DOES A STUDENT'S USE

OF SELF-REGULATION CHANGE IN

THE FLIPPED CLASSROOM?

by

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ABSTRACT

Many college freshmen are required to enroll in remedial math every semester as a result of low college placement exams with many of these students failing to succeed in their remedial math courses. Students may fail their remedial math course due to low levels of control of learning, self-efficacy or self-regulation. The purpose of this study was to investigate if the flipped classroom is an effective teaching method for students in a remedial math course and if this method increases a student's control of learning, self-efficacy and self-regulation.

This study implemented a quasi-experimental design to compare students in a flipped remedial math class to students in a lecture remedial math class using the Motivated Strategies Learning Questionnaire (MSLQ) designed by Pintrich (1991) to measure control of learning, self-efficacy and self-regulation. Data analyses included frequency data to report the descriptive statistics of students in remedial math; independent t-tests to report significant differences of MSLQ scores and posttest COMPASS math scores; and multiple regressions to report associations among dependent and independent variables in the study.

The results found no significant difference for control of learning, self-efficacy, or self-regulation of students in the flipped classroom compared to students in the lecture classroom. A significant difference at $\rho < .10$ was found for math outcomes for students in the flipped classroom compared to students in the lecture classroom. The findings also indicate a small net effect for control of learning, self-efficacy and self-regulation on math placement as well as math outcomes for students in a remedial math course. Also, a student's self-efficacy at the end of the course was predicted by a student's level of self-efficacy and prior academic knowledge at the start of the semester.

In conclusion, the findings of this study suggest that the flipped classroom is an effective teaching method to use in a remedial math class. Limitations of this study include a small sample size as well as validity and reliability concerns with the use of the MSLQ survey suggesting further research is needed to investigate the effectiveness of the flipped classroom in a remedial math class.

CHAPTER ONE

INTRODUCTION TO THE STUDY

Introduction

Community Colleges and Universities recommend or require many new college freshmen to enroll in remedial math courses every semester as a result of college placement exams. Developmental math courses often referred to as "remedial math" are math courses designed to remedy a student's math deficiencies allowing them to enroll in a college level math course. Approximately 60% of community college students enroll in remedial math or writing courses at community colleges each semester (Bailey, Jeong & Cho, 2010). The national average of students enrolling in remedial math was 43% for students at two year colleges and 30% for students at four year public universities as reported by "Strong American Schools" (2008).

Some estimates suggest that only one-third of high school graduates finish ready for college work (Bettinger, Boatman & Long, 2013). It is even more alarming as reported by Bailey, Jeong & Cho (2010) that very few students enrolled in remedial math will complete their required sequence of remedial courses despite the purpose of remedial math courses to promote a student's success in college. They estimate only a third of the community college students enrolled in remedial math complete their required sequence of remedial math courses. However, their research does indicate that math remediation has benefits for students in terms of retention for students that complete their math sequence. They utilized data from the Achieving the Dream sample which was an initiative designed to improve outcomes of community college students. Similar results were found by Attwell, Lavin, Domina, and Levey (2006) who report only 30% of students pass all their remedial math courses. In their study they utilized data from the National Educational Longitudinal Study of 1988 (NELS: 88) to determine student completion of remedial math. These findings illustrate a low percentage of students who enroll in remedial math courses are successful in gaining the skills necessary to succeed in their college-level math course and eventually graduating or acquiring an industry recognized credential. In another study conducted to investigate math remediation and academic attainment, Bahr (2008) found that the majority of remedial math students do not complete their remedial math course or series of courses but his research indicated that if students do complete their remedial math course or courses they experience outcomes that are effectively equivalent to those students who were not required to take a remedial math course. According to Esch (2009), remedial education can be referred to as the Bermuda Triangle of higher education because large numbers of students enter remediation and for all intent and purposes they disappear. Therefore, one of the most pressing challenges facing community colleges is improving outcomes for students that place into remedial math courses (Biswas, 2007).

Day & McCabe (1998) suggest that remedial education is important because it is intended to restore opportunity to those who otherwise may be downgraded to meager wages, poor working conditions and other consequences of socioeconomic marginalization. In addition, today's labor market requires a workforce to have an education higher than a high school diploma. Individuals will need to gain different job skills which will require them to complete special training; such as an industry recognized credential, certificate or degree. Complete College America (2011) estimates that 63% of jobs will require a career certificate or college degree by 2020.

It is clear due to the high number of remedial math students, the low completion rates of remedial math courses and the needs of the current labor market that different teaching methods to improve the success rates of students enrolled in remedial math courses are needed. According to Esch (2009), there is no hard evidence about what works and what does not work in remedial math. This is supported by Levin and Calcagno (2008) who report that the traditional drill and skill approach used to increase the performance of remedial students at community colleges is not as productive as other available alternatives. Other alternatives include but are not limited to inquiry-based learning, cooperative or group learning, or computer assisted instruction. The traditional drill and skill approach or direct instruction is commonly used in college math courses including remedial math courses where the instructor lectures the material in class by writing problems on the board and students are asked to complete homework outside of class. In many of these courses, students are not required to turn in homework assignments and need only to recall the material from class to pass a test. In this setting, students are passive in class watching or taking notes while the instructor solves problems. In this passive setting some students become inattentive during the lecture and find it difficult to recall information from class to complete homework assignments. They are unable to evaluate what they know or do not know about the new material and have a difficult time completing homework assignments on their own and do not have sufficient notes to aid them.

In contrast, an active learning environment requires students to engage in activities and requires them to think about what they are doing. In this setting, students are engaging in the learning process because they are given responsibility for their own learning rather than waiting for the teacher to teach them. An example of an active learning environment is the flipped model.

The flipped model requires students to complete the lecture material outside of class on their own as homework so they are engaging with material prior to coming to class. During class students participate in activities that in other teaching models are considered homework (Baker, 2000). Lecture material can include videos, interactive problems, power point presentations or pen casts. Students have the opportunity to watch videos as many times as needed and take notes at their own pace. They are given time to process new material and to evaluate their learning to determine what concepts they know and where they have questions. At the start of class, students may be asked to recall basic information about the lecture material they reviewed on their own and the remaining class time will be used to answer questions, reinforce concepts through solving problems or completing activities. The goal of the flipped model is to encourage active learning and student engagement in the class room. Flipping the classroom is an inversion of learning activities which puts the responsibility on the student to complete the tasks of gathering information outside of class and applying learning while in class (Berrett, 2012). In other word, students practice skills needed to learn how to acquire knowledge independently and the role of the instructor shifts to a facilitator of knowledge. According to Baker (2000) this disposition of learning allows the instructor to replace their repertoire of “sage of the stage” with “guide on the side” and bring the higher level learning as described in Bloom’s Taxonomy of Learning to the classroom where instructors help students with the more difficult tasks of application rather than rote memorization. As Shibley and Wilson (2012) describe, technology prior to class should be used to help students fulfill the lowest levels of knowledge attainment and understanding while time in class should focus on application and analysis. No matter the technology used, the purpose of this type of course design is to increase engagement. The engagement with the material in the flipped model is the primary component of learning (Koller, 2011). The flipped model is a fairly new model and little research exists to determine if this teaching model is an effective method to influence student learning in a remedial math course.

A study conducted by Lage, Platt, and Treglia (2000) suggests that students generally prefer the flipped model classroom to the traditional lecture classroom. In addition, students in the study reported that they like working in groups and learned a lot working in groups. Overall students in this study reported that they believed they learned more course content in the flipped model format of the class. In this study perceptions of sophomore students enrolled in a microeconomics course used technology to view lecture material outside of class and in class they worked in groups and on more complex problems. Also as stated by Lage, Platt and Treglia (2000) the flipped model classroom addressed the benefits of using technology in teaching such as increased participation and motivation, increased faculty-student interactions and increased information-sharing among faculty. In an article by Brunsell and Horejsi (2011) where they interviewed two chemistry teachers who used the flipped model reported that this model frees up more class time for doing hands-on activities and helping students work through concepts they do not understand and they felt student learning deepens as student to student and individual student to teacher interactions increase.

Robert Talbert (2012) has been chronicling both the flipping of his courses and the study he is performing regarding the flipped classroom and he states:

> "In fact one of the biggest marks in the "con" column of the flipped classroom right now is the lack of systematic research on its effectiveness. There is a lot of enthusiasm and interest but not a lot of data"

He further states that the flipped model puts students in a position where they need to apply the study skill strategies of self-regulated learning such as being an active participant in the learning process while monitoring and controlling his/her own thinking as well as applying a motivation for learning. The term self-regulated learning is defined by Pintrich (2000b, p. 253) as an active, constructive process where learners set goals for their learning and then attempt to control, monitor, and regulate their cognition, motivation, and behavior. Self-regulated learning theory views a student as an active participant in the learning process and according to Pintrich (2004) students that demonstrate self-regulated learning skills are more successful learners. The successful application of self-regulated learning skills teaches students how to become learners (Talbert, 2012). This concept of how students learn and research conducted on self-regulated learning by Pintrich and colleagues resulted in the development of the

Motivated Strategies Learning Questionnaire (MSLQ) which is an instrument used to measure college students motivation and self-regulated learning in the classroom (Schunk, 2005).

Many students that are unsuccessful academically lack or have weak self-regulated learning skills (Pintrich & DeGroot, 1990). According to Knowles, Holton III & Swanson (2005) many adults have not learned to be self-directing inquirers because they have been conditioned to be dependent on teachers to teach them so they often experience a form of culture shock when first exposed to an active learning experience and they will prefer to be passive in the classroom or they lack the skills to actively participate in their own learning. They report that an adult learner may be dependent on the instructor if they have no previous experience with a content area or when they do not understand the relevance of a content area. (Knowles, Holton III, & Swanson, 2005 p. 70) This is often the case for students that enter college underprepared especially those students in a remedial math course so it is critical for remedial math students to learn how to use self-regulation skills to become successful learners. According to Zimmerman (1990) at a time when students lack the will and skill to achieve academically, educators need instructional approaches that can offer direction and insight into the processes of self-regulated learning. The remedial math class is an appropriate setting for students to learn and apply self-regulated learning skills because in most instances remedial instruction as defined by NADE (2002) addresses course specific deficiencies as well as motivational and learning deficiencies. In addition, remedial math courses usually have a smaller number of students enrolled in each class as well as offer many other support services such as supplemental instruction or tutoring.

Context

In Montana, the proportion of students enrolling in remedial math is lower than the national average, but at Montana two-year colleges, the proportion of remedial math students remains high. According to the MUS High School Follow-up Report (2011), 26% of students entering the Montana University System enrolled in remedial math and 8% enrolled in remedial writing for the fall 2011 semester. Students enrolled in remedial math at Montana's two-year colleges for fall 2011 was 44% and 20% of students at four-year colleges in Montana enrolled in remedial math for fall 2011 as reported by the MUS Follow-up Report (2011). In fall 2010, 21.2% of students enrolled at four-year institutions in Montana completed their remedial course in one academic year (MUS Follow-up Report, 2011).

Statement of the Problem

Improving how remedial math courses are delivered to college students is needed to improve the success of students. Traditionally remedial math courses are delivered using the lecture model and according to Le, Rodgers & Santos (2011) the lecture method to deliver remedial math does not lead to success in remedial math. The flipped model classroom shows promise as an effective instructional method for teaching college level remedial math courses because it utilizes computer-based instruction as well as incorporates active and collaborative learning activities in the classroom. Pascarella and Terenzini (2005, p. 90) found that instructional approaches that include active, collaborative, cooperative and constructivist approaches shape learning more powerfully than the conventional lecture-discussion and text-based approaches. In addition, the flipped model provides the following to promote student learning: time for students to watch, process and record lecture material, time for students to evaluate what they know and where they have questions, time in the class for students to actively engage with the course material, time in the classroom to interact with other students and the instructor, and it promotes students in the development of study skill strategies to become independent learners. However, there is little research concerning how remedial math students negotiate the self-regulation requirements of the flipped classroom and whether this aspect of the flipped classroom can help students to become more autonomous learners.

Purpose Statement

The purpose of this quasi-experimental study is to compare the self-regulated learning scores for students that participate in a remedial math course that uses the flipped model to students that participate in a remedial math course that uses the lecture model. The Motivated Strategies for Learning Questionnaire (MSLQ) will be used to measure the self-regulated learning scores of students in each classroom and outcomes will be compared using COMPASS math posttest scores of student in each classroom. The study asks the following questions:

1) What are the student characteristics of students who enroll in a remedial math course?
2) Do the control of learning scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
3) Do the self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
4) Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
5) How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?
6) Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?
7) Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcome) of students in this study?

8) Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?

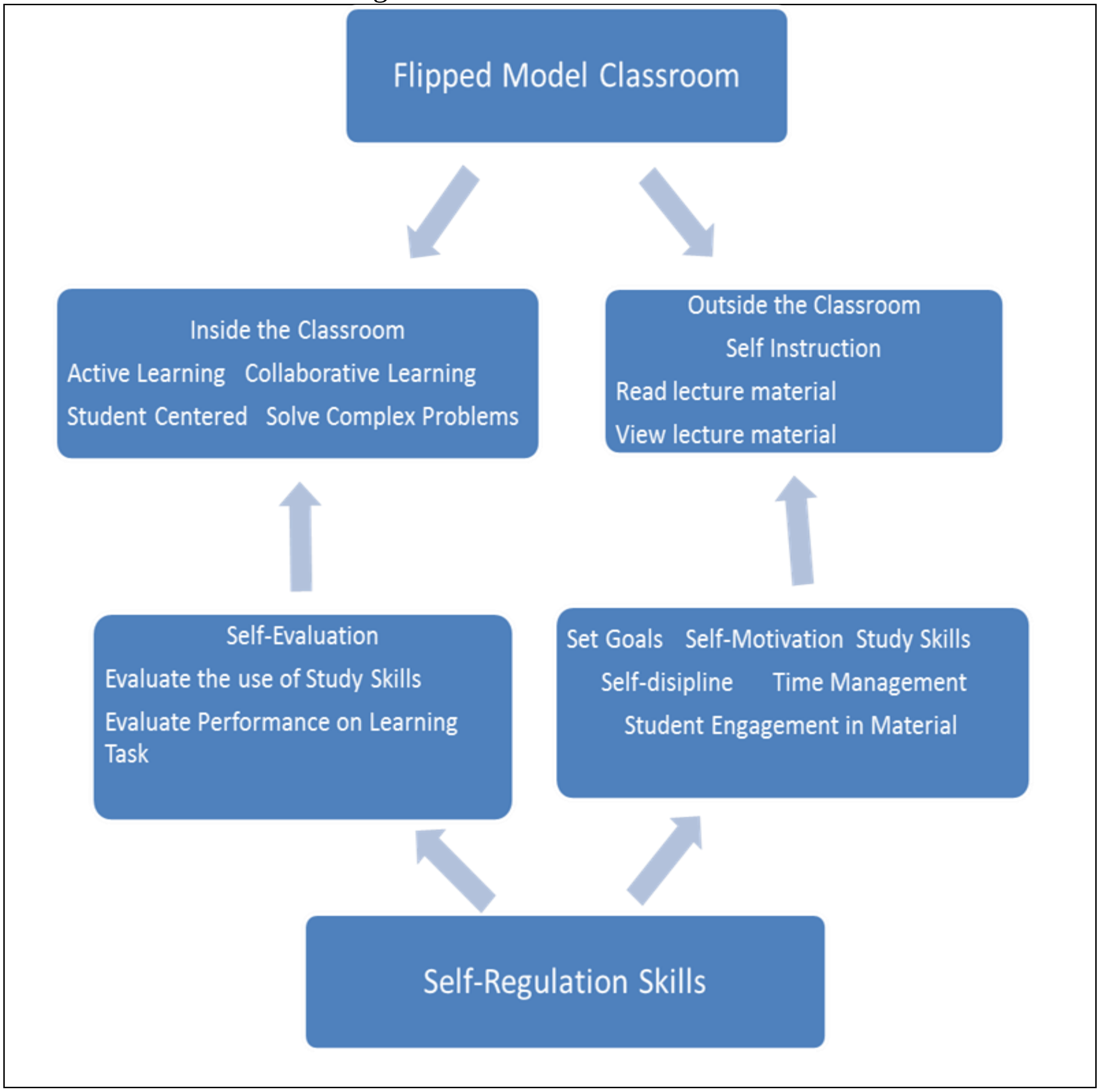
Significance of the Study

The results of this study will be used by Remedial Math Instructors and Administrators at Highlands College as well as other remedial math instructors at similar educational settings to learn more about the flipped model classroom. This study will inform remedial math instructors by providing comparisons of self-regulation scores from the MSLQ post-survey of students that participate in a flipped model remedial math course to students that participate in a lecture model remedial math course. COMPASS post-math placements of students in both classrooms will also be compared. In addition, this study will illustrate if further research needs to be conducted to determine if the flipped model is a feasible teaching method.

Theoretical Framework

The goal of this study is to determine if the flipped model that requires students to apply self-regulatory processes to complete required tasks such as self-instruction and active learning will increase a remedial math student's ability to self-regulate. Therefore, the theoretical framework for this study is the flipped teaching model and self-regulated learning. Figure 1 shows the theoretical framework for this study.

Figure 1: Theoretical Framework



The flipped model classroom uses technology to deliver course content to students outside of class allowing more time for students to practice and apply concepts during class time. The basic design of this teaching model as defined by Baker (2011) as moving the rote transmission of information out of the classroom using technology to open up class time for the students to work on applying principles from that content while the instructor can observe students, answer questions and make suggestions. In the flipped model classroom students are provided an environment that promotes students to learn how to become self-regulated learners by requiring students to learn and practice how to initiate, monitor and exert control over their own learning. This change in pedagogy requires students to apply self-regulated learning skills to acquire knowledge from the lecture material on their own so they can apply and practice concepts in class. Self-regulated learning skills are not an exclusive requirement of the flipped model and are a requirement in any learning environment for students to be successful. According to Zimmerman (2000), self-regulated learning is an important concept in education because self- regulated learners are cognitively, metacognitively, and motivationally active learners who are more successful learners than students that fail to apply self-regulated learning techniques. The lack of self-regulation is linked to lower levels of achievement, regardless of students' intellectual ability, motivation, and self-efficacy beliefs (Bakracevic-Vukman & Licardo, 2010). Students that are self-regulated have the ability to plan, organize, self-monitor and self-evaluate during the learning process. Zimmerman (1990) defines self-regulated learning theories of academic achievement as the following: 1) how a student selects organizes or creates an advantageous learning environment for themselves and 2) how they plan and control self-instruction. He further states the following:

> "A self-regulated learning perspective on students' learning and achievement is not only distinctive, but it has profound implications for the way teachers should interact with students and the manner in which schools should be organized. This perspective shifts the focus of education analyses from students' learning ability and environments as "fixed" entities to their personally initiated processes and responses designed to improve their ability and their environments for learning." (p. 4)

Research Design

This study will be a quasi-experimental design to collect quantitative data. The rationale for this study is to examine if there is an increase in the self-regulation skills of students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course. Course content in both sections of the remedial math course will be the same and both sections of the remedial course will utilize computer software for the completion of homework assignments. The curriculum for both courses will introduce and reinforce the use of self-regulatory skills throughout the semester. Since this study will include students from different sections of the same remedial math course an overall group equivalence will be conducted comparing students in each section of the course before conducting research. The group equivalence will be established by comparing the following mean scores: COMPASS math placement scores, COMPASS reading placement scores, a student's previous math experience in years, enrollment status, and time since last math class. Independent t-tests will be performed to determine group equivalence.

Quantitative data will be collected by utilizing the Motivated Strategies for Learning Questionnaire (MSLQ) survey. This instrument was developed by Paul Pintrich and colleagues (Pintrich et al, 1991), to measure students' motivational beliefs and self-regulated learning. An electronic version of the MSLQ survey will be administered as a pre and post survey to students in a flipped model remedial math course and lecture model remedial math course. The MSLQ survey is a student self-reported survey that includes 24 questions and asks students to answer questions using a scale of 1-7 where 1 is not all true of me and 7 is very true to me. The survey will be administered at the beginning and at the end of the fall 2014 and spring 2015 semesters. The study will utilize independent series t-tests to determine the difference in control of learning, self-efficacy and self-regulation scores by comparing the mean scores of the pre and post MSLQ survey results of students that participate in the flipped model and lecture model remedial math course. Group equivalence will be determined by performing a series of t-tests using the COMPASS pretest math scores and student characteristics.

Operational Definitions

The operational definitions used in this study include the following:

1. *Remedial math student*- a student who is considered under-prepared to be successful in a college level math course based on their college placement exams.
2. *Remedial math courses*- math courses designed to prepare students for a college level math course.
3. *Flipped Model*- Is a teaching model/method that utilizes technology to provide lecture material to students to complete outside of the traditional class time and uses class time to reinforce concepts by solving problems or providing activities for students.
4. *Lecture Model*- Is a teaching model/method where the instructor delivers course content to students in class in the form of a lecture.

5. *Meta-cognition*- is defined as "cognition about cognition" or "knowing about knowing". It includes knowledge about when and how to use particular strategies for learning or for problem solving.
6. *Cognition*- is a group of mental processes that include attention, memory, producing and understanding language, learning, reasoning, problem solving and decision making.
7. *Self- Regulated Learning*- is metacognitively, motivationally, and behaviorally active in one's own learning process and in achieving one's own goals. (Eccles & Wigfield, 2002)

Data Analysis

A goal of this study is to determine if the flipped model is an effective teaching model for a remedial math course and if students demonstrate an increase in their self-regulation skills as a result of their participation. The results of this study can be used to inform other college remedial math instructors to improve the success of their students so every effort will be made to eliminate threats to external and internal validity.

Summary

The subject of this study is to investigate how the flipped model influences the self-regulation skills for remedial math students at a two-year college. Students will be given the MSLQ questionnaire at the beginning of the semester and at the end of the semester. Their answers to the questions will be analyzed to determine if their self-regulation skills have changed as a result of their experience in the flipped model classroom. The outcomes of this study may indicate the use of the flipped model in a remedial math course is beneficial for remedial math students to become more successful learners.

CHAPTER TWO

LITERATURE REVIEW

Introduction

How remedial math education is delivered to students at colleges and universities is a topic of discussion in recent years due to its high cost and low completion rates of students. Critics of remedial education argue that taxpayers should not be required to pay twice for the same educational opportunities arguing for a major restructuring of math remediation or even the elimination of remedial programs altogether (Bahr, 2008). According to Le, Rodgers & Santos (2011) students that enter community college needing to take remedial math fare worst in terms of outcomes with Bailey, Jeong, & Cho (2010) reporting only one-third of students complete their remedial math sequence successfully. This failure to succeed in a remedial math course may be due to the inability for some remedial math students to apply the proper self-regulation skills needed to be successful. It is well documented that students who apply self-regulation skills have been found to foster active cognitive engagement in learning resulting in higher levels of achievement (Weinstein & Mayer, 1986). Van Den Hurk (2006) reports students who are better time planners and who have better self-monitoring skills achieve higher scores on cognitive tests. The review of the literature will contribute to the discussion of implementing a flipped teaching model in remedial math courses to increase the use of self-regulation skills of students in a remedial math course. The review of the literature is presented by discussing the theoretical framework of self-regulation, similarities and differences of the flipped and lecture models, models of the flipped classroom and the MSLQ.

Theoretical Framework: Self-Regulation

The theoretical framework for this study is self-regulation and how the flipped model classroom influences self-regulatory processes of students in a remedial math course. Self-regulated learning is an active, constructive process where learners set goals for their learning and attempt to monitor, regulate, and control their cognition, motivation and behavior, guided and constrained by their goals and the contextual features in the environment (Pintrich, 2000). Similarly, Zimmerman (2008) defines self-regulatory processes as proactive processes such as a students' ability to plan, organize, self-monitor and self-evaluate during the learning process. The model of self-regulated learning developed by Pintrich is based on a social-cognitive framework (Schunk, 2005) and is comprised of four phases. See Table 2.1: Conceptual Framework of Self-Regulation.

Table 2.1: Conceptual Framework of Self-Regulation

Phases of Self-Regulation	Areas for Self-Regulation	Processes
Forethought, planning, activation	Cognition	Goals- Setting and modifying task-specific goals that serves as criteria against which to gauge progress. Prior content knowledge- Activation of relevant content knowledge may occur without awareness through prompting and self-questioning. Metacognitive knowledge- Activation includes declarative knowledge such as learning strategies (rehearsal and note-taking), procedural knowledge (how to implement different strategies), and conditional knowledge (when and why to use different strategies)
Monitoring	Motivation	Goal orientations- reasons learners engage in a task. Self-efficacy- an individual's beliefs about their capabilities to learn or perform. Perceptions of difficulty and ease of learning- individual judgments about how hard or easy they believe the material will be to learn. Task value- individual perceptions of the relevance, importance, and usefulness of the learning. Interest- an individual's degree of liking of the content area or topic being learned.
Control	Behavior	Time and effort planning- time management skills such as creating study schedules and planning time for different activities. Planning for self-observation- determining what methods one will use to assess progress and regulate behaviors.
Reaction, reflection	Context	Students' perceptions of the task and context- may include perceptions about classroom features that may help or hinder learning, types of tasks to be completed, grading practices, and classroom climate factors such helpfulness of the teacher.

Schunk, D. H. (2005). Self-regulated learning: The educational legacy of Paul R. Pintrich. Educational Psychologist, 40, 85-94

This model of self-regulation developed by Pintrich in the Table 2.1 outlines the four phases of self-regulation (forethought, planning, activation, monitoring; control; reaction and reflection) and the four possible areas for self-regulation (cognition, motivation, behavior, and context). Schunk (2005) notes that this model does not presume the phases are linearly ordered and they may occur at any time during task engagement. In addition, there are learning situations when learners may engage in some but not all of the phases and individuals may simultaneously engage in more than one. This model of self-regulated learning has been used by numerous researchers/educators to improve educational practices. The following paragraphs describe studies that investigated student self-regulation in math courses.

In a study conducted by Bembenutty (2009) designed to examine the associations between students' homework activities and their reported use of self-regulated learning strategies found many at-risk students fail to do their homework because they lack the self-discipline necessary to complete their homework. Not completing homework assignments is a huge disadvantage for students because as defined by Zimmerman (2008) as cited in Bembenutty (2009) homework should prompt students to engage in self-initiated and self-directed studying and self-regulation of learning. The study further concluded that many remedial programs designed to assist at-risk students fail because they do not provide the motivational beliefs and self-regulation strategies at-risk students need to become proactive learners. Participants of the study consisted of college freshman (n=58) enrolled in an introductory math course at a New York City College. They consisted of students enrolled in an associated degree program within a large urban community. Students were selected for this study because they failed their math placement exam and placed in remedial math. They were diverse in terms of college majors, demographics and the number of hours they work a week. All participants were enrolled in a self-regulation of learning project which was designed to assist at-risk students to become self-regulated learners before enrolling in the remedial math course. The project helped students become actively involved in the learning process by providing skills necessary to set goals, use strategies, self-monitor, self-adjust and self-evaluate their progress. The participants in the study were asked to complete a survey to determine their motivation for learning math, their use of learning strategies and their activities during homework completion. In addition, students were asked to complete a homework log to report their homework activities. The participants completed four homework logs over two weeks. Pearson correlation coefficients were calculated to assess the direction and magnitude of the linear relations between student's homework activities and the other variables of the study. The results indicated that student's homework activities and beliefs are associated with their reported homework activities especially their beliefs of self-efficacy to learn. The mastering of course material was related to the grade they expected on the midterm exam and the number of hours spent on homework tasks. The study concluded that active involvement of at-risk college students during homework was significantly associated with their academic success. Limitations of this study include the small sample size of participants and a larger sample size may result in different results but overall the results may be generalized to students enrolled in a remedial math course at a technical college.

Shores & Shannon (2007) also conducted a study to investigate the relationships between self-regulated learning, motivation, anxiety, attributions and achievement in mathematics. A total of 761 students selected from fifth and sixth grade math classes in Alabama were surveyed using a version of the Motivated Strategies for Learning Questionnaire, a Test Anxiety Inventory and an Attribution Survey. In addition, academic achievement data was collected for each student participating in the study. Results of the study indicated relationships between motivation, anxiety and test scores for both fifth and sixth grade students in the study but self-regulation and cognitive strategy use were not significantly related to academic performance for the fifth grade students, only the sixth grade students. Researchers in this study concluded that teachers need to design learning environments in math classes that consider students' motivation, anxiety and attributions. Limitations of this study include the use of multiple sections of the math course with multiple instructors, the use of a self-reported survey and different tests used to measure academic performance. This study resulted in similar results to previous research in regard to how motivation and student self-regulation effect student achievement but the study may not be generalizable to college students even though the course content is similar to remedial math courses in college.

In another study investigating self-regulation by Kramarski & Gutman (2006) indicated that a student's knowledge of self-regulated learning strategies is usually insufficient in promoting students achievement because students must also be motivated to use the strategies as well as regulate their time and meta-cognition. They also highlight that many inexperienced learners or at-risk students that lack self-regulatory skills can learn these skills to become more successful learners. In their study they compared two math courses that utilized e-learning. In one classroom they included a program called IMPROVE which is used to teach students self-regulation skills. The IMPROVE program was designed to support self-regulated learning by using a self-metacognitive questioning approach. The goal of the study was to determine if the student's exposed to IMPROVE would have higher grades than students in the other class that was not exposed to IMPROVE. There were 65 ninth grade students who participated in the study which took place in one junior high school in central Israel. Students in both groups were given a math test as a pretest before starting the unit on linear equations and at the end of the five week unit they were given a posttest. The test included three components: problem solving of procedural tasks that assess students' ability to solve standard tasks to assess student ability of basic concepts, problem solving of transfer tasks which included more complex problems and the last component asks students to provide mathematical explanations. Participants in the study also answered a Self-Regulated Learning Questionnaire (SRLQ). The questionnaire consisted of problem solving strategies and self-monitoring questions. An ANCOVA using the pretest scores as a covariate was performed and determined that no significant differences existed in prior problem solving of procedural tasks between the two classes in the study. The results of the posttest indicated that there was a significant difference between the students that experienced IMPROVE during instruction compared to students that did not. Students that experienced IMPROVE outperformed students that did not experience IMPROVE in solving procedural tasks (E=.44), transfer skills of problem solving

(E=.77), and providing mathematical explanations (E=.46). The results of the SRLQ found significant correlations between using self-monitoring strategies and performance on transfer skills and mathematical explanations for the students that experienced IMPROVE while student that did not experience IMPROVE no significant correlations were found between using self-monitoring strategies and performance on procedural tasks. The study concluded that supporting math students with knowledge of self-regulation skills results in positive effects on problem solving, mathematical explanations and self-monitoring. These findings strengthen the recommendations for supporting self-regulated learning in math instruction. A limitation of this study is the short duration of this study as well as the small sample size. This study consisted of junior high school students and the results may not generalize to adult learners in a post-secondary setting but warrants further research with adult learners.

Similar results were found from a study conducted by Perels, Dignath & Schmitz (2009) where they investigated teaching self-regulation skills in a math course. The study compared two math courses where one course incorporated self-regulated skills in addition to teaching the math content and the other course taught just the math content. The study was conducted before and after teaching a unit on “divisor’s and multipliers”. The participants were two sixth-grade classes (n=53) in Germany taught by the same teacher. The design of the study was similar to the previous study where participants completed a pre and post math test in addition to a self-regulated learning questionnaire before the teacher taught a unit lasting 3 weeks. This study also indicated that teaching self-regulated learning strategies in conjugation with math content has a positive outcome for students. The study found students who received self-regulation instruction within regular mathematics lessons of sixth grade students showed knowledge on the trained self-regulation strategies as well as had higher scores on the self-regulation questionnaire. In addition, the study found that it is also possible to support mathematical performance by teaching self-regulatory strategies during regular classes. Limitations of this study were the small sample size and the short duration of the study.

All four studies indicate the importance of a student's ability to use self-regulation skills because they positively influence a student's performance and academic achievement in college. The following paragraphs will discuss the similarities and differences of the flipped model and lecture model to investigate if the flipped model format increases a student's use of self-regulation skills.

Lecture versus Flipped Model Classrooms

Traditionally, in a remedial math classroom students are taught using the traditional lecture method where the instructor provides students with a lecture of new material in class and students' complete homework outside of class. The lecture model creates a teacher-centered classroom where the instructor is in control of how students interpret new material. The instructor chooses the material to be presented in class and how it is presented by providing the course notes and demonstrating how to solve the problems in class while controlling the pace of the material being presented to students.

In contrast, the flipped model is a constructivist approach to teaching which is based on the belief that learning is an active process where learners construct new knowledge by connecting new concepts to existing knowledge. The goal of having students view the material outside of class is to have them actively engage in the new material so they can begin to create a foundation of the new material that will be reinforced in the classroom. The lecture material may consist of videos, power points, or reading assignments. The flipped model is a pedagogical approach that uses technology to deliver lecture material to students outside of class while class time is used to practice new concepts through small group and activity based assignments, in other words, what is normally done in the classroom happens outside the classroom and vice versa (Lage, Platt & Treglia, 2000). The flipped teaching model is also referred to as the inverted classroom and is similar to a hybrid class which is a class that is taught online and in the classroom. Table 2.2 shows the comparison of the flipped and lecture model classroom requirements.

Table 2.2: Comparison of the Flipped and Lecture Model Classroom

	Flipped Model	Lecture Model
Teaching Methodology	Active Learning- students regulate ideas to determine what knowledge is important in lecture material.	Direct Instruction- Instructor controls how students interpret new material by providing new material to students.
Class Time	Student’s actively complete math problems and activities from hand-outs provided in class to practice concepts they viewed in the lecture material on their own. The instructor roams the room answering student questions. In addition, students may work or are required to work problems with peers.	Students listen and watch Instructor present and display new material in class. Students are expected to record notes and example problems from the board. Students have limited time to ask questions about previously presented material.
Homework Assignments	Students are required to take notes from lecture material provided electronically outside of class. In addition, students complete math problems utilizing technology to reinforce math concepts.	Students complete assigned math problems utilizing technology and hand-outs provided in class on their own time.
Role of the Student	Student required being an active participant in the learning process.	Students assumed to be or are expected to be an active participant in the learning process.

As outlined in Table 2.2 the main difference of the flipped model and lecture model is the requirement of active participation. Students need to be active participants in both models to be successful in their math course but in the lecture model classroom it is difficult to assess to what degree a student is active in the learning process. The flipped model is different from the lecture model according to Fulton (2012) because in the traditional lecture classroom the teacher is doing the active work and the students are passively listening while in the flipped classroom students need to be active in the learning process by viewing lecture material using technology and participating in class activities. According to Le, Rodgers & Santos (2011) the lecture method to deliver remedial math does not lead to success because in a lecture model environment of teaching, some students passively receive information from the professor and internalize it through some form of memorization. Anthony (1996) defines passive learning as activities where students are passive receivers of information listening to the teacher's exposition, being asked a series of closed questions where they practice and apply information already presented. In contrast, Anthony (1996) defines active learning as an educational environment where students are given considerable autonomy and control of the direction of the learning activities. The requirements of the flipped model such as using technology to view lecture material, take notes of the lecture material and working actively during class time with peers and the instructor may promote students to be more active in class which may result in an increase in a student's use of self-regulation skills. According to Epper and Baker (2009) the blending of traditional and online instruction of programs at community colleges are providing an initial look at how technology can be used to expand, strengthen, and create efficiencies in the delivery of remedial math. Table 2.3 shows a comparison of the use self-regulation processes and activities in the flipped and lecture model classrooms.

Table 2.3: Comparison of the Use of Self-Regulation in the Flipped and Lecture Model.

Self-Regulation Processes and Activities	Cognition- setting goals and planning tasks. Activation of prior content knowledge. Meta-cognitive knowledge.	Monitoring- goals, self-efficacy, perceptions of ease of learning, task value, and interest.	Control- time and effort planning.	Reaction and Reflection- what methods one will use to assess progress and regulate behaviors.
Homework				
Flipped	Active participation required	May influence self-efficacy and interest	Required	Required
Lecture	Active participation recommended not required.	May influence self-efficacy and interest if students participate	Recommended not required	Required
Class Time				
Flipped	Required	May influence self-efficacy and interest	Required	Required
Lecture	Required	May influence self-efficacy and interest if students participate.	Recommended	Recommended

Self-regulation skills are required for students in the flipped model and the lecture model to be successful math students. The main difference in the flipped model and the lecture model is the accountability to which students are required to apply self-regulation skills. In the lecture model it is difficult to determine to what extent students are actively engaging in content during lectures or completion of homework problems until students completes a test. Active learning is based on a constructivist framework where the nature of students' metacognitive knowledge and the quality of their learning strategies are seen to be critical factors in successful learning outcomes (Anthony, 1996) which is a main component of self-regulated learning where learners actively participate in their own learning to plan, organize, self-monitor and self-evaluate while learning new material. In the flipped classroom students are expected to put time into learning the foundational skills independently and use classroom time to practice and apply those skills (Cole & Kritzer, 2009). The change in the homework requirements of the flipped model may be less threatening for some students because they are not just required to just complete math problems on their own. The active involvement of students participating in the lecture material taking notes may increase motivation while requiring students to practice and improve their use of self-regulation skills. According to Ramdass and Zimmerman (2011), assigning and encouraging students to complete homework can improve their self-efficacy beliefs for learning, thereby enabling them to take more responsibility for their academic achievement. In addition, they state that assignments that are tailored to the interest and achievement level of struggling students may enhance motivation, effort and achievement.

A key learning strategy that students apply while actively engaging in new content is note-taking. Note-taking requires students' to be able to apply self-regulation skills. Students need to actively record and comprehend new material in addition to organize and restructure existing knowledge structures while storing and integrating the freshly processed material (Makany, Kemp and Dror, 2009). They further report that learners misperceive the task demands of note-taking in addition to not realizing the importance of note-taking. The role of good note-taking aids a student in learning new material in a college classroom and it is a skill that students are expected to know. Titworth and Kiewra (1998) found that the level of details in lecture notes accounted for half of the variance in students' final test scores. Unfortunately, many students' especially inexperienced learners do not take proper notes to aid in them in learning of new material in a math course. In some cases, in the lecture model math course many of these students passively sit in class and watch the instructor work problems on the board and have a difficult time taking notes at the same time. According to Kierwa (1985), a student's note taking efficiency in a lecture situation is only around twenty to forty percent. These same students struggle or fail to do their homework because they don't remember how to apply the steps presented in a lecture to complete the math problems on their own as homework. They are solely relying on their auditory skills to learn the new material and miss the opportunity to refer back to their notes. The ability to refer back to their notes for assistance in learning new material according to Makany, Kemp and Dror (2009) would refine their metacognitive knowledge and strategy use. Nolting (2008) summarizes note-taking into two main categories: how to become an active listener and learner. He stresses the importance of students to become active participants in the process of note-taking. In the flipped model classroom students are required to take class notes on their own as homework which allows them to view the lecture material many times and at their own pace. This may be especially helpful for inexperienced learners in a remedial math course that need time to learn how to manage the tasks demands of note-taking influencing their use of self-regulated learning skills. The following paragraphs illustrate research conducted investigating the use of the flipped model classroom.

Models of a Flipped Classroom

A pilot study conducted at Byron School District near Rochester, Minnesota by the math department used the flipped model to teach a calculus and pre-calculus course during the fall 2010 semester due to budget cuts that eliminated funding for new text books as reported by Fulton (2012). They began by flipping a few chapters at a time and the results indicated that the flipped model was an effective method to teach math. The calculus course illustrated a 9.8% average increase in course proficiency and a 6.1% average increase in course proficiency in the pre-calculus course. As a result of this study they changed all math courses to the flipped model. The article did not include sufficient evidence or data to make concrete conclusions about the flipped model as an effective teaching method but the preliminary results are promising.

Another study examining the flipped classroom was conducted at Western Michigan University where they transformed an Introductory Business course (Reck, Schullery & Schullery, 2011). The course was traditionally a taught in a large lecture hall accommodating up to 300 students. This course is a foundations course in the business department and concerns about the lack of student engagement and a lack of faculty willing to teach a large number of students developed which resulted in the new classroom design. The course was transformed to 24 person seminars that met weekly and students were required to prepare for the weekly meeting by engaging in the lecture material before the class meeting. To avoid the pitfall of students not being prepared before the class meeting a five-question quiz was given to students at the beginning of the class meeting as a motivational tool. The remaining class time students worked in small groups on business related topics related to the lecture material. Surveys were distributed to students at the end of the spring 2009 (n= 210) and fall 2009 (n=653) semesters to determine if the new format engaged students and helped them learn. Results of the study indicated that 90% of the students said they usually agree, agree, or strongly agree that students in their sections were prepared for class indicating students were engaged in the course. Furthermore, over 90% of the students agreed that the new format encouraged students to participate in class discussions. In addition, 71.5% and 81.8% of students described themselves as satisfied or very satisfied with the course. They concluded that the redesign of the course was an improvement and the college gained a cost-effective way to promote student engagement in the course. Limitations of the study include the self-selected student survey which students were given extra credit for their responses. Also, students in the traditional format were not given a satisfaction survey so a comparison of both formats could not be obtained. The results of this study indicate that the flipped model may improve student engagement in the classroom and because the course consisted of mainly first-time freshman students one may conclude the same result for first time freshman math students.

The research on the flipped classroom is limited but definitely shows promise as a valid teaching methodology in a remedial math course to promote the use of self-regulation skills to encourage students to become more successful in their math courses. The following paragraphs provide an explanation of the instrument that will be utilized for this study to investigate a students' use of self-regulation skills in a remedial math course.

MSLQ

This study will utilize the MSLQ survey developed by Pintrich et al. (1991). The survey can be used to measure a student's motivation and use of self-regulation skills. It was developed using a social-cognitive view of motivation and learning strategies (Duncan & McKeachie, 2005). Correlational field studies were conducted over a five year period of time using a sample of two-thousand students to investigate college student learning. The results of the studies had consistent results demonstrating that students who possess more positive motivational beliefs engage in a better use of self-regulation skills and were more likely to perform better academically. According to Duncan and McKeachie (2005), the theoretical framework of the MSLQ assumes that motivation and learning strategies are not traits of the learner but rather that motivation is dynamic and contextually bound and learning strategies can be learned and brought under the control of the learner. It was the belief of the researchers of the MSLQ that students' motivation and strategy use might vary depending on the course and specific academic tasks. This aspect of the MSLQ is different from other research on college student learning that focused on students individual differences or learning styles such as the Myer-Briggs (Duncan & Mckeachie, 2005). The MSLQ was chosen for this study because it has been used extensively to evaluate the effects of courses on students and to assess the motivational and cognitive effects of different aspects of instruction (Duncan & McKeachie, 2005) similar to this study. Table 2.4 shows a sample of empirical research investigating self-regulated learning that used the MSLQ with undergraduate college students.

Table 2.4: Empirical Research Using the MSLQ

Citation	MSLQ sub-scale	MSLQ used to address:
Dutton (2003)	Self-Regulation	The effects of epistemological beliefs, motivation and metacognition on performance in case based classes
Hargis (2001)	Entire MSLQ	The effects of constructivist versus objectivist Internet-based science instruction on students' self-regulated learning
Hofer & Yu (2003)	Entire MSLQ	The effects of a learning to learn course on students' motivation and self-regulated learning
McManus (2000)	Entire MSLQ	The effect of different Web-based hypermedia environments on high versus low self-regulating students' performance
Niemi, Nevgi, & Virtanen (2003)	Self-Regulation	The nature of self-regulation in Web-based learning
Ostovar & khayyer (2004)	Entire MSLQ	The relation between motivation and learning strategies

Duncan, T. G., & McKeachie W. J. (2005). The Making of the Motivated Strategies for Learning Questionnaire. *Educational Psychologist*, 40:2, 117-128

Summary

How a student feels about their learning and how they apply self-regulation skills are important factor that influences academic success. It is noted in the research that many inexperienced learners don't believe their effort will impact how they learn nor do they believe they have the ability to be a successful learner. In addition, many have a difficult time applying self-regulation skills. This may be a reason why some students are unsuccessful in a remedial math course. This study investigates if using the flipped model will increase a student's use of self-regulation skills compared to the lecture model. Both models require a student to use self-regulation skills to be successful but the flipped model holds a student more accountable to be engaged in the material by being required to take and bring notes to class and to actively participate in the classroom on math problems. It is documented in research that self-regulation skills can be learned therefore a teaching method like the flipped model may increase the use of one's self-regulation skills benefiting students in a remedial math course.

CHAPTER THREE

METHODOLOGY

Introduction

Remedial math has been the topic of discussion nationally at many colleges in recent years. There is a concern with the high percentage of students that are required or recommended to enroll in remedial math courses when they attend college. A recent report published by ACT (2014) found that the average ACT math score for 2012 graduates was 21. This score translates to 46% of 2012 graduates will be required or recommended to enroll in a remedial math course in college. Enrolling in remedial math courses can delay graduation for students especially if more than one course is required before students can enroll in their degree required math course in addition; it is an added expense in terms of tuition. This is troublesome because many students do not complete their remedial math course or series of remedial math courses successfully. Merseth (2011) refers to remedial math courses as the graveyard of dreams and aspirations due to high failure rates, increased debt burdens, and a lack of credits on a transcript. On the other hand, many students will not complete their college level math course required for degree completion successfully without completing remedial math courses. Some students may perform poorly in remedial math courses due to their lack of ability to self-regulate their own learning. Students who are motived learners and apply self-regulation skills are more successful learners and most importantly students can learn to become self-regulated learners (Duncan & McKeachie, 2005). In addition, students who exhibit higher levels of control of learning and self-efficacy are more successful learners (Pintrich, Smith, Garcia & McKeachie, 1991). They define control of learning as a student's beliefs that their efforts to learn will result in positive outcomes and self-efficacy as one's ability to master a task which includes judgments about one's ability to accomplish a task as well as one's confidence in their skills to perform that task (Pintrich, Smith, Garcia & McKeachie, 1991). So, if a student can increase their ability to control their own learning, their levels of self-efficacy and their use of self-regulation skills as well as become proficient in their remedial math course, they have a better chance of achieving their educational goals. Therefore, the purpose of this study is to answer the following research questions:

1) What are the characteristics of students who enroll in a remedial math course?
2) Do the control of learning scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
3) Do the self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
4) Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?

5) How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?
6) Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?
7) Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcome) of students in this study?
8) Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?

The findings of this study will inform remedial math instructors about the influence of motivation (control of learning and self-efficacy) and study skills (self-regulation) on students who participate in a flipped model and lecture model remedial math course. Knowledge of these findings will allow remedial math instructors to examine the two different pedagogical approaches to teaching a remedial math course which may result in helping students become successful learners resulting in better completion rates in remedial math courses.

The following sections of this chapter describes the context of the study, research design, setting, data collection procedures, sample population, group equivalence, instrumentation overview, and data analysis.

Context of the Study

This study took place at Highlands College which is the two-year college of Montana Tech of the University of Montana. Highlands College is small open enrollment public land grant college located in rural southwest Montana. The college provides educational opportunities to meet the needs of people in the surrounding areas as well as labor and industry. Highlands College offers Certificate and Associate of Applied Science (AAS) degrees in a variety of degree programs (www.mtech.edu) with the largest percentage of students enrolled in the Associate of Science (AS) degree program. A total of 17% of students were enrolled in the AS program in fall 2013 and 29% of students were enrolled in the AS program in spring 2014 at Highlands College. The AS degree program was developed specifically as a transfer degree program where students have the option to complete their general education credits at two year fees before transferring to another college. At Highlands College students who place into remedial math or writing courses are required to enroll in the AS program to complete their remedial coursework before transferring to a four year degree program.

The total headcount of students for fall 2013 was 913 students and 817 students for the spring 2014. The majority of the students enrolled at Highlands College during fall 2013 and spring 2014 are students that originate from the surrounding areas of Beaverhead, Deerlodge, Jefferson, Madison, or Silverbow counties with 72% of students during the fall 2013 semester and 73% of students during the spring 2014 semester. Most students were enrolled as full-time students where 58% of students were enrolled full-time during the fall 2013 and spring 2014 semester. The comparison of male students to female students is approximately 1:1. In fall 2013, 47% of students were male compared to 53% of female students. In spring 2014, 52% of students were male compared to 48% female students. More students enrolled at Highlands College during fall 2013 and spring 2014 were under the age of 25. There were 73% of students enrolled during fall 2013 and 68% of students enrolled during the spring 2014 semester that were under the age of 25. Dual enrollment students accounted for 267students or 30% of the total headcount of students enrolled at Highlands College. Dual enrollment students are not eligible to enroll in remedial math courses at the college level. Therefore, the total number of students on campus excluding the dual enrollment students who are eligible to enroll in remedial math courses at Highlands College was 646 or 30% of students for the fall 2013 semester. A total of 584 students or 28% of students were eligible to enroll in remedial math courses for the spring 2014 semester. Table 3.1 shows the population of all students enrolled at Highlands College for the fall 2013 and spring 2014 semesters.

Table 3.1: Fall 2013 and Spring 2014 Enrollment at Highlands College

	Fall 2013	Spring 2014
Total Headcount Including Dual Enrollment Students	913	817
Male	433 (47%)	421 (52%)
Female	480 (53%)	396 (48%)
Enrollment Status		
Full-time Students	529 (58%)	474 (58%)
Part-time Student	384 (42%)	343 (42%)
Full-time students from surrounding Counties (Beaverhead, Deerlodge, Jefferson, Madison, and Silverbow	656 (72%)	595 (73%)
Enrollment Status by Age		
Non-traditional age (25 or older)	248 (27%)	260 (32%)
Traditional age	665 (73%)	557 (68%)
Student Headcount by Department		
Associate of Science	154 (17%)	234 (29%)
Accounting Business Technology	68 (7%)	70 (8%)
Health Programs	119 (13%)	96 (12%)
Network Technology	36 (4%)	31 (4%)
Trades and Technical	131 (14%)	144 (18%)
Dual Enrollment Students (High School students)	267 (30%)	233 (28%)
Non-Degree Students	138 (15%)	9 (1%)
Total Number of Students eligible to enroll in remedial course work. (students not enrolled in Dual Enrollment Courses)	646	584

A remedial math course in the Montana University System is defined as a course that is a basic skills course with a course number less than 100. Students with low math placement scores are required to complete their required remedial math courses before they can enroll into a college level math course. The series of remedial math courses offered at Highlands College include Basic College Math (Math 061), Introduction to Algebra (Math 090), and Intermediate Algebra (Math 095). The remedial math courses are delivered in a 16 week semester or a 5 week summer semester. All sections of the remedial math courses are offered in a lecture only format or lecture with an online component used to deliver homework assignments and supplementary information.

Table 3.2 shows the Remedial Math Sequence at Highlands College.

Table 3.2: Remedial Math Sequence at Highlands College

Course	Content	Duration of Course and Type	Credits
Math 061	Whole Numbers Fractions Decimals Percent Ratios Proportions	16 week semester Lecture only or Lecture with online component	3
Math 090	Review of fractions and decimals Real number system Algebraic expressions Linear Equations Exponents Polynomials Factoring Polynomials	16 weeks fall and spring 5 weeks summer Lecture only or Lecture with online component	4
Math 095	Review of Polynomials Factoring expressions Quadratic equations System of Equations Graphing Radical Expressions	16 weeks fall and spring 5 weeks summer Lecture only or Lecture with online component	3

Remedial math courses typically have a higher enrollment compared to remedial writing courses (http://mus.edu/CCM/CCA%20Progress%20Metric%201%20-%20Remediation%20Rates%20by%20Subject.pdf). According to Complete College Montana more students at Highlands College enrolled in a remedial math courses (40%) compared to remedial writing courses (3%) after averaging the enrollment of students for the fall 2009, 2010, 2011, and 2012 semesters.

Math 095 was chosen for this study because it is the required math course for degree completion for many two-year degree programs (AAS degrees) and it is the pre-requisite course for the entry level college math course (Math 121) at Montana's four year institutions. During the fall 2013 and spring 2014 semesters, a total of 625 students enrolled in remedial math courses at Highlands College. The majority (46%) of those students were enrolled in Math 095 which is one level below the college level math course of college algebra (Math 121) followed by 33% of students enrolled in Math 090 and 21% of students enrolled in Math 061. During the fall 2013 semester 379 students out of a total of 646 students or 59% of students enrolled in remedial math courses and during the spring 2014 semester 246 students out of 584 students or 42% of students enrolled in remedial math courses.

A successful completion rate of students enrolled in remedial math courses was determined by using a grade of a C or higher. A grade of a C indicates a student passed the course but it does not necessarily indicate that a student has gained the skills to be successful in the next course. According to an interview with Paul Nolting conducted by Boylan (2011), Nolting states "the reason few students complete the developmental [remedial] math sequence is that math is extremely linear so earning a C in a current algebra course most likely translates to failing the next algebra course". The completion of students in remedial courses for fall 2013 and spring 2014 resulted in the following percentages: 65%, 57% (Math 061), 61%, 59% (Math 090), and 62%, 61% (Math 095).

Table 3.3: Student Participation and Completion of Remedial Math at Highlands College

Course	Fall 2013 Enrolled	Completion	Spring 2014 Enrolled	Completion	Total Enrolled
Math 061	81 (21%)	A 25 (31%) B 18 (22%) C 10 (12%) *C or better (65%)* D 8 (10%) F 17 (21%) W 3 (4%)	49 (19%)	A 13 (27%) B 6 (12%) C 9 (18%) *C or better (57%)* D 3 (6%) F 15 (31%) W 3 (6%)	130 (21%)
Math 090	125 (33%)	A 34 (27%) B 28 (23%) C 14 (11%) *C or better (61%)* D 18 (14%) F 19 (15%) W 12 (10%)	72 (30%)	A 12 (17%) B 13 (18%) C 17 (24%) *C or better (59%)* D 13 (18%) F 16 (22%) W 1 (1%)	197 (32%)
Math 095	173 (46%)	A 38 (22%) B 40 (23%) C 29 (17%) *C better (62%)* D 11 (6%) F 38 (22%) W 17 (10%)	125 (51%)	A 29 (23%) B 23 (18%) C 25 (20%) *C or better (61%)* D 13 (11%) F 30 (24%) W 5 (4%)	298 (48%)
Total Enrolled	379/646 (59%)		246/584 (42%)		625/1230 (51%)

The high number of students enrolled in remedial math courses and the low completion rates of these courses at Highlands College illustrates how important it is to identify teaching methods that help students increase their use of self-regulation skills so more students successfully complete their remedial math courses leading to the achievement of their educational goals.

Research Design

This quasi-experimental pretest and posttest design utilized a paper version of the MSLQ survey (Pintrich et al., 1991) to investigate levels of control of learning, self-efficacy and self-regulation of students who participated in a flipped model remedial math course compared to students who participated in a lecture model remedial math course. Also, the educational outcomes of students in each classroom were investigated using the COMPASS math placement exam as a pretest and posttest design. The COMPASS math placement exam is used to predict a student's level of preparedness for students enrolled in the flipped or lecture model classrooms. Descriptive data was collected to learn more about the characteristics of remedial math students and to serve as control variables which are described in greater detail in the section below to determine group equivalence. A series of Pearson Chi-Square and T-tests were used to test group equivalency across a number of individual characteristics. The results of the test of group equivalency is described below. The study instrument, independent variables and dependent variables will be described later in the chapter.

Setting

The study takes place at Highlands College during the fall 2014 and spring 2015 semesters. Students in the study were enrolled in an Intermediate Algebra course (M095) where one section was delivered using the flipped model and one section was delivered using the lecture model for the fall 2014 and spring 2015 semesters. In the flipped model classroom the lecture material and homework assignments were "flipped" where students were required to complete lecture material on their own as homework assignments and during class time they were required to complete homework problems and activities. In the lecture model classroom students were required to take notes during class time of instructor provided lecture material and complete homework problems outside of class. A comparison of the flipped classroom and lecture classroom is in Table 3.4.

Table 3.4: Comparison of the Flipped and Lecture Model Classroom

	Flipped Model	Lecture Model
Teaching Methodology	Active Learning- students regulate ideas to determine what knowledge is important in lecture material.	Direct Instruction- Instructor controls how students interpret new material by providing new material to students.
Class Time	Student's actively complete math problems and activities from hand-outs provided in class to practice concepts they viewed in the lecture material on their own. The instructor roams the room answering student questions. In addition, students may be required to work problems with peers.	Students listen and watch Instructor present and display new material in class. Students are expected to record notes and example problems from the board. Students have limited time to ask questions about previously presented material.
Homework Assignments	Students are required to take notes from lecture material provided electronically outside of class. In addition, students complete math problems utilizing technology to reinforce math concepts.	Students complete assigned math problems utilizing technology and hand-outs provided in class on their own time.
Role of the Student	Student required to be an active participant in the learning process.	Students assumed to be or are expected to be an active participant in the learning process.

At the start of the semester, it was necessary to prepare students in both classrooms how to use study skills or apply self-regulation skills to be successful in a math course. All students in the study were required to participate in study skill activities in and outside of the classroom and given credit for completion of assignments as homework assignment. Study skills assignments and activities were reinforced in both classrooms during the entire semester. After the completion of the time management and notetaking activities the remaining study skills were included with math content for both classrooms. Both classrooms utilized the same curriculum, course handouts, course quizzes, and course final. See Table 3.5 for a list of course content of for the flipped and lecture classrooms.

Table 3.5: Course Content for the Flipped and Lecture Model Remedial Math Courses

Math Content	**Math Study Skills**
Review Material and Syllabus Handout-Polynomials Handout-Solving Equations	How to read the syllabus Presentation- How to Learn Math Presentation-Time Management Handout-Weekly Time Management Handout- Time Management Month at a Glace
Factoring Units (Review Material):	Presentation-Notetaking Class Activity for Notetaking Presentation-Active Listening
Rational Expressions Unit	Presentation-How to study for a Test MSLQ Pre-Survey Presentation-How to Evaluate My Understanding Handout-Test Corrections
Graphing Unit	Verbal Reminders to Apply Study Skills
System of Equations	Verbal Reminders to Apply Study Skills
Radical Expressions	MSLQ Post-Survey COMPASS Post-Exam

Data Collection Procedures

The study population includes all students enrolled in two sections of Math 095 during the fall 2014 semester and two sections of Math 095 during the spring 2015 semester. Class lists, the COMPASS placement exam, a Demographic Questionnaire, and the MSLQ survey were used to collect data. Data collected from class lists provided information of class rank and degree option. The COMPASS placement exam was used to determine pre and post math placements as well as reading score of students. The COMPASS pre math scores were collected from the COMPASS database the first week of classes and the post math scores were collected the last week of classes. Students that did not have COMPASS scores were assigned to complete the COMPASS placement test outside of class as homework during the first week of classes. The Demographic Questionnaire provided data of student characteristics and was collected when students completed the MSLQ pre-survey. The MSLQ survey provided pre and post scores for control of learning, self-efficacy and self-regulation. The MSLQ pre-survey was completed by students approximately the fourth week of classes after the completion of the rational expressions unit. The MSLQ post-survey was completed in class the week of scheduled classes. The MSLQ survey took approximately an hour to complete and was given to students during scheduled class time. All data collected was entered into SPSS for analyses.

Sample Population

The sample population of students that participated in this study are students that completed all of the following requirements: signed a consent form, completed a pre and post Compass exam, and completed a pre and post MSLQ survey. The flipped classroom had a total response rate of 28 out of 53 (53%) of students that completed the requirements of the study and the lecture classroom had a total of 32 out of 59 (54%) of students that completed the requirements of the study.

Data collected for the both samples includes student characteristics; pre COMPASS Math Placement scores; and pre MSLQ survey scores. A Chi-Square was performed using sample characteristics and pre-math placements. In addition, an independent series t-test was performed using pre COMPASS math scores and pre MSLQ survey scores. See Table 3.6 below for a description of both groups in the study and results of the analyses. The analysis is discussed in more detail in the group equivalence section below.

There were a total of 28 students that participated in the flipped classroom and 32 students that participated in the lecture classroom.   The chi-square tests for group equivalency across a number of participant characteristics showed no differences in students in each class. The flipped classroom consisted of 79% female and 21% male students. The students in the lecture classroom was 81% female and 19% male.   In the flipped classroom 64% of students were traditional age and 36% of students were non-traditional age. The lecture classroom had 56% traditional age and 44% non-traditional age students. In the flipped classroom 18% were first semester students and 82% returning students. In the lecture classroom 28% traditional age and 72% returning students. There were more students enrolled in the AS degree program in the lecture classroom which was 62% of students compared to 47% of students in the flipped classroom. There were 14% of students enrolled in a four-year degree program and 39% of students enrolled in a two-year program in the flipped classroom. The lecture classroom had 16% of students enrolled in a four-year program and 22% of students enrolled in a two-year program.   The majority of students in both groups scored between 80 to 89 on the reading placement exam with 68% in the flipped classroom and 69% in the lecture classroom. The majority of the students in this study had earned a high school diploma. There were fewer students in the flipped classroom that completed four math courses in high school and earned a diploma with 57% percent in the flipped classroom compared 78% of students in the lecture classroom. In the flipped classroom 29% of students completed 3 math courses in high school and earned a diploma compared to 19% of students in the lecture classroom. There were 14% of students that completed two or less math courses in high school and earned a GED compared to 3% of students in the lecture classroom. The majority of students in both groups reported their last math course was completed within the last year with 75% in the flipped classroom and 81% in the lecture classroom. There were 18% of students in the flipped classroom who reported it was greater than or equal to four years since their last math course compared to 13% of students in the lecture classroom. There were 43% of students in the flipped classroom who reported a positive or no opinion in terms of the math emotions compared to 44% of students who reported a positive math emotion and 34% of students who reported no opinion in terms of math emotions in the lecture classroom. More students in the flipped classroom completed two courses in college with 50% of students compared to 25% of students in the lecture classroom. There were 25% of students in the flipped classroom that completed one course in the flipped classroom compared to 41% of students in the lecture classroom. This would indicate that more students in the flipped classroom initially tested in lower remedial math courses during their first semester compared to students in the lecture classroom. Most of the students in the study were enrolled in or had completed a college success course with 75% of students in the flipped classroom and 81% of students in the lecture classroom. Fewer students in both groups were required to enroll in a remedial writing course with 14% of students in the flipped classroom compared to 6% of students in the lecture classroom. There were fewer students in the flipped classroom that reported that they had good computer technology skills with 46% of students in the flipped classroom compared to 69% of students in the lecture classroom. The pre-math placements were higher for students enrolled in the lecture classroom with 31% of students placing in Math 095 compared to 14% of students in the flipped classroom. The flipped classroom had 39% of students place into math 061 compared to 22% of students in the lecture classroom.

Table 3.6: Sample Population Characteristics

Characteristics	Flipped n=28	Lecture n=32	Pearson Chi-Square
Gender			.796
Male	6 (21%)	6 (19%)	
Female	22 (79%)	26 (81%)	
Age			.526
Non-traditional (>24)	10 (36%)	14 (44%)	
Traditional Age	18 (64%)	18 (56%)	
Class Rank			.357
First Semester	5 (18%)	9 (28%)	
Returning	23 (82%)	23 (72%)	
Degree Option			.328
4-year degree	4 (14%)	5 (16%)	
2-year degree	11 (39%)	7 (22%)	
AS Degree or transfer	13 (47%)	20 (62%)	
Reading Scores			.941
30 to 79	9 (32%)	10 (31%)	
80 to 98	19 (68%)	22 (69%)	
Previous Math Experience			.226
No H.S. and GED	2 (7%)	1 (3%)	
2 or more and GED	2 (7%)	0 (0%)	
3 in H.S. and Diploma	8 (29%)	6 (19%)	
4 in H.S. and Diploma	16 (57%)	25 (78%)	
Last math class			.633
Less than or equal to 1	21 (75%)	26 (81%)	
2 years	2 (7%)	1 (3%)	
3 years	0 (0%)	1 (3%)	
Greater than or equal to 4	5 (18%)	4 (13%)	
Math Emotions			.687
Negative	4 (14%)	7 (22%)	
No opinion	12 (43%)	11 (34%)	
Positive	12 (43%)	14 (44%)	
College Math			.130
No courses	7 (25%)	11 (34%)	
1 course in college	7 (25%)	13 (41%)	
2 courses in college	14 (50%)	8 (25%)	

Table 3.6: Sample Population Characteristics Continued

Characteristics	Flipped n=28	Lecture n=32	Pearson Chi-Square
College Success			.558
Yes	21 (75%)	26 (81%)	
No	7 (25%)	6 (25%)	
Writing 095			.301
Yes	4 (14%)	2 (6%)	
No	24 (86%)	30 (94%)	
Computer Skills			.176
Fair	7 (25%)	6 (19%)	
Good	13 (46%)	22 (69%)	
Excellent	8 (14%)	4 (13%)	
Pre Math Placement			.187
Math 061	11 (39%)	7 (22%)	
Math 090	13 (46%)	15 (47%)	
Math 095	4 (14%)	10 (31%)	

To complete the MSLQ students were instructed to select their response to the questions using a likert-scale ranging from 1 (not at all true of me) to 7 (very true of me). Analysis indicated that the two groups in the study were equivalent on control of learning beliefs, self-efficacy and self-regulation (See Table 3.7). Students in the flipped model classroom had a mean score of 5.18 (SD = 1.41) for control of learning beliefs, 5.23 (SD=1.17) for self-efficacy and 4.62 (SD = 1.08) for self-regulation. The lecture model classroom had a mean score of 5.18 (SD = 1.41) for control of learning beliefs, 5.23 (SD=1.17) for self-efficacy and 4.64 (SD = .979) for self-regulation.

Table 3.7: Sample Population Test Results

	Test Results		
	Mean (SD)	Mean (SD)	T-test
Pre Math Scores	28.68 (8.61)	33.69 (11.76)	ρ= .068
Pre MSLQ			
Control of Learning	5.18 (1.41)	5.18 (1.28)	ρ= .997
Self-Efficacy	5.23 (1.17)	5.23 (1.21)	ρ= .978
Self-Regulation	4.63 (1.08)	4.64 (.979)	ρ= .955

* The survey results reflect values before the factorial analysis was conducted

Group Equivalence

In order to answer the research questions for this study it was necessary to establish that the students participating in the flipped classroom were equivalent to students participating in the lecture classroom. Group equivalence was determined by comparing the sample characteristics; pretest Compass results and the pre-MSLQ survey results. A Pearson Chi-square was performed for variables that were nominal and an independent sample t-tests was used for scored variables. The results of the tests indicate that there is no significant difference between students participating in the flipped classroom compared to students participating in the lecture classroom, therefore the two groups in this study are equivalent. A Pearson Chi-square is a non-parametric tool designed to analyze group differences when the variable is measured at a nominal level (McHugh, 2013).

Instrumentation Overview

This study utilized the MSLQ survey and the COMPASS Math test. Both instruments utilized a pre and posttest design. The MSLQ was used to measure student's pre and post control of learning, self-efficacy and self-regulation scores. The COMPASS math test was used to measure a student's initial math score at the start of the study and to measure a student's final math score at the end of the study. Additional data collected from a demographic questionnaire and class lists was used to examine student characteristics and determine group equivalence. Dependent and Independent variables are discussed in more detail in the variables section. The following paragraphs provide more detail about the instruments used in this study.

MSLQ Survey

The MSLQ survey developed by Pintrich et al. (1991) was used for this study. The survey can be used to measure a student's motivation and use of self-regulation skills. The original survey contains 81 questions but the survey is not discipline specific and categories can be customized by the user to measure specific areas of interest (Pintrich et al., 1991). For this study students answered the entire survey but the only the sections of control of learning, self-efficacy and self-regulation of interest to answer the research questions. To complete the MSLQ students were instructed to select their response to the questions using a likert-scale ranging from 1 (not at all true of me) to 7 (very true of me). A copy of the original MSLQ survey is located in Appendix A.

Validity and Reliability of the Original MSLQ Survey

The results for validity and reliability of the Original MSLQ survey were presented by Pintrich et al. (1991) in the manual for the use of the MSLQ. Validity was determined using confirmatory analysis and Lambda-Ksi (LX) estimates were calculated for the motivation and self-regulation skills scale items. Lambda-Ksi estimates of .8 or higher indicates well-defined latent constructs. As a result of the confirmatory factor analyses the subscales represent a coherent conceptual and empirically validated framework for assessing student motivation and use of self-regulation skills in the college classroom (Pintrich et al., 1991).

In order to begin the analysis of the data collected for this study utilizing the MSLQ survey. Student were asked to respond to the survey questions using a likert scale of 1-7 where 7 = very true of me and 1= not at all true of me. For responses between 1 and 7, students were asked to select the number that best described them. There were two questions that were recorded as reverse values (1=6, 2=5, 3=4, 4=3, 5=2, 6=1 and 7=0). All data was entered into SPSS for analyses.

A factor analysis was performed to validate the factor validity of the constructs used for this study. The factor analysis was performed using all 24 questions utilized for this study to determine if the questions would be reduced from one factor into the three factors of control of learning, self-efficacy and self-regulation as defined by the authors of the MSLQ. The analysis included the extraction and rotation using principle components method which indicated that there are six factors that accounted for 72% of the variance. The scree plot illustrated that the construct with 24 dimensions would demonstrate validity when loaded into four factors. Another factor analysis was performed and the 24 dimensions were reduced to four factors. The analysis included the extraction and rotation using principle components method. The resulting three interpretable factors are Self-Efficacy (5, 6, 12, 15, 20, 21, 29 and 31), Self-Regulation (36, 44, 54, 55, 56, 76), and Control of Learning (57r, 33r, 18, 2, 9). The resulting eigenvalues range from .507 to .836. Eigenvalues of .70 or greater when the number of variables used are less than 30 are considered fairly reliable (Mertler and Vannatta, 2010) and factor loadings of .8 or higher indicate well-defined latent constructs (Pintrich, 1991). According to Stevens (2001) as reported by Mertler and Vannatta (2010), components with four or more loadings above .60 are reliable regardless of sample size. After examination of the results Question #61 was eliminated from this study due to low validity result below .40. The resulting factors with loadings for this study and the original MSLQ (Pintrich, 1991) and responding questions are listed in Table 3.9.

Table 3.8: Factor Loadings for Self-Efficacy, Control of Learning and Self-Regulation

Question		Current Study	Original MSLQ
	Factor 1: Self-Efficacy		
5	I believe I will receive an excellent grade in this class.	.83	.83
6	I'm certain I can understand the most difficult material presented in the readings for this course.	.63	.70
12	I'm confident I can learn the basic concepts taught in this course.	.64	.63
15	I'm confident I can understand the most complex material presented by the instructor in this course.	.69	.71
20	I'm confident I can do an excellent job on the assignments and tests in this course.	.83	.76
21	I expect to do well in this class.	.80	.89
29	I'm certain I can master the skills being taught in this class.	.73	.77
31	Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	.84	.87
	Self-Regulation		
36	When reading for this course, I make up questions to help focus my reading.	.77	.44
44	If course readings are difficult to understand, I change the way I read the material.	.69	.54
54	Before, I study new course material thoroughly, I often skim it to see how it is organized.	.78	.53
55	I ask myself questions to make sure I understand the material I have been studying in this class.	.65	.58
56	I try to change the way I study in order to fit the course requirements and the instructor's teaching style.	.51	.43
76	When studying for this course I try to determine which concepts I don't understand well.	.62	.61
	Factor 3: Control of Learning		
2	If I study in appropriate ways, then I will be able to learn the material in this course.	.58	.57
9	It is my own fault if I don't learn the material in this course.	.55	.38
18	If I try hard enough, then I will understand the course material.	.61	.84
33r	During class time I often miss important points because I'm thinking of other things.	.64	.40
57r	I often find that I have been reading for this class but don't know what it is about.	.72	.35

Reliability was determined by calculating internal consistency estimates of reliability of the defined factors of control of learning, self-efficacy, and self-regulation. Cronbach's Alpha was also performed to determine the internal consistency of the constructs where values close to 1.0 which indicate a good internal reliability. Cronbach's Alpha values that are greater than .70 are considered acceptable to excellent. The results of Cronbach's Alpha for this study ranged from .77 to .93. Overall, the results of the tests for validity and reliability indicate the MSLQ survey for this study is a valid instrument. The results for the factors of control of learning, self-efficacy and self-regulation are listed in Table 3.9.

Table 3.9: Cronbach's Alphas for the MSLQ scales

Scale	Question Numbers	Reliability Coefficients	
		Current Study	Original MSLQ
Control of Learning Belief	2, 9, 18, 33r, 57r	.78	.68
Self-Efficacy	5, 6, 12, 15, 20, 21, 29, 31	.93	.93
Self-Regulation	36, 44, 54, 55, 56, 76	.83	.79

*r indicates reverse code

<u>ACT COMPASS Placement Test</u>

The ACT COMPASS placement test is a computer-adaptive placement test used at Highlands College to place students in the appropriate math course. The math placement test is a multiple-choice test that evaluates a students' math ability. The test offers five placement domains (test areas): pre-algebra, algebra, college algebra, geometry and trigonometry. In this study students started the test in the Algebra domain which consists of approximately 10 questions. The test is intuitive so if a student answers the questions correctly they will be moved to a higher domain and if they answer questions incorrectly they will be moved to lower domain. A concordance scale created by ACT was used to convert pre-algebra domain scores to algebra domain scores. When students finish the test they are given a cut-score and a math placement which is the name of the course that is appropriate for their skill level. The cut-scores and the math placements used at Highlands College were established using ACT recommendations.

Table 3.10: Highlands College Math Placement Cut-Scores and Math Placements

	Cut-score	Math Placement
Placement Domain Algebra	0-23	Math 061
	24-44	Math 090
	45-70	Math 095
	71-100	Math 121

The reading test was also administered to assist in establishing group equivalency when students completed the math pretest. The reading test is a multiple-choice test that is comprised of five types of reading comprehension passages. The test is scored out of a total of 100 points. A cut-score of 80 or higher is used to indicate if a student has the reading skills required to be successful in a college level course. Details of the math and reading test are located at the ACT website (http://www.act.org/compass/tests/math.html).

Variables

The dependent variables used in this study are post scores for control of learning, self-efficacy, self-regulation, and posttest COMPASS math. The scores for control of learning, self-efficacy and self-regulation were self-reported student responses from the

MSLQ survey. Students rated their responses using a seven point Likert scale and responses were coded as 1 = not at all true of me and 7 = very true of me. Questions on the MSLQ were not grouped by each construct and appeared on the survey in random order. The MSLQ survey is located in Appendix A. Table 3.11 shows the dependent variables in this study as well the code, range and data type.

Table 3.11: Dependent Variables including code, range and data type

Dependent Variables	Code	Range	Data Type
MSLQ Post Control of Learning	1-7	5-35	Scale
MSLQ Post Self-Efficacy	1-7	8-56	Scale
MSLQ Post Self-Regulation Score	1-7	6-42	Scale
COMPASS Post Math Placement		0-100	Scale

The independent variables for this study were chosen because each student characteristic or a combination of student characteristics may influence the results in this study. Table 3.12 shows the independent variables used in this study as well their code, range and data type.

Table 3.12: Independent Variables including Code, Range and Data Type

Independent Variables	Code	Range	Data Type
Gender		0-1	Nominal
Male	0		
Female	1		
Enrollment Status		0-1	Nominal
Non-traditional Age (> or =25)	0		
Traditional Age	1		
Class Rank		0-1	Nominal
First Semester College	0		
Returning Student	1		
Degree Option		0-2	Nominal
4-year degree (BS)	0		
2-year degree (AAS)	1		
AS transfer (AS)	2		
Math Experience			
How many years of math did you complete in high		1-4	Ordinal
school	1		
Did not complete math in H.S. and earned GED	2		
Completed 2 or more years in H.S. and earned	3		
GED	4		
Completed 3 years in H.S. and earned diploma			
Completed 4 years in H.S. and earned diploma			
How many math courses did you complete in college		1-3	Ordinal
Did not complete a college math course	1		
Completed one math course in college	2		
Completed two math courses in college	3		
Time since last math class		1-4	Ordinal
Less than or equal to 1 year	1		
Two years	2		
Three years	3		
Greater than or equal to four years	4		
What are your feelings about Math (Math Emotions)		1-3	Ordinal
Negative	1		
No Opinion	2		
Positive	3		
Completed or Enrolled in a College Success Course (study skills course)		0-1	Nominal
Yes	0		
No	1		

Table 3.12 Continued

Independent Variables	Code	Range	Data Type
Enrolled in Writing 095		0-1	Ordinal
Yes	0		
No	1		
Computer Technology Skills		1-4	Ordinal
I never or rarely use a computer (poor)	1		
I use a computer to access email and internet	2		
(fair)	3		
I frequently use a computer and utilize various			
programs (good)	4		
I'm confident using a computer and can troubleshoot			
most technical problems (excellent)			
COMPASS Reading Placement Test		0-100	Scale

The following paragraphs provide a description of independent variables for this study:

Gender refers to the sex of the participant.

Age refers to the age of a participant where a traditional-age students is defined as student who is less than or equal to twenty-four years old and non-traditional student is a student who is twenty-five years old or older.

Class rank asks participants to identify if they a first semester college student or a returning college student. Students who are first semester students may have more difficulty adjusting to the culture of college than students who have more experience.

Degree option asks participants to identify if they are enrolled in a transfer program (AS), a two-year program (AAS) or a four-year program (BS).

Math experience asks participants to identify how many math courses they completed in high school as well as whether they received a high school diploma or GED. They are also asked to identify how many courses they completed in college.

Time since last math class asks participants to indicate how long it has been since they were enrolled in a math course. This information may indicate if a student simply needs a review of material or if a student needs to learn forgotten material.

How you feel about math (math emotions) asks participants to indicate if they have negative or positive feelings towards math. Negative feelings towards math may impact a participant's performance in a math course

Completed or enrolled in a College Success Course (study skills course) asks participants to indicate if they are enrolled in or completed a College Success Course. A participant's knowledge of study skills could influence how they respond to the MSLQ survey.

Enrolled in Writing 095 asks participants to indicate if they are enrolled in the writing 095 course. The writing 095 course at Highlands College is a remedial writing course. It is noted by previous research that students who are enrolled or place in more than one remedial course are more academically at-risk than students that students that place in one remedial course.

Computer Technology Skills asks participants to rate their computer skills because both courses in this study require students to use a computer. Poor computer technology skills may influence a participant's performance in a math course.

COMPASS Math Placement results were recorded at the start and the end of the study. The pre math placements were used to determine group equivalence of students in the flipped and lecture model classrooms because students with a low math placement may have too many deficiencies to perform well in Math 095 and should in reality be enrolled in the prerequisite course of Math 090. Also, students who score on the higher end of the range for enrollment into Math 095 may only need a brief review of concepts and may not apply study skills strategies as a result of their participation in either classroom.

COMPASS Reading Placement test scores were recorded for each participant in the study. These scores were used to determine group equivalence. In addition, was necessary to determine if a student had the adequate reading skills to be successful in a college math course due to notetaking requirements of students in both classrooms. Students that scored below 80 in reading were advised they may have difficulty in college level courses with reading requirements.

Data Analysis

This study investigated if the flipped model is an effective teaching model for students enrolled in a remedial math course. The results of this study will be used to inform other college remedial math instructors so every effort will be made to eliminate threats to external and internal validity.

Group equivalency was determined by performing a Pearson chi-square on categorical data and t-tests were performed on scored data to determine if students in the flipped classroom were the same as students in the lecture classroom. Also, a factor analysis and reliability measures were analyzed using pre MSLQ scores to establish validity and reliability of the MSLQ survey.

The questions of the study were answered by utilizing frequency data to report descriptive statistics of student characteristics and prior academic experience for students enrolled in the remedial math. In addition, independent series t-tests were performed to compare the post MSLQ scores and posttest COMASS math scores of students in the flipped and lecture classroom. A series of linear multiple regressions were performed to determine if there are associations between pre MLSQ scores on pretest and posttest COMPASS math scores as well as associations between pretest COMPASS scores on post MSLQ scores.

External Validity:

The Instructor for both the flipped and lecture model courses in this study is also the researcher for this study. The instructor will avoid any chance of experimenter bias by not communicating expectations of the study with student participants or demonstrating enthusiasm towards one teaching model. Another threat to external validity in this study may be students that have already completed or are enrolled in the College Success course on the results of the MSLQ pre-survey. These students have been introduced to study skill strategies in the College Success course so they have a better awareness of how they should study and may self-report rating themselves higher on the survey than students that do not have that knowledge. To control for this threat all students in the study were asked to identify if they have completed or are enrolled in the College Success course so data analyses can be performed to determine if they had an influence on the results. Every effort was made to ensure the study results are generalizable to other remedial math courses.

Internal Validity:

The potential sources of internal validity with this pre and posttest design research study includes the following: the two groups being compared in this study may be different, students may do better on the posttest than they did on the pretest but the improvement in the score may or may not be a result of the flipped model classroom; students who complete the MSLQ questionnaire may not answer the questions honestly or they do not have the experience to be able to reflect on their use of study skills or their experience accurately. According to Bowman (2011), students who have lower standardized test scores may offer inflated estimates of their cognitive, intrapersonal and interpersonal development. To avoid these threats of internal validity controls were implemented. Sample selection for this study was random and students enrolled in a math 095 course based on the availability of their schedules. Students did not have knowledge of the course differences when they registered for class. Both math 095 courses in the study were the same. The only difference was the delivery method. Both classes had the same curriculum, homework assignments, tests, and final. They utilized the same text book and online material. Student demographic data was collected to perform statistical analyses to determine if the groups in the study are equivalent. Also, the survey was administered to students after they were introduced to new math concepts to encourage students to reflect accurately on their use of self-regulation to avoid the situation where students did not need to apply many self-regulation skills during the review material. In addition, the instructor reinforced the importance of students responding to the survey honestly by discussing there are no right or wrong answers to the survey and they will benefit more from the results if they answer the survey honestly. To avoid threats of internal validity to the COMPASS posttest, students will receive points for their performance to encourage students to put effort into the test so students do not simply take the posttest to complete it.

Summary

This quasi-experimental study that utilized a pretest and posttest design investigated the effectiveness of the flipped model to teach a remedial math course. The study utilized class lists, a 24 item version of the MSLQ test, an 11 item demographic survey to collect data, and the COMPASS test. The class list was used to identify student characteristics of class rank and degree option. The MSLQ was used to measure a student's use of control of learning, self-efficacy and self-regulation. The demographic survey was used to collect student characteristics of gender, age, and prior academic knowledge. The COMPASS test was used to collect pretest math scores, posttest math scores and reading scores. The study included students that completed the following requirements: signed a consent form, completed a pre and post Compass exam, and completed a pre and post MSLQ survey. The flipped classroom had a total of 28 out of 53 (53%) students that completed the requirements of the study and the lecture classroom had a total of 32 out of 59 (54%) students that completed the requirements of the study. There was a total of 60 students that participated in the study.

Data was analyzed using SPSS software to determine group equivalence of the students in the flipped and lecture classrooms and a factor analysis was performed to determine the validity and reliability of the MSLQ survey. The factor analysis determined that it was necessary to remove one construct from MSLQ survey but overall the instrument was determined to be reliable. To answer the research questions analyses included frequency data to report the descriptive statistics of students in remedial math; independent t-tests were performed to report significant difference of MSLQ data and posttest COMPASS scores; and multiple regressions were performed to report associations among dependent and independent variables in the study.

Results of this study will be used to inform remedial math instructors if the flipped classroom is an effective teaching method for students in a remedial math course and if this method influences a student's use of control of learning, self-efficacy and self-regulation in a remedial math course.

CHAPTER FOUR

RESULTS

Introduction

This chapter contains the results of a quasi-experimental pretest and posttest research study conducted to investigate the use of self-regulation skills of students enrolled in a remedial math course who participate in a flipped classroom compared to students enrolled in a remedial math course who participate in a lecture classroom. The participants of this study are students who enrolled in math 095 during fall 2014 and spring 2015. Two sections of math 095 were taught each semester. One section used the flipped model and one section used the lecture model.

This first section of this chapter reports the studied descriptive data of student characteristics and prior academic experience of students in the remedial math courses. The second section reports the results of the analyses performed using the dependent variables where a series of t-tests were conducted to determine if the MSLQ measures of control of learning, self-efficacy and self-regulation increase for students that participate in the flipped model classroom compared to students that participate in the lecture model classroom. This section also includes the results of the t-test performed to determine if the COMPASS post-math scores increase for students that participate in the flipped classroom compared to students that participate in the lecture classroom. The third section of this chapter reports the results of a series of multiple linear regressions used to determine associations among pre MSLQ results with pre and post COMPASS math scores for students in the flipped and lecture classroom. The research questions for this study are as follows:

1) What are characteristics of students who enroll in a remedial math course?
2) Do the control of learning scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
3) Do the self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
4) Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
5) How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?
6) Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?
7) Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcome) of students in this study?

8) Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?

Descriptive Data Results

Student Characteristics

Students in a remedial math course are a diverse group of learners with different learning needs in the classroom. Some students need to refresh skills while others may need to learn the material for the first time. Individual student characteristics also can influence a student's learning needs in the classroom. Research question#1 asks, "What are the student characteristics of students who enroll in a remedial math course?" The intent of this question was to learn more about students who enroll in a remedial math course to better understand their individual learning needs by exploring the sample characteristics.

Previously, in Chapter 3 (Table 3.6) group equivalence for students in both classrooms determined that students in both classrooms were the same when comparing student characteristics. To investigate characteristics of students in this study, the sample was combined to increase the power of analysis to test remedial math student's relationships with the dependent variables of pre math test, post math test, and the pre and post test results of the MSLQ (control of learning, self-efficacy, and self-regulation) discussed later in this chapter. Descriptive data for participants in the study was collected using class lists, a demographic survey, the MSLQ survey and results of the COMPASS test. Student characteristics include gender, age, class rank, and degree option. A summary of the student characteristics are provided in Table 4.1. The table includes the frequency data for the student characteristics of students that participated in the flipped and lecture classroom.

Table 4.1: Descriptive Statistics of Student Characteristics

Student Characteristics	Flipped	Lecture	Total Sample
Study Sample N (%)	28 (47%)	32 (53%)	60 (100%)
Gender			
Male	6 (21%)	6 (19%)	12 (20%)
Female	22 (79%)	26 (81%)	48 (80%)
Age			
Non-traditional(≥25)	10 (36%)	14 (44%)	24 (40%)
Traditional Age	18 (64%)	18 (56%)	36 (60%)
Class Rank			
First Semester	5 (18%)	9 (28%)	14 (23%)
Returning	23 (82%)	23 (72%)	46 (67%)
Degree Option			
4-year degree	4 (14%)	5 (16%)	9 (15%)
AS Degree or transfer	13 (47%)	20 (62%)	33 (55%)
2-year degree	11 (39%)	7 (22%)	18 (30%)

There were a total of 60 students that participated in this study. 47% of students were enrolled in the flipped classroom and 53% of students were enrolled in the lecture classroom. There were more female students in the study than male students. The flipped classroom was 79% female and the lecture classroom was 81% female. The majority of students in the study were traditional age with a total of 60% traditional age students compared to 40% non-traditional age students. Both classrooms were similar when comparing the age of students with 64% traditional age students in the flipped classroom compared to 56% traditional age students in the lecture classroom. Students in the study were primarily returning students with 82% of students in the flipped classroom compared to 72% of students in the lecture classroom. There were 39% of students enrolled in a two year degree program in the flipped classroom compared to 22% of students enrolled in a two year degree program in the lecture classroom. The majority of students in both classrooms were enrolled in the AS degree option with 47% in the flipped classroom and 62% in the lecture classroom. There were 14% of students in the flipped classroom compared to 16% of students in the lecture classroom enrolled in a four-year degree program.

Prior Academic Experience

Descriptive data of prior academic experience was also collected to learn more about remedial math students. The analysis below combined the two classes into one sample to increase the power to test the relationship between the student's characteristics on MSQL results and COMPASS math scores. Overall, the prior academic knowledge (pretest COMPASS math) of students in both classrooms were similar and not found to be significantly different (Table 3.7).

The intent was to understand how prior math experience may influence the relationship between student's characteristics as well as measures of pretest and posttest math scores and posttest MSQL results. Data was collected utilizing a demographic questionnaire that accompanied the MSLQ pre-survey. Data for prior academic experience includes the following: reading scores, previous math experience, time since last math class, math emotions, participation in a college math course, participation in a college success course, enrollment in a remedial writing course, computer skills and pre COMPASS math placements. A summary of student prior academic experience is provided in Table 4.2. This table includes frequency data for students that participated in the flipped and lecture classroom. Results for pretest and posttest math scores and the MSLQ are in Table 4.3.

Table 4.2: Prior Academic Experience

Variable	**Flipped (%)**	**Lecture (%)**	**Total Sample (%)**
Study Sample N (%)	28 (47%)	32 (53%)	60 (100%)
Reading Scores			
30 to 79	9 (32%)	10 (31%)	19 (32%)
80 to 98	19 (68%)	22 (69%)	41 (68%)
Previous Math Experience			
No H.S and GED	2 (7%)	1 (3%)	3 (5%)
2 H.S. and GED	2 (7%)	0 (0%)	2 (4%)
3 H.S. and Diploma	8 (29%)	6 (19%)	14 (23%)
4 H.S. and Diploma	16 (57%)	25 (57%)	41 (68%)
Time since last math class			
Less than or equal to 1	21 (75%)	26 (81%)	47 (78%)
2 years	2 (7%)	1 (3%)	3 (5%)
3 years	0 (0%)	1 (3%)	1 (2%)
Greater than or equal to 4	5 (18%)	4 (13%)	9 (15%)
Math Emotions			
Negative	4 (14%)	7 (22%)	11 (18%)
No Opinion	12 (43%)	11 (34%)	23 (39%)
Positive	12 (43%)	14 (44%)	26 (43%)
College Math			
No courses	7 (25%)	11 (34%)	18 (30%)
1 course in college	7 (25%)	13 (41%)	20 (33%)
2 courses in college	14 (50%)	8 (25%)	22 (37%)
College Success Course			
Yes	21 (75%)	26 (81%)	47 (78%)
No	7 (25%)	6 (19%)	13 (22%)
Enrolled in Writing 095			
Yes	4 (14%)	2 (6%)	6 (10%)
No	24 (86%)	30 (94%)	54 (90%)
Computer Technology			
Fair	7 (25%)	6 (19%)	13 (22%)
Good	13 (46%)	22 (69%)	35 (58%)
Excellent	8 (29%)	4 (13%)	12 (20%)
Pre Math Placements			
Math 061	11 (39%)	7 (22%)	18 (30%)
Math 090	13 (46%)	15 (47%)	28 (47%)
Math 095	4 (14%)	10 (31%)	14 (23%)
Test Result	Mean (SD)	Mean (SD)	ρ-Value
Pretest COMPASS Math	28.68 (8.61)	33.69 (11.76)	.063

Approximately, one-third of students in both classrooms demonstrated reading scores below 80%. There were 32% of students in the flipped classroom and 31% of students in the lecture classroom with low reading scores. The majority of students reported completing three or four years of math in high school and earning a high school diploma. 57% of students in both classrooms indicated completing four years of math in high school and earning a diploma. There were 29% of students in the flipped classroom and 19% of students in the lecture classroom that reported completing three years of math in high school and earning a high school diploma. In addition, most students in the study reported completing a math course within the past year with 75% of students in the flipped classroom and 81% of students in the lecture classroom. Also, 50% of students in the flipped classroom indicated they completed two college math courses compared to 25% of students in the lecture classroom. There were 41% of students in the lecture classroom compared to 25% of students in the flipped classroom. There were 25% of students in the flipped classroom that indicated they did not complete a college math course compared to 34% of students in the lecture classroom. Overall, 70% of students in the study required prior math remediation before enrolling in the study. Most of the students in the study indicated they were currently enrolled in or had completed a college success course with 75% students in the flipped classroom and 81% of the students in the lecture classroom. A small number of students were required to enroll in a remedial writing course with 14% of students in the flipped classroom and 6% of students in the lecture classroom. More students in the lecture classroom indicated that they had good computer technology skills with 69% of students in the lecture classroom compared to

46% of students in the flipped classroom. There were 25% of students in the flipped classroom that reported their computer technology skills as fair compared to 19% of students in the lecture classroom. More students in the flipped classroom reported their computer technology skills as excellent with 29% of students compared to 13% of students in the lecture classroom. There were no students in either classroom that reported their computer technology skills as poor.

Dependent Variables

The dependent variables for this study are the measures of the posttest scores for the MSLQ and COMPASS math test. The MSLQ scales are control of learning, self-efficacy, and self-regulation. This data was collected to answer the research questions testing for group differences on control of learning, self-efficacy, self-regulation, and posttest COMPASS math scores. The means for the dependent variables are listed in Table 4.3. The table includes the mean scores for the pretest, the posttest, gain scores (posttest minus pretest), the t-values and the ρ-values for the dependent variables. The overall findings indicate that there were no statistical differences between the class type and the MSLQ results or COMPASS math scores for any of the pre and post measures.

Table 4.3: Descriptive Statistics for the MSLQ Scales and the COMPASS Math Test

MSLQ Results Range 1-7	Flipped N=28 Mean (SD)	Lecture N=32 Mean (SD)	T-Value	p-value
Control of Learning				
Pretest	5.19 (1.30)	5.43 (1.18)	-.763	.448
Posttest	5.51 (0.82)	5.66 (0.93)	-.650	.518
Gain Scores	.32 (1.27)	.23 (.762)	.362	.719
Self-Efficacy				
Pretest	5.23 (1.17)	5.22 (1.21)	.031	.976
Posttest	5.42 (1.28)	5.41 (1.41)	.029	.977
Gain Scores	.19 (1.30)	.19 (.998)	.002	.502
Self-Regulation				
Pretest	4.35 (1.25)	4.36 (1.14)	-.015	.988
Posttest	5.51 (0.82)	5.66 (0.94)	-.650	.518
Gain Scores	.49 (1.72)	.53 (.964)	-.123	.903
COMPASS Math*				
Pretest	28.68 (8.61)	33.69 (11.76)	-1.897	.063
Posttest	41.32 (13.36)	40.56 (13.93)	.215	.831
Gain Scores	12.64 (12.03)	6.88 (13.25)	1.76	.084

*COMPASS Math cut-scores: Math 061 (0-23), Math 090 (24-44), Math 095 (45-70).

Independent t-tests were conducted to test the group differences using the mean scores for the pretest and posttest of control of learning as well as using the mean gain scores (posttest minus pretest) of control of learning. The results of the independent t-tests using the mean scores for the pretest and posttest control of learning scores found students in the flipped classroom (M = 5.19, SD = 1.30) and students in the lecture classroom (M = 5.43, SD = 1.18) did not differ significantly on pre control of learning, t (58) = -.763, ρ = .45. Students in the flipped classroom (M = 5.66, SD = 0.93) and students in the lecture classroom (M = 5.51, SD = 0.82) did not differ significantly on post control of learning, t (58) = -.650, ρ = -.52. The results of the independent t-test using the mean gain scores for control of learning found that students in the flipped classroom (M = .32, SD = 1.27) and students in the lecture classroom (M = .23, SD = .762) did not differ significantly in control of learning, t (58) = .362, ρ = .72. The overall gain of control of learning from the pretest to the posttest for students in the flipped classroom was 0.32 compared to 0.23 for students in the lecture classroom.

Independent t-tests were conducted to test the group differences using the mean scores for the pretest and posttest of self-efficacy as well as using the mean gain scores (posttest minus pretest) of self-efficacy. The results of the independent t-tests using the mean scores for the pretest and posttest self-efficacy scores found students in the flipped classroom (M = 5.23, SD = 1.17) and students in the lecture classroom (M = 5.22, SD = 1.21) did not differ significantly on pre self-efficacy, t (58) = .031, ρ= .98. Students in the flipped classroom (M = 5.42, SD = 1.28) and students in the lecture classroom (M = 5.41, SD = 1.41) did not differ significantly on post self-efficacy, t (58) = .029, ρ= .98. The results of the independent t-test using the mean gain scores for self-efficacy found that students in the flipped classroom (M = .19, SD = 1.30) and students in the lecture classroom (M = .19, SD = .10) did not differ significantly in self-efficacy, t (58) = .002, ρ = .50. The overall gain in self-efficacy from the pretest to the posttest for students in both classrooms was 0.19.

Independent t-tests were conducted to test the group differences using the mean scores for the pretest and posttest of self-regulation as well as using the mean gain scores (posttest minus pretest) of self-regulation. The results of the independent t-test using the mean scores for pretest and posttest self-regulation scores found students in the flipped classroom (M = 4.35, SD = 1.25) and students in the lecture classroom (M = 4.36, SD = 1.14) did not differ significantly on pre-self-regulation, t (58) = -.01, ρ= .988. Students in the flipped classroom (M = 5.51, SD = 0.82) and students in the lecture classroom (M = 5.66, SD = 0.94) did not differ significantly on post self-regulation, t (58) = -.650, ρ = .518. The results of the independent t-test using the mean gain scores of self-regulation found that students in the flipped classroom (M = .49, SD = 1.72) and students in the lecture classroom (M = .53, SD = .96) did not differ significantly in self-regulation, t (58) = -.123, ρ = .90. The overall gain in self-regulation from pretest to posttest for students in the flipped classroom was 1.16 compared to 1.30 for students in the lecture classroom.

Independent t-tests were conducted to test the group differences using the mean scores for the pretest and posttest of COMPASS math scores as well as using the mean gain scores (posttest minus pretest) of COMPASS math scores. The results of the independent t-tests using the mean scores for the pretest and posttest COMPASS math scores found students in the flipped classroom (M = 28.68, SD = 8.61) and students in the lecture classroom (M = 33.69, SD = 11.76) did not differ significantly on pretest math scores at $\rho < .05$, $t(58) = -1.897$, $\rho = .06$. Students in the flipped classroom ($M = 41.32$, $SD = 13.36$) and students in the lecture classroom ($M = 40.56$, $SD = 13.93$) did not differ significantly on posttest math scores, $t(58) = .22$, $\rho = .83$. The results of the independent t-test using the mean gain scores for math found that students in the flipped classroom ($M = 12.64$, $SD = 12.03$) and students in the lecture classroom ($M = 6.88$, $SD = 13.25$) were significantly different at a $\rho < .10$ in posttest math scores, $t(58) = 1.76$, $\rho = .08$. The overall gain from pretest to posttest for students in the flipped classroom was 12.64 compared to 6.88 for students in the lecture classroom.

In conclusion, the overall findings indicate no significant difference comparing the pretest and posttest results for control of learning, self-efficacy, or self-regulation. Posttest COMPASS math scores for students in the flipped classroom were significantly different than students in the lecture classroom when testing group differences of gain scores at $\rho < .10$. Students in the flipped classroom demonstrated higher gains in math scores of 12.64 compared to 6.88 for students in the lecture classroom. Posttest COMPASS math scores were not significantly different for students in the flipped and lecture classroom when testing group differences using the pretest and posttest mean scores. Students in both classrooms demonstrated overall gains in their scores from the pretest to the posttest for all three MSLQ measures and the COMPASS math test. Students in the flipped classroom demonstrated higher gains in control of learning of .32 compared to .23 for students in the lecture classroom. Students in both classrooms demonstrated the same overall gain in self-efficacy of .19. Students in the flipped classroom demonstrated lower gains in self-regulation of 1.16 compared to 1.30 for students in the lecture classroom. Students in the flipped classroom demonstrated higher gains in math scores of 12.64 compared to 6.88 for students in the lecture classroom.

Regression Analysis of Variables

A series of linear multiple regression equations were performed to examine the associations among students enrolled in the flipped and lecture classroom using measures of the math pretest, math posttest, the pre MSLQ and the post MSLQ scores. A series of Ordinary Least Squares (OLS) regression models were estimated to answer the research questions. All OLS regression assumptions were tested before analysis and data was found not to violate any assumptions (http://www.statisticssolutions.com/assumptions-of-linear-regression/). In addition, a bivariate correlation analysis was performed to determine if multicollinearity existed among variables in the study (Table 4.5). The following paragraphs discuss the results of the bivariate correlation analysis, the descriptions of the OLS regression models and the results of the OLS models.

A bivariate correlation analysis was used to examine significant correlations between variables in the OLS models and determined a number of items are significantly correlated. Multicollinearity is a problem that arises when moderate to high correlations exits among predator variables (IV's) used in a regression analysis because the variables may be measuring the same amount of variance on the dependent variable (Mertler and Vannatta, 2010). The variables of pre control of learning and pre self-efficacy are significantly correlated, $r = .615$, $\rho < .01$. An $r = .615$ illustrates a moderate to high correlation between pre control of learning and pre self-efficacy suggesting further investigation was needed to determine the presence of multicollinearity. The variables of post control of learning and post self-efficacy are significantly correlated, r = .70, $\rho <$ .01. The correlation of post control of learning and post self-efficacy is not a concern for the presence of multicollinearity because they will not be represented in the same OLS regression.

To further investigate the presence of multicollinearity the variance inflation factors (VIF) and tolerance were calculated. The results indicated that multicollinearity did not exist because the VIF values are less than 10 ranging from 1.02 to 1.75 (Mertler and Vannatta, 2010). The tolerances were greater that .1 ranging from .571 to .983 which also indicates multicollinearity does not exist (Mertler and Vannatta, 2010). Table 4.5 shows the results of the bivariate correlation matrix for the independent and dependent variables.

Table 4.4: Bivariate Correlation Matrix of Study Variables

	Classroom	Pre COL	Pre SE	Pre SR	Pre Math	Post Math	Post COL	Post SE	Post SR
Classroom	1								
Pre COL	.100	1							
Pre SE	-.004	.615**	1						
Pre SR	.002	.423**	.458**	1					
Pre Math	.237	.287*	.363**	.331**	1				
Post Math	-.028	.312*	.368**	.255	.451	1			
Post COL	.085	.575**	.342**	.108	.227	.188	1		
Post SE	-.004	.493**	.598**	.112	.411**	.369**	.700**	1	
Post SR	.020	.240	.276*	.501**	.054	.117	.244	.302*	1

* $\rho < .05$. ** $\rho < .01$. *** $\rho < .001$

After the bivariate correlation analysis, the first OLS analysis was performed to determine the association of pre MSLQ scores on students pretest COMPASS math scores. The sample was combined based on group equivalency and classroom (flipped and lecture) was added as a control.

The first OLS regression was performed to answer research question #6, "Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?" To answer this question, a model-building strategy was used to conduct the OLS regression. Model 1 is the baseline association of classroom plus the pretest score for control of learning on pretest COMPASS math scores. Model 2 is the baseline association of classroom plus the pretest score for self-efficacy on the pre COMPASS math scores. Model 3 is the baseline association of classroom plus the pretest score for self-regulation on the pretest COMPASS math scores. Model 4 is the association of classroom plus all three pre MSLQ measures of control of learning, self-efficacy and self-regulation on the pretest COMPASS math scores. A summary of the model building steps are below and the results of the analyses are in Table 4.5:

Model 1: Pretest COMPASS math score = Classroom + Pre Control of Learning

Model 2: Pretest COMPASS math score = Classroom + Pre Self-Efficacy

Model 3: Pretest COMPASS math score = Classroom + Pre Self-Regulation

Model 4: Pretest COMPASS math score = Classroom + Pre Control of Learning + Pre Self-Efficacy + Pre Self-Regulation

Table 4.5: OLS Regression for Pre MSLQ scores on Pretest COMPASS Math Scores

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	12.35 (6.78)	1.82 (.07)	6.50 (6.95)	.935 (.35)	10.73 (6.28)	1.71 (.09)	2.69 (7.49)	.359 (.72)
Pre COL	2.29 (1.07)	2.13* (.04)					.146 (1.34)	.356 (.721)
Pre SE			3.278 (1.08)	3.046* (.004)			2.34 (1.42)	1.65 (.11)
Pre SR					2.97 (1.09)	2.73** (.008)	1.84 (1.23)	1.50 (.14)
Classroom	4.45 (2.63)	1.69 (.096)	5.04 (2.52)	2.00 (.05)	5.00 (2.56)	1.95 (.056)	4.99 (2.53)	1.97 (.054)
F-value	4.11*		6.61**		5.65**		3.94**	
df	2		2		2		4	
R^2	0.13		0.19		0.17		0.22	
Adj R^2	0.10		0.16		0.14		0.17	

* $\rho < .05$. ** $\rho < .01$. *** $\rho < .001$

The results of the association of classroom plus pre control of learning on pretest COMPASS math scores (Model 1) reports an evaluation of how well the pretest COMPASS math score are predicted by students (classroom) and their pre control of learning score. Results of the regression indicated students and pre control of learning explained 13% variance ($R^2 = .13$, $F(2, 59) = 4.11$, $\rho = .02$). It was found that students (classroom) did not significantly predict pretest math scores ($\beta = 4.45$, $\rho = .096$), however, pre control of learning significantly predicted pretest COMPASS math scores ($\beta = 2.29$, $\rho = .04$).

The results of the association of classroom plus pre self-efficacy on pretest COMPASS math scores (Model 2) reports an evaluation of how well the pretest COMPASS math score is predicted by students (classroom) and their pre self-efficacy score. Results of the regression indicated students and pre self-efficacy explained 19% variance ($R^2 = .19$, $F(2, 59) = 6.61$, $\rho = .003$). It was found that classroom did significantly predict pretest math scores (β = 5.04, ρ = .05), as did pre self-efficacy (β = 3.28, ρ = .004).

The results of the association of classroom plus pre self-regulation on pretest COMPASS math scores (Model 3) reports an evaluation of how well the pretest COMPASS math score is predicted by students (classroom) and their pre self-regulation score. Results of the regression indicated classroom and pre self-regulation explained 17% of the variance (R^2 = .17, F (2, 59) = 5.65, ρ = .006). It was found that classroom did significantly predict pretest COMPASS math scores (β = 1.95, ρ = .056), as did pre self-regulation (β = 2.73, ρ = .008).

The results of the association of classroom plus pre control of learning, pre self-efficacy, and self-regulation on pretest COMPASS math scores (Model 4) reports an evaluation of how well the pretest COMPASS math score is predicted by students (classroom) and all the pre MSLQ scores of control of learning, self-efficacy and self-regulation. Results of the regression indicated classroom, pre control of learning, self-efficacy and self-regulation explained 22% of the variance (R^2 = .22, F (4, 59) = 3.93, ρ = .007). It was found students (classroom) did not significantly predict pretest COMPASS math scores (β = 4.99, ρ = .054) as well as findings for pre control of learning (β = .146, ρ = .91), self-efficacy (β = 2.34, ρ = .11), and self-regulation (β = 1.84, ρ = .14) were not significant predictors of pretest COMPASS math scores.

In conclusion, this OLS regression investigated if pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement). The sample was combined based on group equivalency, however classroom (flipped and lecture) was added as a control. It was found that each individual pre MSLQ measure is a significant predictor on pretest COMPASS math scores. The variable classroom which represented all students in the study was not a significant predictor on pretest COMPASS math scores, although the p-values for classroom in all four models suggest they may be significant with a larger sample size. When all the variables of pre MSLQ measure are included with students in the classroom no significant predictors were determined on the pretest COMPASS math scores.

The second OLS regression analysis was used to determine the association of pre MSLQ scores on student's posttest COMPASS math scores to answer research question #7. The sample was combined based on group equivalency and classroom (flipped and lecture) was added as a control. Research #7 asks, "Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcomes) of students in this study?" To answer research question #7, a model-building strategy was used to conduct the OLS regression. Model 1a is the baseline association of classroom plus the pretest scores for control of learning on the posttest COMPASS math scores. Model 1b includes Model 1a plus the pretest COMPASS math scores. Model 2a is the baseline association of classroom plus the pretest scores for self-efficacy on the posttest COMPASS math scores. Model 2b includes Model 1a plus the pretest COMPASS math scores. Model 3a is the baseline association of classroom plus the pretest scores of self-regulation on the posttest COMPASS math scores. Model 3b includes Model 3a plus the pretest COMPASS math scores. Model 4a is the baseline association of classroom plus all three pre-MSLQ scores of control of learning, self-efficacy and self-regulation on the posttest COMPASS math scores. Model 4b includes Model 4a plus the pretest COMPASS math scores. A summary of the model building steps is below and the results of the analyses are in Table 4.6:

Model 1a: Posttest COMPASS math scores = Classroom + Pre Control of Learning

Model 1b: Posttest COMPASS math scores = Classroom + Pre Control of Learning + Pretest COMPASS math

Model 2a: Posttest COMPASS math scores = Classroom + Pre Self-Efficacy

Model 2b: Posttest COMPASS math scores = Classroom + Pre Self-Efficacy + Pretest COMPASS math

Model 3a: Posttest COMPASS math scores = Classroom + Pre Self-Regulation

Model 3b: Posttest COMPASS math scores = Classroom + Pre Self-Regulation + Pretest COMPASS math

Model 4a: Posttest COMPASS math scores = Classroom + Pre Control of Learning + Pre Self-Efficacy + Pre Self-Regulation

Model 4b: Posttest COMPASS math scores = Classroom + Pre Control of Learning + Pre Self-Efficacy + Pre Self-Regulation + Pretest COMPASS math

Table 4.6: OLS Regression for Pre MSLQ scores on Posttest COMPASS Math Scores

	Model 1a		Model 1b		Model 2a		Model 2b	
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	24.78 (8.77)	2.83** (.006)	18.04 (8.25)	2.187* (.03)	19.92 (9.15)	2.18* (.034)	16.61 (8.57)	1.94 (.058)
Pre COL	3.50 (1.39)	2.52* (.02)	2.25 (1.32)	1.71 (.09)				
Pre Math			0.55 (0.16)	3.48** (.001)			0.51 (0.16)	3.14** (.003)
Pre SE					4.23 (1.42)	2.99** (.004)	2.56 (1.42)	1.803 (.08)
Classroom	-1.61 (3.40)	-.475 (.64)	-4.04 (3.19)	-1.27 (.21)	-0.72 (3.32)	-.217 (.83)	-3.28 (3.19)	-1.03 (.31)
F-value	3.20*		6.60**		4.49*		6.74**	
df	2		3		2		3	
R^2	0.10		0.26		0.14		0.27	
Adj R^2	0.07		0.22		0.11		0.23	

	Model 3a		Model 3b		Model 4a		Model 4b	
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	29.37 (8.47)	3.47** (.001)	23.25 (7.94)	2.93** (.005)	15.83 (9.96)	1.60 (.12)	14.48 (9.32)	1.55 (.13)
Pre COL					1.37 (1.78)	.77 (.44)	1.30 (1.66)	.782 (.44)
Pre SE					2.87 (1.89)	1.53 (.13)	1.72 (1.81)	.95 (.35)
Pre SR	2.92 (1.47)	1.99 (.051)	1.22 (1.43)	.857 (.40)	0.99 (1.63)	.608 (.55)	0.74 (1.56)	.047 (.96)
Pre-Math			0.57 (0.16)	3.49** (.001)			0.50 (0.17)	2.98** (.004)
Classroom	-0.77 (3.45)	-.224 (.82)	-3.62 (3.26)	-1.11 (.27)	-1.07 (3.37)		-3.57 (3.26)	-1.09 (.28)
F-value	2.00		5.66**		2.52(.052)		4.08**	
df	2		3		4		5	
R^2	0.07		0.23		0.16		0.27	
Adj R^2	0.03		0.19		0.09		0.21	

* ρ < .05. ** ρ < .01. *** ρ <.001

The results of the association of classroom plus pre control of learning on posttest COMPASS math scores (Model 1a) reports the findings to determine if students (classroom) predict posttest COMPASS math scores. The results of the regression indicated classroom and pre control of learning explained 10% of the variance ($R^2 = .10$, $F (2, 59) = 3.20$, $\rho = .048$). It was found students (classroom) did not significantly predicted posttest COMPASS math scores ($\beta = -1.61$, $\rho = .64$) but findings indicate pre-control of leaning is a significant predictor of posttest COMPASS math scores ($\beta = 3.50$, $\rho = .02$).

The results of the association of students (classroom) plus pre control of learning and pretest COMPASS math scores on posttest COMPASS math scores (Model 1b). Model 1b reports the findings to determine if the posttest COMPASS math score is predicted by students (classroom), their pre control of learning score and their pretest COMPASS math score. The results of the regression indicated students (classroom), pre control of learning and pretest COMPASS math scores explained 26% of the variance ($R^2 = .26$, $F (3, 59) = 6.60$, $\rho = .001$). It was found that classroom did not significantly predict posttest COMPASS math scores ($\beta = -4.04$, $\rho =.21$) and pre control of learning did not significantly predict posttest COMPASS math scores ($\beta = 2.24$, $\rho = .09$), but pretest COMPASS math scores did significantly predict posttest COMPASS math scores ($\beta = .55$, $\rho = .001$).

The results of the association of classroom plus pre self-efficacy on posttest COMPASS math scores (Model 2a) report the findings to determine if students (classroom) predict posttest COMPASS math scores. The results of the regression indicated classroom and pre self-efficacy explained 14% of the variance ($R^2 = .14$, $F (2, 59) = 4.49$, $\rho = .015$). It was found students (classroom) did not significantly predicted posttest COMPASS math scores (β = -.719, ρ = .83) but findings indicate pre self-efficacy is a significant predictor of posttest COMPASS math scores (β = 4.23, ρ = .004).

The results of the association of students (classroom) plus pre self-efficacy and pretest COMPASS math scores on posttest COMPASS math scores (Model 2b). Model 2b reports the findings to determine if posttest COMPASS math scores are predicted by students (classroom), their pre self-efficacy score and their pretest COMPASS math score. The results of the regression indicated students (classroom), pre self-efficacy and pretest COMPASS math scores explained 27% of the variance (R^2 = .27, F (3, 59) = 6.74, ρ = .001). It was found that classroom did not significantly predict posttest COMPASS math scores (β = -3.28, ρ =.31) and pre self-efficacy did not significantly predict posttest COMPASS math scores (β = 2.56, ρ = .08), however pretest COMPASS math scores did significantly predict posttest COMPASS math scores (β = .51, ρ = .003).

The results of the association of classroom plus pre self-regulation on posttest COMPASS math scores (Model 3a) reports the findings to determine if students (classroom) predict posttest COMPASS math scores. The results of the regression indicated classroom and pre self-efficacy did not significantly explain 7% an amount of the variance (R^2 = .07, F (2, 59) = 2.00, ρ = .14). It was found students (classroom) did not significantly predict posttest COMPASS math scores (β = -.77, ρ = .14) as well as pre self-regulation did not predict posttest COMPASS math scores (β = 2.92, ρ = .051).

The results of the association of students (classroom) plus pre self-regulation and pretest COMPASS math scores on posttest COMPASS math scores (Model 3b). Model 3b reports the findings to determine if posttest COMPASS math scores are predicted by students (classroom), their pre self-regulation score and their pretest COMPASS math score. The results of the regression indicated students (classroom), pre self-regulation and pretest COMPASS math scores explained 23% of the variance (R^2 = .23, F (3, 59) = 5.66, ρ = .002). It was found that classroom did not significantly predict posttest COMPASS math scores (β = -3.62, ρ =.27) and pre self-regulation did not significantly predict posttest COMPASS math scores (β = 1.22, ρ = .40), however, pretest COMPASS math scores did significantly predict posttest COMPASS math scores (β = .57, ρ = .001).

The results of the association of pre control of learning, pre self-efficacy, pre self-regulation and students (classroom) on posttest COMPASS math scores (Model 4a) reports the findings to determine if posttest COMPASS math scores are predicted by all three pre MSLQ scores of control of learning, self-efficacy, and self-regulation as well as students. The results of the regression indicated pre control of learning, pre self-efficacy, pre self-regulation and students (classroom) explained 16% of the variance (R^2 = .16, F (4, 59) = 2.52, ρ = .052).

It was found pre control of learning did not significantly predict posttest COMPASS math scores (β = 1.37, ρ = .44); pre self-efficacy did not significantly predict posttest COMPASS math scores (β = 2.89, ρ = .13); pre self-regulation did not significantly predict posttest COMPASS math scores (β = .994, ρ = .55), and classroom did not significantly predict posttest COMPASS math scores (β = -1.07, ρ = .75).

In conclusion, this OLS regression analysis was used to determine the association of pre MSLQ scores on student's posttest COMPASS math scores (placement). The sample was combined based on group equivalency and classroom (flipped and lecture) was added as a control. The findings of each individual measure of pre control of learning, and pre self-efficacy pre self-regulation are significant predictors of posttest COMPASS math scores. The finding for pre self-regulation with a ρ-value of .051 indicates it may be a significant predictor on posttest COMPASS scores. The finding for classroom indicates is it not a significant predictor in all four models on posttest COMPASS math scores. When all the pre MSLQ measures plus students in the study were included in the model no significant associations were found on posttest COMPASS math scores. The models were repeated and the control for pretest COMPASS math scores was added to all four models. When the pretest COMPASS math scores are included the pre MSLQ measures are not significant predictors on posttest COMPASS math scores. When all the variables of pre MSLQ measures, students in the classroom and pretest COMPASS math scores are included in the regression the results indicate that pretest COMPASS math scores are the only significant predictor on posttest COMPASS math scores.

The third OLS regression was used to determine the association of pre COMPASS math scores on post MSLQ scores to answer research question #8, "Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?" To answer this question the sample was combined based on equivalency (Table 3.6) and a model-building strategy was used to conduct the OLS regression. Model 1a is the baseline association of pretest COMPASS math scores on post control of learning scores. Model 1b is Model 1a plus pre control of learning scores. Model 2a is the baseline association of pretest COMPASS math scores on post self-efficacy scores. Model 2b is Model 2a plus pre self-efficacy scores. Model 3a is the baseline association of pretest COMPASS math scores on post self-regulation scores. Model 3b is Model 3a plus pre self-regulation scores. A summary of the model building steps is below and the results of the analyses are in Table 4.7:

Model 1a: Post Control of Learning = Pretest COMPASS Math

Model 1b: Post Control of Learning = Pretest COMPASS Math + Pre Control of Learning

Model 2a: Post Self-Efficacy = Pretest COMPASS Math

Model 2b: Post Self-Efficacy = Pretest COMPASS Math + Pre Self-Efficacy

Model 3a: Post Self-Regulation = Pretest COMPASS Math

Model 3b: Post Self-Regulation = Pretest COMPASS Math + Pre Self-Regulation

Table 4.7: Do Pretest COMPASS Math Scores Predict Posttest MSLQ Scores

	Model 1a		Model 2b	
Dependent Variable	Post Control of Learning			
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	5.00 (0.35)	14.35***	3.32 (0.00)	3.32 (.045)
Pre Control of Learning			0.40 (0.08)	4.93*** (.000)
Pretest Algebra	0.02 (0.35)	1.77 (.08)	0.01 (0.01)	.599 (.55)
F-value	3.147		14.37***	
df	1		2	
R^2	0.05		0.34	
Adjusted R^2	0.04		0.31	

	Model 1a		Model 2b	
Dependent Variable	Post Self-Efficacy			
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	7.34*** (0.00)	3.70 (0.50)	7.60*** (0.00)	1.46 (0.66)
Pre Self-Efficacy			0.59 (0.13)	4.70*** (.000)
Pretest Algebra	0.02 (0.35)	1.77 (.08)	0.03 (0.01)	2.04 (0.046)
F-value	3.147		19.08***	
df	1		2	
R^2	0.05		0.40	
Adjusted R^2	0.04		0.38	

*p< 0.10, **p< 0.05, ***p<0.01

Table 4.7: Do Pretest COMPASS Math Scores Predict Posttest MSLQ Scores Continued

	Model 3a		Model 3b	
Dependent Variable	Post Self-Regulation			
	B (SE)	T-Value (ρ)	B (SE)	T-Value (ρ)
Constant	4.70 (0.42)	11.30*** (.000)	3.20 (0.49)	6.53*** (.000)
Pre Self-Regulation			0.47 (0.10)	4.51*** (.000)
Pretest Algebra	0.01 (0.01)	.415 (.68)	-0.12 (0.12)	-1.04 (.30)
F-value	0.172		10.27***	
df	1		2	
R^2	0.00		0.27	
Adjusted R^2	-0.01		0.24	

*p< 0.10, **p< 0.05, ***p<0.01

The results of the association of pretest COMPASS math scores on posttest control of learning (Model 1a) reports the findings to determine if pretest COMPASS math scores predict the posttest control of learning scores. The results of the regression indicated pretest COMPASS math scores did not significantly explain variance in posttest control of learning scores (R^2 = .05, F (1, 59) = 3.15, ρ = .081). It was found that pretest COMPASS math scores did not significantly predict posttest control of learning scores (β = .02, ρ =.08).

The results of the association of pretest COMPASS math plus pretest control of learning (Model 1b) reports the findings to determine if pretest COMPASS math scores and pretest control of learning scores predict the posttest control of learning scores. The results of the regression indicated pretest COMPASS math scores and pretest control of learning scores did explain 34% variance (R^2 = .34, F (1, 59) = 14.37, ρ = .000). It was found that pretest COMPASS math scores did not significantly predict posttest control of learning scores (β = .01, ρ = .55). The findings indicate that pretest control of learning scores did significantly predict the posttest control of learning scores (β = .40, ρ = .000).

The results of the association of pretest COMPASS math scores on posttest self-efficacy scores (Model 2a) reports the findings to determine if pretest COMPASS math scores predict the posttest self-efficacy scores. The results of the regression indicated pretest COMPASS math scores did significantly explain 17% of the variance (R^2 = .17, F (1, 59) = 11.02, ρ = .001). It was found that pretest COMPASS math scores did significantly predict posttest control of learning scores (β = .05, ρ =.001).

The results of the association of pretest COMPASS math plus pretest self-efficacy (Model 2b) reports the findings to determine if pretest COMPASS math scores and pretest pre self-efficacy scores predict the posttest self-efficacy scores. The results of the regression indicated pretest COMPASS math scores and pretest self-efficacy scores did significantly explain 40% variance (R^2 = .40, F (2, 59) = 19.08, ρ = .000). It was found that pretest COMPASS did significantly predict posttest self-efficacy scores (β = .03, ρ = .046) as well as pretest self-efficacy scores (β = .59, ρ = .000).

The results of the association of pretest COMPASS math scores on posttest self-regulation scores (Model 3a) reports the findings to determine if pretest COMPASS math scores predicts the posttest self-regulation scores. The results of the regression indicated pretest COMPASS math scores did not significantly explain variance in posttest self-regulation scores (R^2 = .003, F (1, 59) = .172, ρ = .68). It was found that pretest COMPASS math scores did not significantly predict posttest control of learning scores (β = .01, ρ =.68).

The results of the association of pretest COMPASS math plus pretest self-efficacy (Model 3b) reports the findings to determine if pretest COMPASS math scores and pretest pre self-regulation scores predict the posttest self-regulation scores. The results of the regression indicated pretest COMPASS math scores and pretest self-regulation scores did significantly explain 27% variance ($R^2 = .27$, $F (2, 59) = 8.13$, $\rho = .000$). It was found that pretest COMPASS math scores did not significantly predict posttest self-regulation scores ($\beta = -.12$, $\rho = .30$). It was found that pretest self-regulation scores did significantly predict posttest self-regulation scores ($\beta = .47$, $\rho = .000$).

In conclusion the third OLS regression was used to determine the association of pretest COMPASS math scores on post MSLQ scores. The results indicate that pretest COMPASS math scores is a significant predictor on posttest self-efficacy scores. In addition, pretest MSLQ measures are significant predictors on their posttest MSLQ score.

Summary of Results

The purpose of this research is to investigate efficiency of using the flipped model in a remedial math course. To answer the research questions, the MSLQ scores of control of learning, self-efficacy and self-regulation of students that participate in a flipped model remedial math course were compared to students that participate in a lecture model remedial math course. The study also examined course outcomes of students in both classrooms using posttest COMPASS math scores. In addition, three separate models were constructed to perform linear multiple regressions to investigate if pre MSLQ scores predict pretest COMPASS math scores, if pre MSLQ scores predict posttest COMPASS math scores and if pretest COMPASS math scores predict posttest COMPASS math scores.

There were a total of 60 students in the study with 47% of the students in the flipped classroom and 53% of students in the lecture classroom over a two semester period. The students in both classrooms were found to be equivalent across student characteristics and prior academic knowledge. A series of t-tests performed found no significant differences of between students in the flipped and lecture classroom (Table 3.6). Notable differences although not significant are as follows: more students is the flipped classroom (50%) compared to students in the lecture classroom (25%) completed two math courses in college before enrolling in Math 095, and 39% of students in the flipped classroom placed in math 061 on their COMPASS pretest compared to 22% of students in the lecture classroom.

A series of independent series t-tests were performed to compare the MSLQ scales for students in both classrooms and the data revealed no significant difference for the measures of control of learning, self-efficacy, or self-regulation of students in the flipped classroom compared to students in the lecture classroom. A significant difference of $\rho < .10$ was found for math outcomes using posttest COMPASS math gain scores for students in the flipped classroom compared to students in the lecture classroom. The overall change in posttest COMPASS math scores was 12.64 for students in the flipped classroom compared to 6.87 for students in the lecture classroom.

The last series of analyses included three separate models constructed for linear multiple regressions. The first linear multiple regression was performed to investigate the association of students in the flipped and lecture classroom plus pre MSLQ scales on the pretest COMPASS math scores. A small association was found to be significant for all three pre MSLQ scales when the regression was conducted using the variables of classroom and each separate MSLQ scale of control of learning, self-efficacy and self-regulation. The amount of variance for each separate MSLQ scale plus classroom was 13% for control of learning, 19% for self-efficacy and 17% for self-regulation. When all variables are included in the regression no significant associations were found for individual variables although the combined variables contribute to 22% variance in the COMPASS pretest scores. Therefore, the variation found in pretest COMPASS math scores when all the variables are combined may be due to the explanatory power and significance of the independent variables coefficients of pre control of learning, pre self-efficacy, and pre self-regulation being divided up between them even though the bivariate correlation and VIF values did not indicate multicollinearity (Table 4.5).

The second linear multiple regression was performed to investigate the association of students in the flipped and lecture classroom plus pre MSLQ scores on posttest COMPASS math scores. The regression were repeated including the pretest COMPASS math scores. When the pretest COMPASS math scores were not included in the regression model control of learning, and self-efficacy were found to have a small but significant association with posttest COMPASS math scores. Self-regulation did not have a significant association with posttest COMPASS math scores, however a $\rho = .051$ suggest the results may have been significant with a larger sample size. When the regression model included the pretest COMPASS scores and each separate pre MSLQ scores for control of learning, self-efficacy and self-regulation they were not significant but pretest COMPASS math scores were found to be significant. The significant effect size for the pretest COMPASS math scores were small ranging from .50 to .57. When all variables are included the combined variables contribute to 27% variance in the COMPASS pretest scores. Similar to the OLS regression the variation found in posttest COMPASS math scores when all the variables are combined may be due to the explanatory power and significance of the variable coefficients of pre control of learning, pre self-efficacy, and pre self-regulation being divided up between them even though the bivariate correlation and VIF values did not indicate multicollinearity (Table 4.5).

The third OLS regression model was performed to investigate the association of pretest COMPASS math scores on post MSLQ scores of control of learning, self-efficacy and self-regulation. The regression was repeated including the pre MSLQ scores. It was determined that the pre MSLQ scores did have significant associations with post MSLQ scores (Table 4.8). The self-efficacy model was the only regression to demonstrate an association for pretest COMPASS math scores with post MSLQ scores. Model 2a indicates a significant association between pretest COMPASS scores and post self-efficacy scores. The effect size of the pretest COMPASS math score is small at .05. In Model 2b when the variable for the pre self-efficacy score is added to the regression and the effect size for the pretest COMPASS math score decreases to .03. The variable of pre self-efficacy is also found to have a significant association with post self-efficacy scores but has a higher effect size of .59. The combined variables contribute 40% variance in post self-efficacy scores. It would be expected that the pre self-efficacy score would have an association to the post self-efficacy score because both variables were correlated to one another. The significant association of the pretest COMPASS math score would indicate that a student's prior math knowledge plus their belief in their ability to succeed in math at the beginning of the semester has an impact on their level of self-efficacy at the end of the math course.

CHAPTER FIVE

CONCLUSIONS

Introduction

The purpose of this study is to investigate the flipped teaching model in a remedial math course compared to lecture model in a remedial math course at Highlands College. The study uses the MSLQ survey to compare control of learning, self-efficacy and self-regulation of students in each classroom. In addition, the study uses posttest COMPASS math scores to compare the course outcomes of students in each classroom. The results of the study determined there are no significant differences between students in each classroom when comparing the results of the MSLQ survey. The study also finds that there is no significant difference in course outcomes using posttest COMPASS math scores of students in each classroom. The study also investigates the associations of pre MSLQ results with pretest math scores (math placement), pre MSLQ results with posttest math scores (course outcomes), and pretest math scores with post MSLQ results. This chapter includes an overview of the study, methodology, and a discussion of the results. It also includes the limitations of the study as well as recommendations for practice and future research.

Overview of Study

Many colleges and universities are researching and investigating best practices to teach remedial math courses to help students prepare for their degree required math course (Engagement Center for Community College Student, 2016). Remedial math is a concern for many colleges due to low retention and completion rates for students enrolled in remedial math in addition to the added expense of remedial math for students and colleges. Research of best practices discuss alternative methods to deliver remedial math courses to students to encourage remedial math course completion as well as retention of students leading to an increase in graduation rates. Research also indicates that students that exhibit higher levels of motivation (control of learning and self-efficacy) and self-regulation are more successful learners (Pintrich, 2004). An alternative method to improve the delivery of remedial math discussed in this study is the flipped classroom. This study investigates if the requirements of the flipped classroom encourage students to become successful learners by increasing their motivation and self-regulated learning skills.

This study is designed to determine if the flipped model is an effective teaching model for teaching remedial math. One group of students participated in a remedial math course that used the flipped model and the other group participated in a remedial math course that used the lecture model. Students completed a pretest and posttest using the MSLQ and COMPASS math test. At the end of the semester students completed a posttest using the MSLQ and COMPASS math test. To determine effectiveness of the flipped model the post MSLQ scores and posttest Compass math scores were compared for students in each classroom. In addition, associations of the MSLQ scores with pretest and posttest COMPASS math scores are investigated. The method and the research design which asked eight questions are explained in Chapter 3. The data analyses consisted of frequency data to present the descriptive statistics, t-tests results and a series of linear multiple regressions. The presentation of results are explained in Chapter 4 and discussed in further detail below.

Methodology

This study utilized a pretest and posttest design using the MSLQ survey developed by Pintrich, Smith, Garcia & McKeachie (1991) and the COMPASS math test. Student descriptive data was collected using class lists and a demographic survey administered to students during the MSLQ pretest. To participate in the study students were required to sign a consent form, complete the pre and post MSLQ survey, and complete the pre and post COMPASS math test. There were a total of sixty students enrolled in math 095 that completed all the requirements to participate in the study during the fall 2014 and spring 2015 semesters. The flipped classroom had a total 28 out of 53 (53%) students that participated and the lecture classroom had a total of 32 out of 59 (54%) students that participated. All data was entered into SPSS software for analysis.

Before analysis could be conducted to answer the research questions, it was necessary to determine if the students in the flipped classroom and the lecture classroom were equivalent. Group equivalence was established by comparing the sample characteristics; pretest scores for math and reading; and the pretest MSLQ results. A Pearson Chi-Square was performed for variables that were categorical and an independent series t-test was used for scored variables. The results indicated there was no significant differences between students in the flipped classroom compared to students in the lecture classroom, therefore it was determined the two groups were equivalent. After group equivalence was determined, it was necessary to perform a factor analysis to validate the factor validity of the constructs of the MSLQ survey. The factor analysis resulted in three interpretable factors consisting of control of learning, self-efficacy and self-regulation with factor loadings ranging from .51 to .84 indicating fairly reliable constructs (Mertler & Vannatta, 2010).

The dependent variables used for this study are the post scores for control of learning, self-efficacy, self-regulation and post math test. Independent variables included student characteristics and their prior academic experience (Table 4.1 and 4.2). Data analysis included descriptive statistics that reported frequency data for student characteristics and prior academic experience; t-tests that reported significance of the MSLQ survey results and the posttest math scores; and OLS regressions reported associations of MSLQ survey results with COMPASS math test scores for all students in the study. The results of the analysis is discussed in Chapter 4. A discussion of the results and the research questions are below. The research questions for this are as follows:

1) What are characteristics of students who enroll in a remedial math course?
2) Do the control of learning scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
3) Do the self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?

4) Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
5) How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?
6) Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?
7) Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcome) of students in this study?
8) Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?

Discussion of Research Results

This section will discuss the research questions and results used to answer each question. This study obtained a variety of demographic characteristics providing a look inside the remedial math classroom as well as providing insight about students who enroll in a remedial math course but the sample size of students in each classroom was small. The small sample size limited the power of analysis to accurately reflect on the influence of the flipped classroom in a remedial math course which leading to an exploratory analysis. The sample was combined based on group equivalency (Table 3.6) for research questions 1, 6, 7 and 8 due to the small sample size. This allowed for a more accurate investigation of the characteristics of students enrolled in a remedial math course and further explorations of associations among dependent and independent variables. To answer research questions 2, 3, 4 and 5 the data remained separate for students in the flipped and lecture classroom to allow for comparisons of both teaching methods.

Research Question #1

Research Question #1 addresses the student characteristics and prior academic experience of students enrolled in a remedial math course at Highlands College. The research question is as follows, "What are the student characteristics and prior academic experience of students enrolled in a remedial math course?"

Previous literature reviewed in chapter 2 discusses the diverse background and characteristics of students that enroll in a remedial math course. These different characteristics of students provide an opportunity for remedial math instructors to learn more about the unique learning needs of students enrolled in their classes. To answer this research question the following paragraphs will discuss the characteristics of gender, age, and degree option of students in this study (Table 4.1) and how these characteristics compare to previous research of remedial math students.

This study found that 80% of the remedial math students were female compared to 20% of the students were male. This result is consistent with research that indicates that more female students enroll in remedial math courses than male students (Bettinger & Long, 2007; Bailey, Jeong, & Cho, 2010; Bettinger, Boatman, & Long, 2013). There are many different reasons that may contribute to gender differences in remedial math courses such as but limited to socio-cultural influences that may lead to female students avoiding additional math courses or STEM pathways in high school (Wang & Degol, 2017). According to NCES (2015), only 31% of female students accounted for STEM degree attainment in 2012. Current enrollment trends indicate an increase of female students attending post-secondary education compared to male students which may contribute to a higher number of female students that enroll in remedial math especially if these students have been out of school for a period of time. The majority of students (56%) enrolled in post-secondary education were female in 2014 (NCES, 2016).

This study also found 60% of students in the study were traditional age compared to 40% non-traditional age students. A traditional age student refers to individuals who less than or equal to twenty-four years old. The higher number of traditional age students in remedial math courses is consistent with research that indicates that a high number of recent high school graduates are not prepared for college-level work (Bettinger, Boatman, & Long, 2013). Also, it is estimated that 20% of first-year undergraduate college students who enroll at four year universities will be recommended/required to enroll in one or more remedial math course before they can enroll in their gateway level math course (Pachhofer & Putton, 2014). Complete College America (2016) similarly reports that 24% of first-semester undergraduate students will require math remediation and 52% of students enrolling at two-year colleges will require math remediation. In 2014-2015 all students who enrolled at Montana Tech that placed in remedial courses were required to enroll in a two-year AS degree program at Highlands College. This requirement may account for a higher number of traditional age students in this study because 70% of students in this study were enrolled in the AS degree program or other four-year degree program.

According to Horton (2015), both traditional and non-traditional students face a variety of barriers that put them at-risk of not achieving their academic goals. Horton reports that older students who have delayed enrollment in post-secondary education that are also academically unprepared have a greater risk of dropping out of college. Similarly, other research indicates non-traditional age students suffer higher attrition rates compared to traditional age students (Grabowski et al, 2016; NCES, 2011). Possible causes for the high attrition rates of non-traditional students as reported by Horton (2015) are due to multiple organizational, instructional, and interpersonal barriers non-traditional students have in reaching their academic goals. According to Complete College America (2017), only 15% of non-traditional students graduate with an associate's degree over a three year time period compared to 24 % of traditional age students who graduate with an associate's degree over a three year period of time. Also, 22% of non-traditional age students graduate with a bachelor's degree over a six year period of time compared to 71% of traditional age students who graduate with a bachelor's degree over a six year period.

The majority of the students in this study indicated they were returning students who completed one or more remedial math course in college before they enrolled in math 095. Overall, 33% of students reported they had completed one remedial math course in college which indicates they started in math 090 and 37% of students reported they had completed two remedial math courses in college which indicates they started in math 061. This finding is also consistent with research that indicates that more students who are enrolled at a public two year institutions will be required to complete one or more remedial math courses (Dillon & Smith, 2013). Literature suggests students that need to complete math remediation especially a series of math courses are less likely to complete their math series leading to degree attainment (Bahr, 2008; Bailey, Jeong, & Cho, 2010).

In conclusion, the characteristics of students in this study illustrate the unique academic needs of students in a remedial math course. These characteristics and being academically disadvantaged in math places students at a higher risk of not achieving their academic goals. A greater understanding of remedial students by utilizing the knowledge of individual characteristics and the influence of motivation and self-regulation on student success will lead to future success for students enrolled in a remedial math course.

Research Question #2

This question compares the control of learning scores of students in the flipped classroom to students in the lecture classroom. Control of learning was defined by questions on the MSLQ that ask students to reflect on how they applied study skills to complete class assignments (Table 3.9). The questions tried to identify if a student believed whether or not they were responsible or in control of their own learning inside and outside of the classroom. The research question asked the following: “Do control of learning scores using the MSLQ survey increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course? The results indicate the increase of control of learning was not significant between the two classrooms (Table 4.4). Therefore, the requirement of the flipped classroom of students extending effort outside of class in the form of note-taking and viewing class lectures did not result in a higher level of control of learning compared to students in the lecture classroom. One plausible explanation may be students in the flipped classroom as a group, were struggling to learn how perform these tasks on their own. Overall, there was a general trend in control of learning from the pretest to the post test for both classes. The flipped classroom had the overall larger gain.

Control of learning refers to a student's beliefs that their efforts to learn will result in positive outcomes (Pintrich, Smith, Garcia & McKeachie, 1991). Research indicates that students that exhibit higher levels for control of learning experience more positive educational outcomes compared to students that exhibit a low level of control of learning (Pintrich, 2004; Pintrich & De Groot, 1990). Generally students enrolled in a remedial math course would have a lower levels of control of learning related to math.

Research Question #3

Research Question #3 addresses the relationship between self-efficacy and students in the flipped and lecture classroom. Self-efficacy was characterized by questions on the MSLQ that asked students to reflect on their confidence and belief that they would be successful in their math class (Table 3.9). The research question asks the following: "Do self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?" The results of indicate the increase for self-efficacy was not significant between the two classes (Table 4.4). Therefore, the requirement of the flipped classroom did not encourage students to become more confident in their ability as math learners than students in the lecture classroom. Overall, there was a general increasing trend in self-efficacy scores from the pretest to the post test for both classes. The flipped and lecture classroom had the same gain.

Self-efficacy is a self-appraisal of one's ability to master a task which includes judgments about one's ability to accomplish a task as well as one's confidence in their skills to perform that task (Pintrich, Smith, Garcia & McKeachie, 1991). Students with a higher self-efficacy for a particular task are more likely to extend the effort needed to succeed compared to students that exhibit lower levels of self-efficacy for a particular task (Pachloffer & Putten, 2014). In other words, students with high self-efficacy or belief that they can do well in math will perform better than students that do not believe they can do well in math. Success in a remedial class is expected to increase a student's self-efficacy for math.

Research Question #4

Research Question #4 addresses the relationship of self-regulation between students in the flipped and lecture classroom. Self-regulation was characterized by questions on the MSLQ that asked student to reflect on how they plan and organize how they are going to study and prepare for class (Table 3.9). The research question asks the following: "Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?" The results indicate the increase for self-regulation was not significant between the two classes. Therefore, the requirements of the flipped classroom did not encourage students to become more independent learners than students in the lecture classroom. Overall, there was a general trend in self-regulation increasing from the pretest to the post test for students in both classrooms. Students in the lecture classroom had the overall larger gain in scores. One plausible explanation is the difficulty as a group students in the flipped classroom are having adjusting to the requirements of the flipped classroom.

Self-regulation refers to planning activities such as goal setting and task analysis which help to activate, or prime, relevant aspects of prior knowledge that make organizing and comprehending the material easier. Self-regulating activities are believed to improve performance by assisting learners in checking and correcting their behavior as they proceed on a task (Pintrich, Smith, Garcia & McKeachie, 1991).

<u>Research Question #5</u>

Research Question #5 addresses the relationship between posttest COMPASS math scores for students in the flipped and lecture classroom. The research question asks the following: "How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?" The results of the independent series t-tests found significant levels of $\rho < .10$ when testing group differences using the pretest and posttest math scores as well as the overall gain scores for math (Table 4.3). These finding suggest a moderate level of significance ($\rho < .10$) for math outcomes of students that participated in the flipped classroom compared to students that participated on the lecture classroom. In terms of social significance these findings suggest that math outcomes of students in the flipped classroom meet standards of efficacy by demonstrating overall math gains of students in the flipped classroom twice that of students in the lecture classroom (Rapoff, 2010). These findings are also of interest because the results of research question #7 discussed below found pre MSLQ scores of control of learning, self-efficacy and self-regulation to be significant predictors on posttest COMPASS math scores.

Bhagat, Chang, & Chang (2016) compared the flipped and lecture classroom using outcomes of students in a high school trigonometry course and found the difference in outcomes for middle-level achievers and high-level achievers was not significant. They did find a significant difference in outcomes of low-level achievers in the flipped classroom compared to low-level achievers in the lecture classroom. The researchers conclude that students with the lowest scores on the pretest benefited the most in terms of outcomes due to their experience in the flipped classroom. Another study conducted by Clark (2015) indicates the difference in outcomes between students in a flipped classroom and students in a lecture classroom are not significant for students enrolled in a secondary Algebra I course. The study was conducted over a seven week period and used unit tests to measure student performance.

In conclusion, several studies have been conducted examining the effectiveness of the flipped classroom compared to other traditional face-to-face instruction resulting in mixed results where some studies report positive results while others report negative results. The difference in results as noted by Sun, Xie & Anderman (2016) may be due to the variability in the design and implementation of the flipped classroom. These studies differ in subject area, measures of achievement to determine outcomes or general delivery of the flipped classroom.

Research Question #6

Research Question #6 addresses the relationship between pre MSLQ scores for control of learning, self-efficacy and self-regulation and their association with pretest math scores (Table 4.6). The research question asks the following: "What is the relationship between pre MSLQ scores of control of learning, self-efficacy and self-regulation with pretest COMPASS math scores of students in the flipped and lecture classroom?" The results indicate that each individual measure of control of learning, self-efficacy and self-regulation is a significant predictor of pretest math scores. When the measures are combined in the regression model control of learning, self-efficacy and self-regulation are significant predictors of pretest math scores indicating a small net effect or overlap between the MSLQ variables of control of learning, self-efficacy and self-regulation.

Similar results were found in a study conducted by Brown and Walberg (1993) who conducted a study to determine if motivational factors have an impact on student standardized tests scores. The study consisted of middle grade students who were separated into two groups. One group was provided motivational instructions before they completed a mathematics concepts test and the other group was given traditional instructions before they completed the same test. The results indicate a significant difference in test performance between students that received motivational instructions compared to students that received traditional instructions. They concluded that an attempt to increase motivation in students can make a substantial difference in standardized test scores.

In conclusion, the possibility of using measures of control of learning, self-efficacy or self-regulation to predict math placement scores warrants further investigation. The idea that an increase in these measures may positively influence math placement resulting in higher math placements or more accurate math placements would benefit students in several ways. Students may be able to avoid enrollment in remedial math courses or enroll in fewer remedial math leading to graduation sooner saving money and time.

Research Question #7

Research Question #7 addresses the relationship between pre MSLQ scores with posttest math scores (Table 4.7). The question asks the following: "What is the relationship between pre MSLQ scores of control of learning, self-efficacy and self-regulation with the posttest COMPASS math scores for students in the flipped and lecture classroom?" The results indicate each individual pre MSLQ measure is a significant predictor of posttest math scores. When the results of all measures are included in the regression model the variables are not significant predictors of posttest math scores. Overall, these results suggest a student's level of control of learning, self-efficacy and self-regulation at the start of a math class may influence their performance outcomes in class. Further investigation was performed including pretest math scores in the regression models indicating a significant association for pretest math scores only. These findings suggests prior knowledge is a larger predictor of course outcomes compared to control of learning, self-efficacy or self-regulation.

As previously discussed studies utilizing the MSLQ concluded that the control of learning, self-efficacy and self-regulation positively influences academic performance of students in various educational settings (Pintrich, Smith, Garcia & McKeachie, 1991; Duncan and McKeachie, 2005). In another study performed by Sun, Xie & Anderman (2018) utilizing the MSLQ in a flipped classroom which examined the relationships between self-efficacy, self-regulation and prior math knowledge on achievement of homework assignments in an online class. They found significant associations for all three variables on achievement of homework assignments. They conclude that their findings suggest that the more confident students feel in their abilities for learning math, the more often they would take actions to control when and where to learn online materials, and they would monitor as well as reflect on their own understandings of learned knowledge when completing their homework goals. In contrast, a study conducted by Pachlhofer and Putten (2015) using the MSLQ resulted in opposite findings concluding that a student’s previous ACT score was not a significant predictor of predicting a student’s overall outcome in their self-paced remedial math course. In addition, the findings indicated that self-efficacy and self-regulation were not significant factors of course outcomes. They did find a significant relationship with a students need or interest to perform well in their remedial math course.

In conclusion, previously reported research findings of studies that use the flipped model have mixed results and are difficult to generalize to this study due to variability in designs. Some results suggest students who believe they have control of their learning, believe they can succeed and have the ability regulate their academic activities are more likely to achieve their academic goals while other results suggest these factors are not significant to student academic outcomes.

Research Question #8

Research Question #8 addresses the relationship between pretest math scores with post MSLQ scores for control of learning, self-efficacy and self-regulation (Table 4.8). The research question asks the following: "What is the relationship between pretest COMPASS math scores with post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participated in this study?" The results indicate each individual measure for the pretest MSLQ scores has a significant association with its respective posttest MSLQ scores. Results also indicate that there is a significant association between pretest math scores and posttest self-efficacy scores. In addition, there is a significant association between pretest math scores plus pre self-efficacy scores on posttest self-efficacy scores. Overall, there was a general trend of an increase from pretests and posttests for MSLQ measures for students in both classrooms.

These findings suggest that a student's prior math knowledge and how they felt about their math ability at the start of the course influences how they felt about their ability at the end of the course. In other words, if a student was prepared for the class and confident they could do well in class these feelings influenced how they felt about their ability to do well at the end of the class. Similar findings were reported by Pajares and

Miller (1994) that concluded prior knowledge affected student performance largely through its influence on math self-efficacy.

In conclusion, summary findings of this study indicate that students in the flipped classroom and the lecture classroom both experience increases in their control of learning, self-efficacy and self-regulation as well as math outcomes. In addition, the findings indicate a small net effect for control of learning, self-efficacy and self-regulation on math placement as well as math outcomes for students in a remedial math course. Also, an association of a student's self-efficacy at the end of the course was predicted by a student's initial level of self-efficacy and prior academic knowledge.

Instructor Reflections of the Flipped Classroom

This study resulted in a small sample size of 28 students in the flipped classroom and 32 students in the lecture classroom. The study took place during the fall 2014 and spring 2015 semesters. There were two instructor observations performed using the format outlined by Millis (1992) during the study to determine if researcher bias existed in the instruction of the flipped and lecture classroom. As a result of these observations and the researcher's observations it was determined not to continue the study using additional classes to obtain a larger sample size. Instead the current design of the flipped classroom was altered to improve class delivery and teaching in future remedial math classrooms using the flipped model.

A common theme that emerged from classroom observations of the flipped classroom was the extra time provided for the instructor to "present more examples and more difficult problems in class" (Appendix B). As the instructor, the researcher found this aspect of the flipped classroom to have a positive influence on students encouraging them to seek individual help from the instructor or from their peers. The extra time in class as observed by the researcher increased student engagement during class time as well as helped them learn how to better prepare for a math course through evaluation of their notes and their understanding of the assigned material.

Another common theme noted by the researcher and the class observations was the difficulty students had preparing notes for class. Even though students in the flipped classroom were instructed on how to take notes at the start of the semester some students would arrive to class with incomplete notes and in some instances without notes to participate in class. The intervention of the flipped classroom was changed at the completion of the spring 2015 semester due to the difficulty some students experienced taking notes and preparing for class in the flipped classroom. Changes to the flipped classroom include providing more explanation and hands-on activities designed to teach students how to take notes when preparing for class which are reinforced during the semester in contrast to the lesson on note-taking provided during the study. Another change as a result of the observations and findings of this study are the addition of class discussions and activities regarding student's attitudes toward math and how their beliefs can influence their success in a math course.

In conclusion, the flipped classroom was observed to have a positive influence on students in the classroom as noted by the researcher, classroom observations and findings of this study. The study findings that influenced the continuation of the flipped classroom in a remedial math course were the group differences in math outcomes ($\rho <$

.10) of students in the flipped classroom compared to students in the lecture classroom as well as the findings that indicate control of learning, self-efficacy and self-regulation are significant predictors of math outcomes. In the flipped classroom students are allowed more time to interact with the instructor as well as other students. Modifications of the flipped classroom include more time teaching students how to take notes when they prepare for class and the addition of class discussions/activities designed to help students develop a positive attitude toward math to increase their self-efficacy.

Recommendations from Study

The purpose of this study was to investigate if the flipped classroom was an effective teaching model to increase the motivation and self-regulation of students enrolled in a college remedial math course. The results from this study did find significant results when comparing math outcomes at $\rho < .10$ for students that participated in the flipped classroom compared to students that participated in the lecture classroom. The results from this study did not find significant results when comparing the increase of motivation or self-regulation when comparing students who participated in a flipped classroom compared to students who participated in a lecture classroom. The results OLS regressions performed to further explore the associations between independent and dependent variables resulted in small net effects. After reviewing the results of this study and reviewing literature addressing similar questions recommendations for practice include:

1. Develop and implement a system to identify at-risk characteristics of students in remedial math courses to allow math instructors to develop interventions designed to address the individual learning needs of students at the start of the semester.
2. Develop and implement a system to have students self-assess on measures of control of learning, self-efficacy and self-regulation at the start of the semester.
3. Develop a systemized flipped classroom model to promote greater development of control of learning, self-efficacy and self-regulation in the flipped classroom.

<u>Recommendation #1</u>

The first recommendation as a result of this study is to develop and implement a system to identify at-risk characteristics of students in remedial math courses to allow math instructors to develop interventions designed to address the individual needs of students at the start of the semester. Often times the student that may be at-risk goes unidentified until the student is failing academically leading to academic suspension. As discussed in research question #1, “What are the characteristics of students in a remedial math course?” the findings indicate student characteristics such as age or being a non-traditional student places students at-risk of not achieving their academic goals. According to Horton (2015), factors that impact college persistence and success include under preparation, completion of high school by GED, poverty, being a first-generation college student, being a minority student, having older siblings who dropped out of high school, lacking knowledge about college admissions/matriculation, caring for a child, delayed entry into post-secondary education or financial independence. A possible intervention to identify at-risk characteristics of students is to ask students to complete math autobiographies at the start of the semester in combination with more detailed demographic questionnaires to gain more information about student's characteristics that may impact their success.

Recommendation #2

The second recommendation is to develop and implement a system to have students self-assess on measures of control of learning, self-efficacy and self-regulation at the start of the semester. Research question 6, investigated the influence of pre MSLQ measures of control of learning, self-efficacy and self-regulation on pretest COMPASS math scores. The findings of this study indicated a student's level of control of learning, self-efficacy and self-regulation are significant predictors of pretest COMPASS math scores. Math instructors could use this information to make better informed math placement decisions, especially for students who have math placement scores near the top or bottom range of cut-off scores for math placement.

Another benefit of assessing a student's level of control of learning, self-efficacy and self-regulation is their influence on course outcomes. Research question 7, investigated the influence of pre MSLQ measures of control of learning, self-efficacy and self-regulation on posttest COMPASS math scores. The findings indicated a student's level of control of learning, self-efficacy and self-regulation at the start of the semester are significant predictors of posttest COMPASS math scores (course outcomes). Math instructors could use this knowledge to identify at-risk students at the start of the semester and implement individual study plans or classroom interventions designed to greater develop the skills of control of learning, self-efficacy and self-regulation for students in a remedial math course.

Recommendation #3

The third recommendation as a result of this study is to develop a systemized flipped classroom model to promote greater development of control of learning, self-efficacy and self-regulation in the flipped classroom. A more systemized flipped model would allow for more accuracy when evaluating specific learning tasks of the flipped classroom. According to Anderman, Sun & Xie (2016) current research on the use of flipped teaching lacks a systematic design to investigate what features of the flipped classroom influence motivation and self-regulation factors of students in the flipped classroom. A possible method is to identify specific learning tasks that lead to the development of motivation and self-regulation skills would be including students in the evaluation process. The accumulation of qualitative data in combination of quantitative data would provide more detail needed to determine the effectiveness of these learning tasks.

In conclusion, the three recommendations as a result of the findings of this study include activities to enhance the learning environment and learning skills of students in a remedial math courses. The focus of the recommendations of the study is how to improve the success of students in a remedial math course that uses the flipped classroom. Recommendations include learning more about students to identify students that may be at-risk of failure through utilizing student's characteristics as well as measures of motivation and self-regulation. In addition to systemizing the design of the flipped classroom to identify and evaluate specific learning tasks in the flipped classroom that may influence the development of motivation and self-regulation of students in remedial math.

Limitations of Study

The limitations of this study were identified during the implementation and review of the findings of this study. The limitations discuss how to improve this study based on reviewed research. The limitations that influenced the findings of this study are sample size, as well as validity and reliability concerns with the use of the MSLQ survey. The following paragraphs discuss the possible implications of sample size and the use of the MSLQ on research findings of this study.

The small sample size of this study limited the ability to research the differences among students in the flipped classroom and the lecture classroom. The impact of a small sample size resulted in combining the students in this study leading to an exploratory study to investigate the associations of the dependent and independent variables. The small sample size may have impacted the findings of my study. The ρ-value criteria of $\rho < .05$ for this study may not have accurately reflected the analysis of comparisons in the study. According to Faber and Fonseca (2014), very small samples undermine the internal and external validity of a study leading to less confidence in the findings of the study.

Another limitation that may have impacted the findings of this study was the implementation of the MSLQ survey. The results of the factorial analysis indicated that validity and reliability results for this study using the MSLQ differed from research reported by Pintrich, Garcia and McKeachie (1991) the creators of the MSLQ survey as well as other research reported in Chapter 2. As a result of the factorial analysis of the data collected for this study it was determined the factor structure was different for control of learning and self-regulation. The factor structure for self-efficacy remained the same. According to Pintrich and DeGroot (1991), social desirability response bias may influence student self-reported responses leading to a change in factor structure as well as reliability of results. They note they have observed a change of factor structures using the MSLQ with junior high students compared to college students but the results fit into the general conceptual model (Pintrich and DeGroot, 1991). Response bias in this study in addition to the sample size may account for the change of factor structure. As discussed previously the majority of the students in this study were enrolled in or had completed a college success course which may have created response bias when students rated their control of learning and self-regulation skills.

Recommendations for Future Research

The recommendations for future research are based on the recommendations and limitations of this study to further research the effectiveness of the use of the flipped classroom in a remedial math course. Recommendations for future research include increase sample size, use multiple instruments to measure outcome data and include qualitative measures to enrich the data collection to evaluate the effectiveness of the flipped classroom.

The first recommendation for future research is to increase sample size. This may involve changing the requirements of the study to encourage students completing the criteria to participate in the study. This study utilized a pre and posttest design with the posttest delivered at the end of the semester. Some students did not meet the requirement of the study because they either finished the course early or dropped the course at mid-term so not all students that completed the course were represented in the data. Another strategy to increase sample size and improve the research methods of this study is to conduct the research with other remedial math instructors at two year colleges. Coordinating research with other math instructors may enable the expansion of participants as well as expand the knowledge of researchers of the flipped classroom.

The second recommendation for future research is to use multiple instruments to measure outcome data and include qualitative measure to enrich the data collection. The use of multiple instruments for measuring motivation and self-regulation in addition to the MSLQ would provide more insight an accuracy to these factors. In addition, multiple instruments for measuring course outcomes would provide more information about a student's academic performance in the classroom.

Conclusions

The purpose of remedial math courses are to teach students prerequisite math skills needed for them to be successful in their degree required math course leading to degree attainment. Remedial math courses are viewed as a barrier to degree attainment for students due to the low completion rates of students in remedial math courses. This study investigated the use of the flipped classroom in a remedial math course by asking the following research questions:

1) What are the student characteristics of students who enroll in a remedial math course?
2) Do the control of learning scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
3) Do the self-efficacy scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
4) Do the self-regulation scores on the MSLQ increase in students that participate in a flipped model remedial math course compared to students that participate in a lecture model remedial math course?
5) How do the posttest COMPASS math scores of students who participate in a flipped model remedial math course compare to posttest COMPASS math scores of students who participate in a lecture model remedial math course?
6) Do the results of pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the pretest COMPASS math scores (course placement) of students in this study?
7) Do the results of the pre MSLQ scores of control of learning, self-efficacy or self-regulation predict the posttest COMPASS math scores (course outcome) of students in this study?

8) Do the results of pretest COMPASS math scores predict post MSLQ scores of control of learning, self-efficacy and self-regulation for students that participate in this study?

The findings of the research questions resulted in three recommendations. The first recommendation is for remedial math instructors to better assess student characteristics of students in their classrooms. This recommendation is based on the finding that students in a remedial math course have other student characteristics in addition to being academically disadvantaged that place them at-risk of not achieving their academic goals. For instance, students that are non-traditional age are considered at-risk of not achieving their academic goals and may have specific learning needs to be successful (Horton, 2015). The increased knowledge of student characteristics may enable math instructors to better identify and address specific learning needs of students in a remedial math course at the start of the semester in contrast to reacting to student failure later in the semester.

The second recommendation is to have students self-assess their levels of motivation (control of learning and self-efficacy) and self-regulation at the start of the semester. This recommendation is developed to address two findings of the study. The first finding that lead to this recommendation is the finding that indicated that pre MSLQ measures of control of learning, self-efficacy and self-regulation were found to be significant predictors on pretest COMPASS math results. Math instructors can use this information to better evaluate a student's math placement into a remedial math course as well as identify students that may be at-risk of succeeding in a remedial math course due to low levels of control of learning, self-efficacy or self-regulation. The second finding that lead to this recommendation is the finding that indicated that the pre MSLQ measures of control of learning, self-efficacy and self-regulation were found to be significant predictors of posttest COMPASS math scores. Math instructors could use knowledge of these measures to improve classroom practice by providing individual study plans or classroom interventions designed to greater develop the skills of control of learning, self-efficacy and self-regulation for students in a remedial math course. Overall, armed with this knowledge, math instructors can implement remedies to address deficiencies in motivation and self-regulation skills for students enrolled in remedial math to promote student success.

The third recommendation is to develop a systemized flipped classroom model to promote greater development of control of learning, self-efficacy and self-regulation in the flipped classroom. This recommendation is based on the findings that pre MSLQ measures of control of learning, self-efficacy and self-regulation were a significant predictor of pretest COMPASS scores as well as posttest COMPASS scores. Also, research conducted by Anderman, Sun & Xie (2016) recommends a systematic design to investigate what features of the flipped classroom influences motivation and self-regulation factors for students in the flipped classroom. Identifying specific learning tasks that lead to the development of motivation and self-regulation skills involves students in the evaluation process of specific learning tasks to learn more about the effectiveness of the flipped classroom.

The future research recommendations addressed the limitations of sample size and validity concerns with the results obtained from the MSLQ. Future research recommendations included working with other remedial math instructors to conduct research to determine the effectiveness of the flipped classroom. In addition, use multiple instruments to measure outcome data and include qualitative data to provide more information to evaluate the effectiveness of the flipped classroom.

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APPENDICES

APPENDIX A

MOTIVATED STUDENT LEARNING QUESTIONNAIRE

MOTIVATED STUDENT LEARNING QUESTIONNAIRE

Name _________________________________ Student ID
Number_____________________

1. Gender (Circle One)	Male Female
2. Enrollment Status	Non-traditional age (> or = 25) Traditional age
3. Class Rank	First Semester in college Returning Student
4. Degree Option	4-year (B.S.) 2-year (AAS) AS or Transfer
5. How many years of math did you complete in high school?	Did not complete H.S. and earned GED Completed 2 or more years in H.S. and earned GED Completed 3 years in H.S. and earned diploma Completed 4 years in H.S. and earned diploma
6. How many math courses did you complete in college?	Did not complete a college math course Completed one math course in college Completed two math courses in college
7. Time since last math class?	Less than or equal to 1 year Two years Three years Greater than or equal to four years
8. What are your feelings about Math?	Negative No Opinion Positive
9. Did you complete or are you enrolled in a College Success Class?	Yes No
10. Are you enrolled in Writing 095?	Yes No
11. How would you rate your Computer Technology Skills?	I never or rarely use a computer (poor) I use a computer to access email and the internet (fair)

	I frequently use a computer and utilize various programs (good) I'm confident using a computer and can troubleshoot most technical problems (excellent)
THANK YOU FOR YOUR PARTICIPATION The below information is to be filled out by the researcher	
Placement Score and date:	
Compass Pretest scores and placement: Compass Posttest scores and placement:	
Midterm average and grade Final course average and grade Number of days absent	

The following questions ask about your learning strategies and study skills for this class. **There are no right or wrong answers**, so please answer the questions about how **you** study in a math class as accurately as possible.

Use the scale below to answer the following questions. If you think the statement is very true of you, circle 7; if a statement is not true of you, circle 1. If a statement is more or less true of you, find the number between 1 and 7 that best describes you.

1	2	3	4	5	6	7
Not at all true of me						Very true of me

1. In a class like this, I prefer course material that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2. If I study in appropriate ways, then I will be able to learn the material in this course.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3. When I take a test I think about how poorly I am doing compared with other students.	1	2	3	4	5	6	7
4. I think I will be able to use what I learn in this course in other courses.	1	2	3	4	5	6	7
5. I believe I will receive an excellent grade in this class.	1	2	3	4	5	6	7
6. I'm certain I can understand the most difficult material presented in the readings for this course.	1	2	3	4	5	6	7
7. Getting a good grade in this class is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8. When I take a test I think about items on other parts of the test I can't answer.	1	2	3	4	5	6	7
9. It is my own fault if I don't learn the material in this course.	1	2	3	4	5	6	7
10. It is important for me to learn the course material in this class.	1	2	3	4	5	6	7
11. The most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade.	1	2	3	4	5	6	7

12. I'm confident I can learn the basic concepts taught in this course.	1	2	3	4	5	6	7
13. If I can, I want to get better grades in this class than most of the other students.	1	2	3	4	5	6	7
14. When I take tests I think of the consequences of failing.	1	2	3	4	5	6	7
15. I'm confident I can understand the most complex material presented by the instructor in this course.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
16. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.	1	2	3	4	5	6	7
17. I am very interested in the content area of this course.	1	2	3	4	5	6	7
18. If I try hard enough, then I will understand the course material.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
19. I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20. I'm confident I can do an excellent job on the assignments and tests in this course.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
21. I expect to do well in this class.	1	2	3	4	5	6	7
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7
23. I think the course material in this class is useful for me to learn.	1	2	3	4	5	6	7
24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25. If I don't understand the course material, it is because I didn't try hard enough.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
26. I like the subject matter of this course.	1	2	3	4	5	6	7
27. Understanding the subject matter of this course is very important to me.	1	2	3	4	5	6	7
28. I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29. I'm certain I can master the skills being taught in this class.	1	2	3	4	5	6	7
30. I want to do well in this class because it is important to show my ability to my family, employer, or others.	1	2	3	4	5	6	7

31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	1	2	3	4	5	6	7
32. When I study the readings for this course, I outline the material to help me organize my thoughts.	1	2	3	4	5	6	7
33. During class time I often miss important points because I'm thinking of other things.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
34. When studying for this course, I often try to explain the material to a classmate or friend.	1	2	3	4	5	6	7
35. I usually study in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36. When reading for this course, I make up questions to help focus my reading.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
37. I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.	1	2	3	4	5	6	7
38. I often find myself questioning things I hear or read in this course to decide if I find the convincing.	1	2	3	4	5	6	7
39. When I study for this class, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40. Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7
41. When I become confused about something I'm reading for this class, I go back and try to figure it out.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
42. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.	1	2	3	4	5	6	7
43. I make good use of my study time for this course.	1	2	3	4	5	6	7
44. If course readings are difficult to understand, I change the way I read the material.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
45. I try to work with other students from this class to complete the course assignments.	1	2	3	4	5	6	7
46. When studying for this course, I read my class notes and the course readings over and over again.	1	2	3	4	5	6	7
47. When a theory, interpretation, or conclusion is presented in class or in the readings, I try	1	2	3	4	5	6	7

to decide if there is good supporting evidence.							
48. I work hard to do well in this class even if I don’t like what we are doing.	1	2	3	4	5	6	7
49. I make simple charts, diagrams, or tables to help me organize course material.	1	2	3	4	5	6	7
50. When studying for this course, I often set aside time to discuss course material with a group of students from the class.	1	2	3	4	5	6	7
51. I treat the course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52. I find it hard to stick to a study schedule.	1	2	3	4	5	6	7
53. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.	1	2	3	4	5	6	7
54. Before, I study new course material thoroughly, I often skim it to see how it is organized.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
55. I ask myself questions to make sure I understand the material I have been studying in this class.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
56. I try to change the way I study in order to fit the course requirements and the instructor’s teaching style.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
57. I often find that I have been reading for this class but don’t know what it is about.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
58. I ask the instructor to clarify concepts I don’t understand well.	1	2	3	4	5	6	7
59. I memorize key words to remind me of important concepts in this class.	1	2	3	4	5	6	7
60. When course work is difficult, I either give up or only study the easy parts.	1	2	3	4	5	6	7
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
62. I try to relate ideas in this subject to those in other courses whenever possible.	1	2	3	4	5	6	7
63. When I study for this course, I go over my class notes and make an outline of important concepts.	1	2	3	4	5	6	7
64. When reading for this class, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65. I have a regular place set aside for studying.	1	2	3	4	5	6	7

66. I try to plan around the ideas of my own related to what I am learning in this course.	1	2	3	4	5	6	7
67. When I study for this course, I write brief summaries of the main ideas from the readings and my notes.	1	2	3	4	5	6	7
68. When I can't understand the material in this course, I ask another student for help.	1	2	3	4	5	6	7
69. I try to understand the material in this class by making connections between the readings and the concepts from the lectures.	1	2	3	4	5	6	7
70. I make sure that I keep up with the weekly readings and assignments for this course.	1	2	3	4	5	6	7
71. Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	1	2	3	4	5	6	7
72. I make lists of important items for this course and memorize the lists.	1	2	3	4	5	6	7
73. I attend this class regularly.	1	2	3	4	5	6	7
74. Even when course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6	7
75. I try to identify students in this class whom I can ask for help if necessary.	1	2	3	4	5	6	7
76. When studying for this course I try to determine which concepts I don't understand well.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
77. I often find that I don't spend very much time on this course because of other activities.	1	2	3	4	5	6	7
78. When I study for this class, I set goals for myself in order to direct my activities in each study period.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
79. If I get confused taking notes in class, I make sure I sort it out afterwards.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
80. I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6	7
81. I try to apply ideas from course readings in other class activities such as lecture and discussions.	1	2	3	4	5	6	7

APPENDIX B

OBSERVATIONS

Classroom Observation Visit

Faculty Member: Denise Elakovich

Campus: Highlands College

Course: M 095 Intermediate Algebra

Date: Fall 2014, Spring 2015

Observer: Michelle Morley

Classroom:

Both classrooms were set up similarly with dry erase boards as well as a smart board or smart podium. The students did not have assigned seating and could choose which did not impede on the learning environment.

Rapport:

Because there was no assigned seating, students were comfortable with each other and were found to be engaging with each other at the beginning of class. The instructor began each class by asking students questions to assess their preparation for the days topic and would stop periodically throughout the lecture as well to make sure the students were understanding the material.

Style:

The instructor utilized the classroom space in terms of showing problem examples on either the dry erase board, smart podium or smart board which allowed students to easily engage and follow along while taking notes. The students could interrupt as necessary throughout the lecture to ask questions without having to wait for the instructor to invite questions.

Comments:

There were initial concerns going in that due to the differences in delivery format (conventional classroom v flipped model) that the instructor would teach the sections differently, however, that was not the case. In each section the instructor had the same interactions with the class, however, the content was somewhat different. While each section covered the same concepts, in the flipped model, the instructor could provide more examples in class, given the need for the students to prepare for that day's lecture prior to class including reading, and taking notes on the material. Regardless of delivery, the instructor could fully develop the concepts and show how the concepts continued to build on each other, not only reinforcing the current but also the prior material in class.

A surprising finding was in the flipped model, many of the students did not have the materials prepared for class, so there were concepts that the instructor would have to readdress much like it was being taught in the traditional/conventional classroom teaching model.

Classroom Visit Instrument (consolidated)*

Faculty Member:	Denise Elakovich
Campus:	Highlands College
Course:	Math 095, Intermediate Algebra
Sections:	01 (9 AM), 02 (10 AM)
Date:	11/17/2014
Visitor:	Jeff Draper

Classroom:
The physical surroundings of both classrooms were adequate and similar.

Instruction:
At the beginning of class, the instructor explained what the next topic was, and how it fit in with what had already been covered. In 01, the format of the class was lecture, including worked examples, followed by students working problems themselves, and reviewing solutions together. In 02, students' previously prepared notes were checked, and problem sets were given at the start of the class. Solutions were reviewed, and supplementary assistance and explanation was given by the instructor. Both classes covered the same topics: rationalizing denominators and solving radical expressions. Students were told what was coming up for the next class, and what preparations they should be making.

Rapport:
Students were inquisitive and responsive in both sections. "Small talk" prior to class starting suggested students were comfortable. The instructor "checked in" with students throughout both classes to see to what extent they had prepared for class, if they were tracking with what was going on, or otherwise needed assistance. Time was allowed for students to think about questions, to address specific questions, or clarify students' inquiries.

Style:
The instructor had a stable pace and maintained a positive and upbeat attitude. The instructor had a conversational tone and sought eye contact with students. Student note-taking was facilitated by the instructors' clear and concise writing on the board or SmartPodium.

Comments:
Because of the different class formats (conventional and "flipped"), the 02 section was able to cover more examples problems in class, including a few more difficult problems. However, the 01 section had a more comprehensive presentation. These differences are offset by differences in homework between the two sections (01 prepares notes before class, 02 does not). Both classes gave students opportunities to raise questions or request clarification.

It seemed very effective how the instructor was able to show how what they were doing was building on what they had already learned. This both reinforced the older material, as well as helped students from feeling overwhelmed by keeping clear for them what was new, and what was not. The topic was made less intimidating by putting it in context of what had already been learned; that the topic was really just adding another aspect to what they already knew, versus coming across as a whole, big, new, concept.

*Evaluation format taken from Appendix A of "To Improve the Academy" Vol. 11, 1992.