom. The results from the independent $t$-test assuming equal variances were as follows: $t (58) = -.217$. The two groups did not differ statistically with significance of $p = .239$. The mean of the scores from the flipped classroom student academic achievement posttest items was not significantly different from the mean of the scores from the traditional classroom students’
academic achievement posttest items as noted in Table 4. Thus, the researcher failed to reject null hypothesis 1. Figure 1 displays distributions of the student academic achievement data of the posttest results by instructional format.

Figure 1. Histogram of Student AA Posttest Results by Instructional Format. Instructional Format 1 = Flipped Classroom & Instructional Format 2 = Traditional Classroom

The histogram at the top represents the student academic achievement posttest results of the treatment group, and the histogram at the bottom represents the student academic achievement posttest results of the control group. The descriptive statistics for the posttest academic achievement items for both groups are noted in the previous section under independent t-test summary. For the treatment group’s data, statistical analysis revealed a median of 20.50, a Range of 28, and Inter Quartile Range of 7. The highest score on the posttest for the treatment
group’s academic achievement items was 28 and the lowest score on the posttest for the treatment group’s academic achievement items was 0. For the control group data, statistical analysis revealed a median of 20.50, a Range of 20, and Inter Quartile Range of 7. The highest score on the posttest for the control group’s academic achievement items was 28 and the lowest score on the posttest for the control group’s academic achievement items was 8. The histograms provide further visual analyses which confirm that the groups did not demonstrate a statistically significant difference for the student academic achievement items.

**Research Question 2**

Is there a difference in Mathematics III students’ mathematics critical thinking skills between students in traditional and flipped classrooms when the flipped classroom model is implemented during a nine-week semester?

**Null Hypothesis (H₀2)**

There will not be a statistically significant difference in the mean posttest results in student critical thinking skills on the Mathematics III posttest (questions 30 through 34) between the control and experimental groups.

An independent samples *t*-test was conducted to determine if there was a statistically significant difference between the independent variable, teacher pedagogy, and the dependent variable, student critical thinking skills. Data from both classrooms were entered into SPSS, and a variable, instructional format 1 (flipped) or instructional format 2 (traditional), was added to identify groups. Student critical thinking skills posttest scores from the flipped classroom were compared to the student critical thinking skills posttest scores from the traditional classroom. The results from the independent *t*-test assuming equal variances were as follows: *t* (58) = .612. The two groups did not differ statistically with significance of *p* = .665. The mean of the scores
from the flipped classroom students’ critical thinking skills posttest items was not significantly
different from the mean of the scores from the traditional classroom students’ critical thinking
skills posttest items, as noted in Table 4. Thus, the researcher failed to reject null hypothesis 2.
Figure 2 displays distributions of the student critical thinking skills data of the posttest results by
instructional format.

Figure 2. Histograms of Student CTS Posttest Results by Instructional Format. Instructional
Format 1 = Flipped Classroom & Instructional Format 2 = Traditional Classroom

The histogram at the top represents the student critical thinking skills posttest results of
the treatment group and the histogram at the bottom represents the student critical thinking skills
posttest results of the control group. The descriptive statistics for the posttest critical thinking
skills items for both groups are noted in the previous section under independent \( t \)-test summary.
For the treatment group’s data, statistical analysis revealed a median of 3.50, a Range of 4, and
Inter Quartile Range of 3. The highest score on the posttest for the treatment group’s critical
thinking skills items was 5 and the lowest score on the posttest for the treatment group’s critical
thinking skills items was 1. For the control group’s data, statistical analysis revealed a median of 3.00, a Range of 5, and Inter Quartile Range of 3. The highest score on the posttest for the control group’s critical thinking skills items was 5 and the lowest score on the posttest for the control group’s critical thinking skills items was 0. The histograms provide further visual and numerical analyses which confirms that the groups did not demonstrate a statistically significant difference at a significant level for the student critical thinking skills items.

Summary

The data collected from students were categorized into two categories: Academic Achievement, which corresponded to items 1-29 on the student pre-and posttest, and Critical Thinking Skills, which comprised questions 30-34 on the student pre-and posttest. Each item on the student pre- and posttest yielded one point. An alpha of 0.05 was used for each independent t-test. The alpha level was set at 0.05 since this is the standard widely used in psychology and educational research to justify a claim of a statistically significant effect; an event which occurs 5% of the time is a rare event and is not an infrequent event of mere chance (Cowles & Davis, 1982). The alpha of 0.05 is the probability of the researcher rejecting the null hypothesis when the same experiment would produce similar results 95% of the time.

An independent t-test, Test of Normality, and histograms were used to evaluate normality amongst the treatment and control groups’ pretest scores with regards to instructional format (traditional format or flipped format). Employing three methods (Independent t-test and Shapiro-Wilk’s analyses, as well as the examination of frequency distributions) a statistically significant difference was not shown between the groups’ pretest academic achievement items as well as the groups’ critical thinking skills items, which confirmed normality. These tests confirmed that the groups were comparable and as a result posttest analysis could be performed
between both groups.

An independent \( t \)-test was used to evaluate differences between the treatment and control group posttest academic achievement scores with regards to instructional format (traditional format or flipped format). There was not a statistically significant difference shown. The \( t \)-test yielded a value of \( t(58) = -0.217 \) with scores from the flipped classroom academic achievement posttest yielding \( m = 19.6786 \) and \( sd = 6.56621 \), and scores from the traditional classroom academic achievement posttest results yielding \( m = 20.0000 \) and \( sd = 4.57881 \). Additionally, the \( p \)-value of \( .239 \) for the posttest academic achievement comparison was greater than the alpha of \( 0.05 \), and the 95% confidence intervals of the differences contained zero (\( -3.28257, 2.63971 \)), which also confirmed the two groups did not differ on the posttest academic achievement variable which resulted in the failure to reject \( H_01 \) (student academic achievement).

A second independent \( t \)-test was used to evaluate differences between the treatment and control group posttest critical thinking skills scores with regards to instructional format (traditional format or flipped format). There was not a statistically significant difference shown. The \( t \)-test yielded a value of \( t(58) = 0.612 \) with scores from the flipped classroom critical thinking skills posttest yielding \( m = 3.3571 \) and \( sd = 1.49603 \) and scores from the traditional classroom academic achievement posttest yielding \( m = 3.1000 \) and \( sd = 1.68870 \). Additionally, the \( p \)-value \( .665 \) for the posttest critical thinking skills was greater than the alpha of \( 0.05 \) and the 95% confidence intervals of the differences contained zero (\( -.58440, 1.09869 \)), which also confirmed the two groups did not differ on the posttest critical thinking skills variable which resulted in the failure to reject \( H_02 \) (student critical thinking skills).
CHAPTER FIVE: DISCUSSION

Introduction

Ways to improve student academic achievement and critical thinking skills in mathematics have been heavily discussed in the education arena for the past two decades (Walshaw & Openshaw, 2011). In mathematics education, stakeholders are searching for curricula that keep students engaged in addition to increasing academic achievement. Mathematics educators are beginning to implement varied curricula in hopes of positively changing students’ attitudes and dispositions towards mathematics, to effectively teach mathematics, and to boost standardized test scores (Takaci & Budinski, 2011). Further, many mathematics educators are seeking innovative ways to present material to students by attending numerous professional development trainings utilizing various online resources, and incorporating non-traditional curricula into their traditional classrooms in an effort to improve their teaching efficacy (Jones et al., 2010). This research study examined an alternative to the traditional curriculum and the impact that change had on student academic achievement and student critical thinking skills.

Purpose

The purpose of this static-group comparison non-equivalent control group design was to determine if a statistically significant difference existed between the treatment and control groups’ academic achievement scores as well as their critical thinking skills scores in Mathematics III when a posttest was given after a flipped classroom teaching format was implemented. Numerous studies exist which reveal the positive effects alternative curricula have on secondary education. The research is deficient, however, with few empirical studies that measure the benefits of the inverted classroom within the secondary classroom. Thus, this research study sought to fill a gap in the literature by determining the effects (if any) that the
implementation of the flipped classroom may have upon student academic achievement and critical thinking skills in secondary mathematics.

Chapter one presented background information, the problem and purpose statements, the significance and hypotheses of this research study, pertinent definitions, a research summary, and the assumptions and limitations that the researcher encountered during this research project. Chapter two incorporated a literature review that examined current journals, articles, and publications on differentiated instruction, teacher pedagogy, educational technology, and the flipped classroom. Chapter two also introduced a theoretical framework that supported the facets of this study. Chapter three described the methodology used to collect and examine data for this research study. Chapter four reported the results from the data collected and the analysis of the data using SPSS. In chapter five, the researcher discusses conclusions from the study and suggests implications for further research.

**Participants and Setting**

The population included the 2015 graduating class from a high school in South East Georgia and the participants were students in the 2015 graduating class who took a Mathematics III course during the first semester and have also taken the pre- and posttest. The 2015 graduating class at the study site in South East Georgia numbered 468 persons. The classes that could potentially be included in the study were all Mathematics III courses at the research site. From that pool, the actual classes that participated in this study were chosen as a convenience sample. The students in these classes became participants in this study if their course sections were chosen to participate.

The location of this study was at a high school in South East Georgia. The treatment was implemented during the Fall of 2013 and was nine weeks in length. During this study, the
control group received traditional instruction while the treatment group received flipped instruction. This research study included 58 student participants, 30 females and 28 males, all in two sections of 11th-grade Mathematics III classes. The control group had 30 students (15 females and 15 males) and the treatment group had 28 students (14 females and 14 males). This research study included 2 teacher participants; one was assigned to the control group and the other was assigned to the treatment group.

Methods

The researcher used SPSS to evaluate the data collected. Independent \( t \)-tests, Shapiro-Wilk’s Test of Normality, and histogram distributions were used to confirm normality between the traditional and flipped classrooms’ AA and CTS variables. Levene’s Test of Equality of variances was used to confirm that the two sample classrooms had equal variances on the AA and CTS posttest variables and independent \( t \)-tests were used to explore differences in means between the treatment and control groups’ posttest scores. Two null hypotheses were used to examine the two research questions. The first null hypothesis was analyzed using an independent \( t \)-test to determine if a statistically significant difference existed in the means of the posttest scores in the academic achievement variable between the traditional and the flipped classroom. The second null hypothesis was analyzed using an independent \( t \)-test to determine if a statistically significant difference existed in the means of the posttest scores for the critical thinking skills variable between the traditional and the flipped classroom.

Summary of Findings

Findings for Research Question 1

The first question of this research study focused on the flipped classroom’s potential for a statistically significant effect on mathematics students’ academic achievement. The researcher
failed to reject the null hypothesis since results indicated no significant difference and showed that students who took Mathematics III when the flipped classroom was implemented did not earn higher academic achievement posttest scores than their traditional counterparts.

Although the results for this research question proved statistically insignificant, mathematics educators can still implement various flipped classroom models as an alternative curriculum to incorporate differentiation of learning and reaching students with various learning styles. In turn, student academic achievement may be impacted. These findings are important for high school mathematics educators because alternative modes of teaching can provide an innovative substitute that is at least no worse than today’s traditional mathematics classrooms delivery methods. Some teachers or school administrators may be reluctant to innovate in the classroom, fearing that their students’ performance on high stakes testing may actually be lower as a result of the innovation. This research has shown that the inverted curriculum is an innovation that can be used without fear of lowering student achievement.

**Findings for Research Question 2**

The second question of this research study that addressed the flipped classroom did not result in a statistically significant effect on mathematics students’ critical thinking skills. The researcher failed to reject the null hypothesis since the results indicated no significant difference and showed that students who took Mathematics III in the flipped classroom did not earn higher critical thinking posttest scores than their traditional counterparts.

Although the results for this research question proved statistically insignificant, mathematics educators can still explore various flipped classroom models as an alternative curriculum to implement multiple representations of various concepts in the mathematics classroom. These findings are important for high school mathematics educators because they
warrant the idea that flipped classroom activity may have potential impact on other areas of education.

**Discussion**

The flipped classroom is a relatively new concept in general education (Bergmann & Sams, 2012a; SOPHIA Learning, LLC., 2013). Articles, journals, or research studies that were available on the flipped classroom have not yet addressed the effect of the flipped classroom on student academic achievement and student critical thinking skills in the high school mathematics classroom.

The two research questions of this study considered whether the flipped classroom had an effect on student academic achievement and student critical thinking skills in the high school mathematics classroom. This study found that the flipped classroom students’ posttest scores were not significantly different in comparison to the traditional classroom students’ posttest scores. While it is possible that the students’ dispositions towards the treatment in the flipped setting might have affected the AA and/or CTS results, the differences in pedagogical strategies, instructional methods, and classroom discussions in that the control and treatment instructor taught the content standards differently could have had a larger effect. A study conducted by Johnson and Renner (2012) pertaining to the flipped classroom in computer science education yielded similar results. In respect to this result, they suggested it represented a failed attempt at the flipped method of instruction in their research setting (students did not embrace the flipped methods but insisted on traditional teaching) rather than a result applicable to the flipped classroom model in general. Although students embraced the flipped classroom methods during class time in this study, the researcher could not guarantee that the students actually followed the flipped methods once they left the classroom. The researcher spoke with the treatment teacher
after the study was completed to understand the teacher’s perspective of the implementation of the project on student academic achievement as well as student critical thinking skills. The teacher’s perspective of student interaction with and their experience in the flipped classroom included the following ideas:

1. Students that really took advantage of the flipped classroom format were students that were already intrinsically motivated before the study.
2. Every student had access to the Internet to view the flipped material so there were no technical reasons why the students could not participate.
3. Before each class session began, the class would discuss the viewed flipped classroom media for about 10 minutes, an approach which the teacher adopted to confirm the students’ participation.

Conclusion

In today’s classrooms, mathematics educators must implement the use of digital technologies while facilitating learning processes instead of just lecturing (Sankey et al., 2011). To assist mathematics educators on a journey toward more varied instructional practices and to cater to numerous students’ learning styles, alternate curricula are now increasingly used. This is seen as a means of helping teachers deal with the increasing ratio of students to teachers while helping them meet the expectation of reaching every student in their classrooms. Often, students start each year deficient in mathematics, adding another concern for the math educator: the student’s ability to progress sufficiently in the mathematics sequence. Although these students may arrive behind, they still must be afforded the opportunity to learn the math concepts or jeopardize their chances of graduating, which may increase their chances of dropping out. Mathematics graduation requirements can cause talented students to struggle and are the
academic initiators behind the nation’s high school and college dropout rates (Sheehy, 2012). The signs of struggling math students show up as early as eighth grade and students who fail eighth grade mathematics or English are 75% more likely to dropout (Convissor, 2014).

According to the federal government, about 7,000 students drop out of school every weekday and the nation loses $319 billion in potential earnings associated with the dropout crisis annually (The White House, 2009). Further, approximately 2,000 of America’s high schools produce half of the nation’s school dropouts (The White House, 2009). In order for America to remain competitive globally, students must be not only proficient in mathematics, but they must excel in mathematics. This study provided insight about how a pattern for structuring mathematics courses and curriculum impacts students and educators.

The results of this study indicate that the implementation of the inverted curriculum in secondary mathematics may not yield the results that are suggested in recent publications. However, there are various factors that need to be considered. Participants’ comfort levels with technology, participants’ degree of involvement with the flipped material outside of the classroom, teacher participants’ instructional and pedagogical practices, and the actual content to be studied should be taken in consideration. Therefore, additional research and study is suggested.

The results, while not conclusively positive, provided information about the potential to use alternative curricula in secondary mathematics. The findings from this study could encourage educators to implement alternative curricula infused with technologies in their classrooms to support students with various learning styles, expose students to various pedagogy, provide students with additional one-to-one time for collaborations with the instructor, and provide a platform upon which students have meaningful discussions with their peers. The
benefits of implementing flipped instruction could possibly increase teacher efficacy and as a result, positively impact student academic achievement and critical thinking skills in secondary mathematics. This is an area where further research involving a large number of teachers should be conducted by some organization which could fund such a project. Alternative curricula may also provide a means to help empower mathematics students toward success in mathematics at the level of the Mathematics III classroom and beyond. However, more research will be required to determine the full impact of the broad variety of curriculum patterns made possible by digital technologies.

Educators should note that the flipped method of instruction is not an all or nothing approach (Bergmann & Sams, 2012b) and that the outcome of this study should not be seen as the representative for flipped classroom curricula in general. To begin the process of flipping a classroom, educators can flip certain lessons (not each and every lesson), or simply flip lessons that they feel are appropriate. There is not a specific way to flip a class; educators must give each class what they need by deciding when and what lessons to flip. However, educators must realize that implementing the inverted curriculum effectively may take additional time and effort compared to the traditional curriculum. While there are numerous pieces of digital media available for almost every topic in education (Alvarez, 2012), educators must know that if specific content is not available, they will be required to produce or create such media (in some cases, the search for relevant media can take as long as creating relevant media).

From this study, the researcher concluded that the inverted instructional setting could provide remediation as well as enrichment for all learners and give educators the insight they need to determine which students are struggling and which students should move on. Since the educator can quickly determine students’ needs in the flipped instructional setting, tailored
instruction can be given to each student by means of differentiation. Students viewing the content before it is introduced in class provides benefits to both the student and educator. Some student benefits may include the learners being familiar with the lesson before they get to class, participation and collaboration with peers to diffuse any content misconceptions, the implementation of computer and digital technology in mathematics instruction, and the possibility of extending the learners’ knowledge to in-depth complex problems or real life application problems. Some teacher benefits may include the ability to differentiate instruction more effectively, the role as a facilitator rather than a lecturer, more confidence about discussing the content in class (since it has already been introduced), and experiencing higher levels of self-efficacy which could in turn increase student academic achievement.

**Implications**

**Implications for Practice**

In the traditional classroom, mathematics teachers are usually pressed for time to teach students the required curriculum (Berrett, 2012). Since there has been a push from Georgia Performance Standards and similar initiatives in other states to utilize digital technology in mathematics education, educators are left with few choices other than incorporating alternate curricula while simultaneously teaching the mandated standards (Georgia Department of Education, 2013c). The flipped classroom approach addresses these issues by infusing digital technologies and differentiation of instruction, incorporating multiple representations, and offering students the chance to learn collaboratively.

Mathematics educators that believe in their ability to positively impact student academic achievement in the mathematics classroom have a profound impact on math education. Bandura’s Self-Efficacy Theory (1994) suggested that people who have high-self efficacy and
believe in their ability to achieve will set high goals, commit to those goals, rehearse success mentally, and think analytically in stressful situations (Hunt-Ruiz, 2011). This theory implies that when teachers have a high teaching efficacy, they set high standards for their own teaching, set higher standards for student learning, and persevere through challenges in the teaching and learning process. To ensure that mathematics students receive a teacher with high teaching efficacy, school districts should invest in various professional development courses that address teacher efficacy (Hunt-Ruiz, 2011).

**Implications for Research**

This research study was based on the hypothesis that flipped instruction in the mathematics classroom would benefit students since the flipped classroom model incorporated technology, differentiated instruction, and a shifted teaching style. Although the results of this study did not support these hypotheses, this study provided insight for future research on this topic and showed that flipped instruction is a viable method of differentiating instruction. A study conducted on the flipped classroom in mathematics instruction that is implemented over a longer period of time may provide a greater effect on student academic achievement and student critical thinking skills in posttest results. Including an additional semester of study may have shown different outcomes.

Further research studies are needed on the flipped classroom in mathematics education. This topic is fairly new and only a few studies were available that specifically addressed this research topic. There were several studies and articles that addressed the implementation of technology in the mathematics classroom with tools such as laptops, iPads, and other technologies, while other studies described teachers’ experiences with the flipped classroom (Alvarez, 2012; Bergmann & Sams, 2012b; Berrett, 2012; Fulton, 2012a). There are also
studies that discussed experimental research on the flipped classroom, but only a few directly mentioned the flipped classroom method’s impact on mathematics education.

Although the results of this study did not support the hypotheses, the research contained herein should still be considered relevant since this study adds to the small body of literature conducted in the area of alternative curricula for secondary mathematics. In order for students to meet national mathematics standards, implementation of some sort of alternate curriculum is important and imminent (Adams & Pierce, 2012; Jones et al., 2010). Inverted curricula and alternatives to the traditional setting which incorporate digital technologies in secondary mathematics will provide opportunities for further research. In the very near future, conducting other studies regarding high school mathematics and the effect of the flipped classroom on student academic achievement will be possible, which could address specific mathematics issues in mathematics classes such as differentiation of instruction, implementation of a variety of forms of digital technology, student motivation, and student engagement in mathematics.

Research on the practice in the inverted classroom could provide many benefits to students in the mathematics instructional setting. Benefits such as student collaboration, more one-on-one time for educators to work with individual students, integration of digital technology, and multiple representations could positively impact student academic achievement. Additional research in this area may also influence teaching practices since this curriculum approach would provide educators with an additional resource; a resource that provides initial or additional content instruction to students. Since the student receives specific content instruction (via digital media) that the teacher has created/previewed, the teacher is confident that the material is appropriate and rigorous, which could in turn decrease teacher burnout and increase teaching efficacy.
Since students’ academic achievement and critical thinking skills prove crucial to meet national standards in mathematics as well as predict school success rates (Fulton, 2012a; NCTM, 2005), examining the effect of the flipped classroom in all high school mathematics courses will be beneficial. Further, for the 2013 and 2014 academic school years, the state of Georgia has agreed to subsidize testing fees for the American College Test (ACT) for all 10th-grade mathematics students in public high schools. Thus, ideas for further research on the impact of the flipped classroom in mathematics education would include the implementation of the flipped classroom in courses that offer standardized test preparation in mathematics (SAT and ACT test prep classes) to determine if this inverted curriculum could elevate academic test scores. Additionally, the implementation of the flipped classroom at levels beyond high school is another area that needs further exploration to determine the effectiveness (if any) of the flipped classroom on student academic achievement in mathematics education.

Although the size of this study is a major shortcoming to the research and limits the questions which were able to be addressed, a study with a larger sample size might determine if certain subgroups are positively impacted by the implementation of the flipped classroom in all mathematics classes. Future research studies should consider the following questions:

1. Do high school girls benefit more than their male classmates in a flipped classroom?
2. How would the flipped classroom affect minority students?
3. How would the flipped classroom impact academic achievement and critical thinking skills for socioeconomically disadvantaged students?
4. What will the effect of this inverted curriculum be on students with disabilities?
5. Would a flipped mathematics classroom positively impact student academic achievement and student critical thinking skills in elementary and middle schools?
There are multiple scenarios that could be examined to provide insight to the benefits of implementing the flipped classroom in mathematics education.

**Assumptions, Limitations, & Weaknesses**

The researcher assumed that all students were equally knowledgeable and that if learning disabilities were present, the outcome of the study would not be affected. The researcher assumed that all students performed to the best of their ability during each assessment. The researcher assumed that the teachers were ethical, certified in the field of mathematics in the state of Georgia, and highly qualified professionals. The latter two assumptions were confirmed since each adult participant held current Georgia certification and was deemed highly qualified as verified by the county office. The researcher also assumed that the educators followed the guidelines of the Local Board of Education as well as Liberty University’s Institutional Review Board (LU IRB) while they participated in this study and while they implemented the aforementioned assessments.

When conducting research, limitations and validity issues are inevitable. Some foreseen limitations included the treatment teacher’s feelings about pedagogy and how technology may affect the implementation of that pedagogy, the teacher’s knowledge of the flipped classroom, the teacher’s comfort level with technology in general, students’ fluency regarding technology, ease of use with and knowledge of technology, student’s understanding of and adaptation to the flipped classroom, and that technology issues arose during the investigation. A specific technological issue existed which had the potential to cripple the study: students being unable to access the online instructional material after school hours. If students were not able to access the instructional documents online or independently employ the teacher-made videos, a major limitation to the study would have been introduced. To address this issue, the library was made
available to students before and after school so that they would have access to computers and consequently, the online resources. To address the treatment teacher’s disposition about the study, every effort was made to ensure the teacher was comfortable with technology and additional support was provided as needed (training, one-on-one technology support, etc.).

Some validity issues that arose during the study included the location for the investigation, the volume of literature addressing the research topic, and the sample group which may not have been representative of Georgia’s total secondary mathematics student population.

One limitation of this study was lack of randomization. A non-equivalent control group design was used for this study and this design type lacks random assignment to the experimental and control group since the results of the posttest could be attributed to preexisting conditions as opposed to the treatment itself. Although lack of randomization was a characteristic of this research study, with the use of pretest and posttest data, reliable results were still expected (Gall et al., 2007). To eliminate this threat, a pre- and posttests were given to student participants in the study and a Test of Normality (on pretest data) as well as a Levene’s Test of Equality of Variances (on posttest data) was utilized for the student data to ensure that both groups were comparable. Both the Test of Normality and Levene’s test concluded that all assumptions were met to compare student data.

A second weakness of the study was the amount of literature that was available regarding the topic. Since research regarding the impact of the flipped classroom model is fairly new (studies have been published within the last few years), the researcher was limited by the number of items in the literature that could possibly explain or support the new theories, findings, and conclusions that were presented in this study. However, the lack of literature available allowed the researcher to fill a gap in the current literature with respect to the flipped and high school
mathematics classrooms. The researcher is hopeful that this study will provide introductory work for future related research studies.

Other weaknesses of the study included the pretest and posttest instruments and the study site itself. The pretest and posttest instruments may have included material that a future researcher will find to be of no value for student assessment in respect to consideration of the flipped classroom model. Conversely, the instruments may also serve as a weakness of the study since the researcher may have excluded material that a future researcher would deem relevant for a study of the impact of the flipped classroom on students. The researcher chose instruments that were relevant for this study. However, these instruments may need to be revised based on the needs of a replication study.

The study site may have posed a weakness to the study since the population, school character, and curricular implementation may not have been representative; hence, the pretest and posttest instruments may need to be revised to be useful in replication studies. Teachers should review prerequisite skills relevant to this study to ensure their students are ready for the introduction of these new concepts. Another limitation was the location of the study. The location of this research study was in South East Georgia. The results, conditions of the study, and the topic in which the sample students were evaluated were very specific and may be difficult to replicate for a different sample of high school mathematics students. To address this limitation, the researcher selected a school that reflected demographics similar to many high schools in the State of Georgia. The study results cannot be generalized across various demographic or geographic locations.

Another limitation of this research study was the small sample size. At the research site, there were a total of 13 Mathematics III sections. This research study only included subjects
from four sections which were taught by two different instructors. Thus, only 31% of the school’s Mathematics III population was part of the research study. To address this threat, the researcher randomly chose the sample population from the total population of Mathematics III classes at the research site. After looking over the configurations (demographics, gender, student progress) of the remaining Mathematics III sections, the researcher concluded that the selected sample was normal. The study results cannot be generalized to other level mathematics classes and to other content areas. A sample this size may present challenges in respect to making generalizations from the study results. When making inferences about the results of this study, one must be mindful of these assumptions and limitations and do so cautiously.

**Recommendations**

There are unanswered questions about the effects of the flipped classroom on student academic achievement and student critical thinking skills in the mathematics classroom. As a result of this research study, the paradigm shift in mathematics and the implementation of national mathematics standards, the following recommendations are suggested:

1. Schools should consider implementing at least some facets of the flipped classroom as a differentiation tactic.
2. High schools should consider implementing technology into their upper mathematics courses on a regular basis in the form of computers, laptops or iPads.
3. Students should have the option of viewing digital media as it relates to the concept being taught during class if they require further explanation, desire further enrichment, or if they wish to extend their understanding of the topic of the lesson.
4. Schools should facilitate student progress in high school mathematics classrooms by instructing and motivating students to view upcoming curriculum topics via digital
media.

5. Districts should offer professional development courses on a continuum that specifically addresses teacher efficacy for mathematics teachers.
REFERENCES


Unpublished EdD thesis. University of Kansas, Kansas


Bergmann, J., & Sams, A. (2012a). Before you flip, consider this: Leaders of the flipped classroom movement say each teacher will have a different experience, but securing
school leadership support, time, and IT resources will be important to every effort. *Phi Delta Kappan*, 94(2), 25.


doi:10.1126/science.1191040


McAdamis, S. (2001). Teachers tailor their instruction to meet a variety of student needs. *Journal of Staff Development, 22*(2), 1-5.

National Board for Professional Teacher Standards (NBPTS). (2013). What is pedagogy?


President Obama announces steps to reduce dropout rate and prepare students for college and careers. [Press Release].


Appendix A: Recruitment Form

RECRUITMENT FORM: TEACHER

Date: September 23, 2013

Select Mathematics III Teachers
County High School

Dear Mathematicians,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctoral Degree in Education, and I am writing to invite you to participate in my study.

If you choose to participate, you will be asked to implement a flipped or traditional curriculum in your classroom and administer a pre and posttest to your students. If you are chosen to implement a flipped classroom, all resources to (dvds, links, and other media that students will need to watch to learn mathematics concepts) “flip” your classroom will be provided by the researcher. It should take approximately eight to ten weeks for you to complete the procedure[s] listed. Your participation will be completely confidential, and no personal, identifying information will be required.

To participate, contact me at (omitted) or at 1174 Bulldog Circle Conyers, GA 30012 so that I can note your approval to participate in this study.

An informed consent document is attached to this letter. The informed consent document contains additional information about my research. Please sign the informed consent document and return it to me at 1174 Bulldog Circle Conyers, GA 30012 to indicate that you have read it and would like to take part in the study.

JoRanna M. Saunders, Ed. S.
Doctoral Student
Appendix B: Teacher Consent Form

CONSENT FORM

“The Flipped Classroom: It’s Effect on Student Academic Achievement & Critical Thinking Skills in the High School Mathematics Classroom”
JoRanna M. Saunders, Principal Investigator
Liberty University
College of Education

Dear Participant,

You are invited to participate in a research study concerning the implementation of the flipped classroom. The following information is provided for you to decide whether you wish to participate in the present study. You were selected as a possible participant because you currently teach Mathematics III at Rockdale County High School.

This study is being conducted by JoRanna M. Saunders a student of the College of Education and a teacher at Rockdale County High School.

Background Information:

The purpose of this study is to evaluate the flipped classroom implementation on student academic achievement and student critical thinking skills. The study will be a static-group comparison non-equivalent control group design that will take approximately eight to ten weeks. Data will be collected at the beginning and the end of the study and will involve a student pretest and a student posttest.

Procedures:

The flipped classroom teacher will be expected to “flip” the classroom by allowing students to complete classwork at home (via teacher made videos, YouTube videos, or any other media which contain the content to be learned by students (all media mentioned will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, or extend learning through further investigation or application problems. The traditional classroom teacher will be expected to teach as he/she normally would by allowing students to complete classwork in the classroom (via lectures followed by teacher facilitated activities) and students are to return to the next class period with completed homework (which the student had completed at home). If time permits, the teacher will review homework for any misconceptions or misunderstanding of concepts.

During the implementation period, the researcher will make frequent visits to the classroom to ensure the study is progressing appropriately. The researcher will be the sole individual involved in data collection.

Risks and Benefits of being in the Study:

There are minimal risks associated with this study. The risks are no more than the participants
would encounter in everyday life.

There are no direct benefits to participation.

**Compensation:**

There is no compensation associated with this study.

**Confidentiality:**

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

**Voluntary Nature of the Study:**

Please be aware that this is a voluntary study and you are free to decide not to participate or to withdraw at any time without affecting your relationship with Liberty University, the researcher, the school, or the local board of education.

**Contacts and Questions:**

The researcher conducting this study is JoRanna M. Saunders. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact the researcher at (omitted) or the researcher’s advisor, Dr. Nathan Putney at (omitted) or at (omitted).

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please sign your consent with full knowledge of the nature and purpose of the procedures. A copy of this consent form will be given for you to keep.

**Statement of Consent:**

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature of Participant: __________________________ Date: _____________

Signature of Investigator: __________________________ Date: _____________

JoRanna M. Saunders, Ed. S., School of Education at Liberty University, Researcher

Researcher Contact Information: JoRanna M. Saunders
(omitted)
(omitted)
Liberty University Contact Information: Institutional Review Board
1971 University Blvd, Suite 1837, Lynchburg, VA
2450215
Email at irb@liberty.edu.

IRB Code Numbers: 1683.093013          IRB Expiration Date: 09/30/2014
Appendix C: Student Assent Form

Assent of Child to Participate in a Research Study

What is the name of the study and who is doing the study?
The Flipped Classroom: It’s Effect on Student Academic Achievement & Critical Thinking Skills in the High School Mathematics Classroom”
Principal Investigator: JoRanna Saunders

Why am I doing this study?
I am interested in studying student academic achievement and student critical thinking when the flipped classroom is the mathematics classroom curriculum.

Why am I asking you to be in this study?
You are being asked to be in this research study because your class has been chosen to participate.

If you agree, what will happen?
If you are in this study you will help the researcher to evaluate how the flipped classroom affects student academic achievement and student critical thinking skills in the mathematics classroom.

Do you have to be in this study?
No, you do not have to be in this study. If you want to be in this study, then tell the researcher. If you don’t want to, it’s OK to say no. The researcher will not be angry. You can say yes now and change your mind later. It’s up to you.

Do you have any questions?
You can ask questions any time. You can ask now. You can ask later. You can talk to the researcher. If you do not understand something, please ask the researcher to explain it to you again.

Signing your name below means that you want to be in the study.

_________________________________________________                           ______________________________
Signature of Child      Date

JoRanna M. Saunders
(omitted)
Faculty Advisor: Dr. Nathan Putney
(omitted)
Liberty University Institutional Review Board,
1971 University Blvd, Suite 1837, Lynchburg, VA 24502
or email at irb@liberty.edu.
Appendix D: Permission Letter

PERMISSION FORM: ROCKDALE COUNTY PUBLIC SCHOOLS

August 1, 2013

Dear Dr. Brundage:

As a graduate student in the Curriculum & Instruction Department at Liberty University, I am conducting research as part of the requirements for a Doctoral Degree in Education (Ed. D). The title of my research project is “The Flipped Classroom: It’s Effect on Student Academic Achievement & Critical Thinking Skills in the High School Mathematics Classroom”. The purpose of my research is to evaluate the flipped classroom implementation on student academic achievement and student critical thinking skills in the high school mathematics classroom.

I am writing to request your permission to conduct my research in County Public Schools at Rockdale County High School in two Mathematics III classrooms. The study will be a static-group comparison non-equivalent control group design that will take approximately eight to ten weeks. Data will be collected at the beginning and the end of the study and will involve a student pretest and a student posttest.

Participants will be asked to participate in this study by either being in the control group (traditional teaching methods occur) or by implementing the flipped instruction (treatment group). The flipped classroom teacher will be expected to “flip” the classroom by allowing students to complete classwork at home (via teacher made videos, YouTube videos, or any other media which contain the content to be learned by students (all media will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, or extend learning through further investigation or application problems. The researcher will be the sole individual involved in data collection.

The data collected will be used to addresses students’ deficiencies in high school mathematics and investigate whether this alternative curriculum will encourage student academic achievement and impact student critical thinking skills in the secondary mathematics classroom. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement on approved letterhead indicating your approval.

Sincerely,

JoRanna M. Saunders, Ed. S
Liberty University Doctoral Student
RCHS Mathematics Department Chair
Appendix E: Instruments

INSTRUMENT: STUDENT PRETEST

Mathematics III

Name: ____________________________  ID: __

Pretest

Date ___________  Period __

Name each polynomial by degree and number of terms.

1) $6n^3 + 6n^2 - 7$
   A) quintic trinomial
   B) constant trinomial
   C) cubic trinomial
   D) linear binomial

2) 1
   A) constant monomial
   B) quartic monomial
   C) linear polynomial with 0 terms
   D) linear monomial

3) $-8x^6 + 9x^3 + 10x^2 - 2$
   A) cubic trinomial
   B) sixth degree polynomial with four terms
   C) quartic polynomial with six terms
   D) quartic polynomial with four terms

4) $9x^2 + 6$
   A) quartic binomial
   B) constant binomial
   C) quadratic binomial
   D) linear binomial

Determine the leading coefficient for each function.

5) $2y^4$

6) $-6a^2$

7) $-4a^6$

8) $8n^2 + 5n$

Determine the degree for each function ($a=1, b=2, c=3, d=4$).

9) $-3k$

10) $-10x$

11) $-5x^2$

12) $-3p^4 - 10p + 5$

Evaluate each function.

13) $g(t) = -2t - 2$; Find $g(-7)$
    A) $-8$  B) $-4$
    C) $12$  D) $18$

14) $h(t) = -3t + 5$; Find $h(-9)$
    A) $26$  B) $-22$
    C) $14$  D) $32$

15) $g(x) = 2x^2 - 5x$; Find $g(-4)$
    A) $52$  B) $42$
    C) $7$  D) $207$

Determine if the function is even, odd, or neither ($a=$even, $b=$odd, $c=$neither, $d=$both).

16) $-9p^6 + 2p^5$

17) $2r^2$
18) \(7r^3\)

19) \(-9\)

Determine if the function is symmetric: (a=symmetric with respect to the y-axis, b=symmetric with respect to the x-axis, c=symmetric with respect to the origin, d=no symmetry).

20) \(9n^2 + 6n - 9\)

21) \(8n^2 + 5n + 3\)

22) \(-6k^6 - 9k - 6\)

23) \(-9n^5 - 2n^4 + 9n^3\)

Divide.

24) \((5b^2 - 28b + 14) ÷ (b - 5)\)
   A) \(5b - 3 - \frac{1}{b - 5}\)
   B) \(\frac{5b - 2}{b - 5}\)
   C) \(5b - 5 + \frac{2}{b - 5}\)
   D) \(5b - 1 + \frac{2}{b - 5}\)

25) \((5x^2 - 25x) ÷ (x - 5)\)
   A) \(5x - 1 - \frac{4}{x - 5}\)
   B) \(\frac{5x}{x - 5}\)
   C) \(5x - 1 + \frac{3}{x - 5}\)
   D) \(5x - 3 + \frac{3}{x - 5}\)

26) \((2v^2 + 11v - 4) ÷ (v + 5)\)
   A) \(2v + 1 - \frac{11}{v + 5}\)
   B) \(v - 2 - \frac{4}{v + 5}\)
   C) \(2v + 1 - \frac{9}{v + 5}\)
   D) \(v - 1 - \frac{12}{v + 5}\)

27) \((9n^2 + 46n - 49) ÷ (n + 6)\)
   A) \(9n - 7 + \frac{1}{n + 6}\)
   B) \(9n - 6 + \frac{6}{n + 6}\)
   C) \(9n - 8 - \frac{1}{n + 6}\)
   D) \(9n - 5 - \frac{4}{n + 6}\)

28) \((6r^2 - 12r) ÷ (r - 2)\)
   A) \(6r - 1 + \frac{2}{r - 2}\)
   B) \(6r + 3\)
   C) \(6r\)
   D) \(6r - 2\)
29) \((2x^2 + 25x + 80) \div (x + 8)\)
   
   A) \(2x + 10 + \frac{10}{x + 8}\)
   B) \(2x + 10 + \frac{12}{x + 8}\)
   C) \(2x + 12 + \frac{6}{x + 8}\)
   D) \(2x + 9 + \frac{8}{x + 8}\)

Evaluate each function.

30) \(p(a) = 3a^2 - a\); Find \(p(-6)\)

31) \(p(a) = a^2 - 5a\); Find \(p(-5)\)

Describe the end behavior of each function.

32) \(f(x) = x^2 + 4x + 6\)

33) \(f(x) = -x^5 + 3x^3 - 2x + 4\)

34) \(f(x) = -x^4 + 2x^3 - x + 1\)
INSTRUMENT: STUDENT POSTTEST

Mathematics III

Posttest

Name_________________________ ID: 1

Date_________________ Period____

Name each polynomial by degree and number of terms.

1) \(-8x^3 + x^2 + 5x + 3\)  
   A) cubic polynomial with four terms  
   B) quartic polynomial with four terms  
   C) quadratic trinomial  
   D) quartic trinomial

2) \(-5a^6 - 5a^5 - 3a^3 + a\)  
   A) sixth degree trinomial  
   B) cubic polynomial with four terms  
   C) sixth degree polynomial with four terms  
   D) quartic polynomial with six terms

3) \(-8x^3 - 8x^2 - 7\)  
   A) cubic trinomial  
   B) quadratic trinomial  
   C) quartic trinomial  
   D) cubic binomial

4) \(-3m^6 + 7m^4 - 4m^3 - 7\)  
   A) quartic polynomial with six terms  
   B) cubic polynomial with four terms  
   C) quadratic monomial  
   D) sixth degree polynomial with four terms

Determine the leading coefficient for each function.

5) \(6r^4 - 5r^2 - 2r + 7\)
6) \(m^5\)

7) 9
8) 3

Determine the degree for each function (a=1, b=2, c=3, d=4).

9) \(2x^4 + 8x - 10\)
10) \(3m^3\)

11) \(-4n\)
12) \(-9m^4 + 10\)

Evaluate each function.

13) \(p(x) = x^3 + 6x; \) Find \(p(-1)\)
   A) \(-155\)  
   B) \(-252\)
   C) \(-7\)  
   D) 20

14) \(p(n) = 3n^3 - 3n^2; \) Find \(p(2)\)
   A) \(144\)  
   B) \(12\)
   C) \(1344\)  
   D) \(-6\)

15) \(h(r) = 2r - 4; \) Find \(h(-2)\)
   A) \(-8\)  
   B) \(-14\)
   C) \(4\)  
   D) \(-10\)

Determine if the function is even, odd, or neither (a=even, b=odd, c=neither, d=both).

16) \(8p^4 - 9p^3\)
17) \(7x^5\)
18) $-7$

19) $-8n$

Determine if the function is symmetric (a=symmetric with respect to the y-axis, b=symmetric with respect to the x-axis, c=symmetric with respect to the origin, d=no symmetry).

20) $2k^3 + 5k + 5$

21) $-1$

22) $3x^6 + 6x^5 - 2x^3 - 8$

23) $-4p^4 - 5p^3 + 2$

Divide.

24) $(-6n^3 - 17n^2 - 5n + 12) \div (n + 2)$

A) $-6n^2 - 5n + 4 + \frac{6}{n + 2}$

B) $-6n^2 - 5n + 7 + \frac{3}{n + 2}$

C) $-6n^2 - 5n + 7 + \frac{6}{n + 2}$

D) $-6n^2 - 5n + 5 + \frac{2}{n + 2}$

A) $n^3 + n^2 - 9n - 2 - \frac{3}{n + 8}$

B) $n^3 + n^2 - 9n - 1 - \frac{5}{n + 8}$

C) $n^3 + n^2 - 9n + 1 - \frac{6}{n + 8}$

D) $n^3 + n^2 - 9n - 4 - \frac{4}{n + 8}$

25) $(n^4 + 9n^3 - n^2 - 74n - 19) \div (n + 8)$

26) $(x^3 - x^2) \div (x - 1)$

A) $x^2$

B) $x^2 + x - 2 - \frac{2}{x - 1}$

C) $x^2 + x - 3 + \frac{5}{x - 1}$

D) $x^2 + x + 2 - \frac{4}{x - 1}$

27) $(r^3 - 13r^2 + 35r + 46) \div (r - 7)$

A) $r^2 - 6r - 8 - \frac{8}{r - 7}$

B) $r^2 - 6r - 9 + \frac{2}{r - 7}$

C) $r^2 - 6r - 7 + \frac{1}{r - 7}$

D) $r^2 - 6r - 7 - \frac{3}{r - 7}$
28) \( (5m^2 + 35m + 43) \div (m + 5) \)
   A) \( 5m + 11 - \frac{5}{m + 5} \)
   B) \( 5m + 10 - \frac{7}{m + 5} \)
   C) \( 5m + 10 - \frac{12}{m + 5} \)
   D) \( 5m + 11 - \frac{11}{m + 5} \)

29) \( (2b^2 + 24b + 62) \div (b + 8) \)
   A) \( 2b + 10 - \frac{7}{b + 8} \)
   B) \( 2b + 8 - \frac{2}{b + 8} \)
   C) \( 2b + 7 - \frac{2}{b + 8} \)
   D) \( 3b + 9 - \frac{3}{b + 8} \)

**Evaluate each function.**

30) \( p(n) = n^3 - 4n; \) Find \( p(6) \)

31) \( f(t) = 3t - 4; \) Find \( f(-6) \)

**Describe the end behavior of each function.**

32) \( f(x) = x^4 - 3x^2 - 2x + 3 \)

33) \( f(x) = x^3 - 3x^2 + 2 \)

34) \( f(x) = -x^2 - 6x - 6 \)
Appendix F: Parent Consent Form

CONSENT FORM
“The Flipped Classroom: It’s Effect on Student Academic Achievement & Critical Thinking Skills in the High School Mathematics Classroom”
JoRanna M. Saunders, Principal Investigator
Liberty University
College of Education

Dear Parent of Participant,

Your student is invited to participate in a research study concerning the implementation of the flipped classroom. The following information is provided for you to decide whether you wish to allow your student to participate in the present study. Your student was selected as a possible participant because they are currently registered for a Mathematics III class at Rockdale County High School.

This study is being conducted by JoRanna M. Saunders a student of the College of Education and a teacher at Rockdale County High School.

Background Information:

The purpose of this study is to evaluate the flipped classroom implementation on student academic achievement and student critical thinking skills. The study will take approximately eight to ten weeks. Data will be collected at the beginning and the end of the study and will involve a student pretest and a student posttest. The flipped classroom teacher will “flip” the classroom by allowing students to complete classwork at home (via teacher made videos, YouTube videos, or any other media which contain the content to be learned by students (all media mentioned will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, and/or extend learning through further investigation or application problems. The traditional classroom teacher will be expected to teach as he/she normally would by allowing students to complete classwork in the classroom (via lectures followed by teacher facilitated activities) and students are to return to the next class period with completed homework (which the student had completed at home).

Procedures:

During the implementation period, the researcher will make frequent visits to the classroom to ensure the study is progressing appropriately. If assigned to the traditional classroom, your student will be expected to take a pretest, participate in class as usual, and take a posttest. The pre and posttest will take a class period to complete (approximately 90 minutes) and will contain concepts that the students will currently be learning in Mathematics III. If assigned to the flipped classroom, your student will be expected to take a pretest, complete classwork at home (via teacher made videos, YouTube videos, or any other media which contain the content to be learned by students (all media mentioned will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, and/or extend learning
through further investigation or application problems. The above mentioned teacher made videos, YouTube videos, or any other media which contain the content to be learned by your student will be approximately 15 minutes in length and will require that your student have access to the Internet as well as an online device to view the content (i.e. laptop, tablet, smart phone, etc.). In the event that your student does not have access to the Internet and/or an online device, the researcher will provide access by either lending your student an online device (if Internet is available to the student outside of school), allowing the student to view the media at school (before or after school), or providing the student with a DVD player and DVD disc(s) which will contain the content to be learned by your student. The pre and posttest will take a class period to complete (approximately 90 minutes) and will contain concepts that the students will currently be learning in Mathematics III.

Risks and Benefits of being in the Study:

There are minimal risks associated with this study. The risks are no more than the participants would encounter in everyday life.

There are no direct benefits to participation.

Compensation:

There is no compensation associated with this study.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

Voluntary Nature of the Study:

Please be aware that this is a voluntary study and you are free to decide not to allow your student to participate or to withdraw your student at any time without affecting your relationship with Liberty University, the researcher, the school, or the local board of education.

Contacts and Questions:

The researcher conducting this study is JoRanna M. Saunders. You may ask any questions you have now. If you have questions later, you are encouraged to contact the researcher at (omitted) or the researcher’s advisor, Dr. Nathan Putney at (omitted) or at (omitted).

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Suite 1837, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please sign your consent with full knowledge of the nature and purpose of the procedures. A
copy of this consent form will be given for you to keep.

**Statement of Consent:**

I have read and understood the above information. I have asked questions and have received answers. I consent to allow my student to participate in the study.

Signature of Participant: ___________________________ Date: ________________

Signature of Parent or Guardian: __________________________ Date: ________________

Signature of Investigator: ___________________________ Date: ________________

JoRanna M. Saunders, Ed. S., School of Education at Liberty University, Researcher

Researcher Contact Information: JoRanna M. Saunders
(omitted)
(omitted)

Liberty University Contact Information: Institutional Review Board
1971 University Blvd, Suite 1837, Lynchburg, VA 24515
Email at irb@liberty.edu.

**IRB Code Numbers:** 1683.093013  
**IRB Expiration Date:** 09/30/2014
Appendix G: Parent Recruitment Form

RECRUITMENT FORM: PARENT

Date: September 24, 2013

Parents of Select Mathematics III Students
          High School

Dear Select Parents,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctoral Degree in Education, and I am writing to invite your student to participate in my study.

If you choose to allow your student to participate, your student will be assigned to either the flipped or traditional classroom. If assigned to the traditional classroom, your student will be expected to take a pretest, participate in class as usual, and take a posttest. If assigned to the flipped classroom, your student will be expected to take a pretest, complete classwork at home (via teacher made videos, YouTube videos, or any other media which contain the content to be learned by students (all media mentioned will be provided by the researcher)) and return to the next class period to further discuss these concepts, complete homework, and/or extend learning through further investigation or application problems, and take a posttest. It should take approximately eight to ten weeks to complete this study. Your student participation will be completely confidential, and no personal, identifying information will be required.

To participate, please review and sign the attached informed consent document so that I can note your approval to allow your student to participate in this study.

The informed consent document contains additional information about my research. Please allow your student to return the signed informed consent document to their teacher to indicate that you have read it and would like your student to take part in the study.

JoRanna M. Saunders, Ed. S.
Doctoral Student
Appendix H: School Board & University Approval

APPROVAL: COUNTY PUBLIC SCHOOLS & LIBERTY UNIVERSITY

September 17, 2013

Ms. JoRanna M. Saunders

Dear Ms. Saunders:

I have reviewed your research proposal entitled, The Flipped Classroom: It’s Effect on Student Academic Achievement, Critical Thinking Skills, and Teacher Efficacy in the High School Mathematics Classroom. I am approving your request with the following conditions:

- You must have parental permission to include students in this study. The permission letter must outline the purpose of the study, what students will be doing as part of the study, how much time will be involved, and that participation in the study will not interfere with regular instruction. You may also use an opt-out format for this letter.
- Results must be reported in a confidential manner so that the anonymity of participant is protected.
- Participation must be voluntary.

I wish you every success as you begin this very important project. I would appreciate a copy of the final report along with any recommendations that your research may offer the Rockdale County Public Schools.

Please let me know if you have any questions.

Sincerely

Executive Director Office of Support Services

cc:
LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

September 30, 2013

JoRanna M. Saunders
IRB Exemption 1683.093013: The Flipped Classroom: Its Effect on Student Academic Achievement, & Critical Thinking Skills in the High School Mathematics Classroom

Dear JoRanna,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and that no further IRB oversight is required.

Your study falls under exemption category 46.101 (b)(1,2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:

(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
   (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, or reputation.

Please note that this exemption only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption, or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

Liberty University | Training Champions for Christ since 1971