The Effects of the Use of a Self-monitoring Form on Achievement and Self-regulated Learning in a Developmental Mathematics Course

By

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Dedication

This dissertation is lovingly dedicated to my mother, Greta Sooja Kim, who always believed that I could do more than I dreamed. This is a product of her enduring love and support.

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Abstract

For most undergraduate degrees, students are required to fulfill a baseline of mathematics requirements. However, some students are not prepared to begin in a college-level mathematics course and must begin coursework in a developmental mathematics course. Therefore, identifying ways to increase the student success rate in developmental mathematics courses is an important issue faced by many post-secondary institutions.

The purpose of this study was to investigate student use of a self-monitoring instrument when working online in a university developmental mathematics course, Intermediate Algebra, which blended online learning and face-to-face instruction. Comparisons of achievement on exams, self-regulated learning levels, and course grade were made between students using a self-monitoring instrument while working online and those that did not use this instrument.

There were 661 students included in this semester-long study. There were three phases in this study. In Phase 1, students in the experimental group received the most intense treatment. Students were asked to complete a self-monitoring record form after every online assignment for a total of four times. During Phase 2, the treatment was moderate as students were asked to complete the online record form after every other online assignment for an additional two occurrences. In Phase 3 the treatment was removed and students were not required to complete any online record forms. All participants were asked to complete a questionnaire in class four different times throughout the semester to measure levels of self-regulation when working online.

This study used a nonequivalent-control-group experimental design with repeated measures. ANCOVA results indicated that the experimental group as a whole performed slightly but statistically significantly better than the control group on two of the three unit assessments- the Unit 3 Exam which was completed at the end of Phase 2 and the Unit 4 Exam which was completed at the end of Phase 3. ANOVA revealed that during Phase 2, the experimental group as a whole had a small yet statistically significant increase in their level of self-regulation compared to the control group yet in Phase 3 those differences did not remain statistically significant. Positive correlations were identified between students' composite score on the fourth measurement of levels of self-regulated learning and their final course grade as well as subscale scores, Goal Setting, Environment Structuring, Help Seeking, and Self-evaluation, and students' final course grade.

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CHAPTER 1

The Research Problem

Introduction

Currently almost 80% of high school graduates continue in postsecondary education (Aud, Hussar, Kena, Bianco, Frohlich, Kemp, & Tahan, 2011), yet, many of these students are unprepared to take college-level courses (Aud et al., 2011; Bahr, 2010; Bettinger & Long, 2009; Boylan, 2009; Martorell & McFarlin, 2011; Parsad, Lewis, & Greene, 2003). Being unprepared for college coursework is a widespread phenomenon among students attending college (Attewell, Lavin, Domina, & Levey, 2006; Aud et al., 2011; Breneman, 1998; Martorell & McFarlin, 2011) as it was reported that over 2 million students annually fall into this group who are not ready (Boylan, 2009). Based on entrance exam scores reported by American College Testing (ACT, 2005, 2012), students have shown deficiencies in mathematics, science, reading, and writing. In its most recent annual report, *The Condition of College & Career Readiness 2012* (ACT, 2012), it was reported that of the 52% of high school graduates who took the ACT exam, only 25% met all four benchmarks indicating readiness for college-level coursework. On the contrary, 28% of the test takers did not meet any of the four benchmarks indicating the likelihood to struggle in a college-level course (ACT, 2012). Nevertheless, these fundamental skills are needed to complete courses required for degree attainment (Bahr, 2008, 2010; Bettinger & Long, 2009; Martorell & McFarlin, 2011).

The most common way institutions of higher education are tackling this issue is by offering developmental courses, often referred to as remedial courses, in mathematics, reading and writing to students who are academically deficient in these areas (Attewell et al., 2006; Bahr, 2010; Bettinger & Long, 2009; Martorell & McFarlin, 2011; Parsad et al., 2003). The National

Center for Educational Statistics (Parsad et al., 2003) reported that in 2000, 76% of postsecondary institutions offered at least one developmental course in mathematics, reading or writing. These courses are intended to bolster students' prerequisite knowledge in order to prepare them for college-level courses (Bahr, 2008, 2010; Bettinger & Long, 2009; Parsad et al., 2003).

Aud et al. (2011) reported that in the 2007-2008 school year, 20% of incoming freshmen at all postsecondary institutions enrolled in at least one remedial course. Specifically, students enrolled in developmental mathematics courses accounted for a significant portion of this student population (Collins, 2010; Duranczyk & Higbee, 2006; National Mathematics Advisory Panel, 2008; Parsad et al., 2003). According to the National Center for Educational Statistics' website, 14.6% of incoming freshmen at all postsecondary institutions enrolled in a remedial mathematics course in 2003 compared to 5.5% who enrolled in a reading course and 6.9% who enrolled in a writing course (Aud et al., 2011).

Instruction in developmental courses is being transformed by the use of the Internet in delivering some instruction (Ellis, Ginns, & Piggott, 2009; Parsad et al., 2003; Wadsworth, Husman, Duggan, & Pennington, 2007; Yen & Lee, 2011). Using the Internet for instruction is called online learning, or electronic learning (e-learning), and is a growing trend in the use of educational technology, in both K-12 and postsecondary institutions (Ellis et al., 2009; Yen & Lee, 2011). Alongside this trend, blended learning, blending face-to-face instruction with online learning activities (Allen & Seaman, 2011; Bluic, Goodyear, & Ellis, 2007; Kim & Bonk, 2006; Lust, Vandewaetere, Ceulemans, Elen, & Clarebout, 2011; Means, Toyama, Murphy, Bakia, & Jones, 2010; Picciano, Seaman, Shea, & Swan, 2012; Vaughan, 2007; Wu, Tennyson, & Hsia, 2010; Yen & Lee, 2011), is emerging as a common learning environment in higher education

(Chen, Lambert, & Guidry, 2010; Garrison & Kanuka, 2004; Lust et al., 2011; Means et al., 2010). It is estimated that almost 70% of students in higher education were enrolled in at least one blended, or hybrid, course during the 2008 academic year (Chen et al., 2010).

Learning that takes place online requires students to be active rather than passive learners (Winters, Greene, & Costich, 2008) and as these environments offer more freedom in learning, students must also be self-directed (Wang, 2011) and self-motivated (Yen & Lee, 2011), characteristics of a self-regulated learner (Zimmerman, 2002). Self-regulated learning has been defined as an active process of learning comprised of metacognitive, motivational and behavioral constructs (Elliott et al., 2005; Lan, 1996; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Winters et al., 2008; Zimmerman, 1994, 2002, 2008). It has been suggested that the quality of a student's self-regulated learning behaviors is connected to his/her academic achievement when working in an online learning environment (Kaufman, Zhao, & Yang, 2011; Winters et al., 2008).

Self-monitoring, which was introduced as a data recording technique, was found to transform an individual's behaviors; the mere act of recording one's own behaviors could change behaviors (Schmitz & Perels, 2011). Self-monitoring as a self-regulated learning strategy has been described as a conscious awareness of one's behaviors; the individual evaluates the effectiveness of his/her behaviors and makes decisions about subsequent actions based on these judgments (Lan, 1996). Self-monitoring has been found to be an effective strategy to increase student achievement (Kaufman et al., 2011; Lan, 1996; Schmitz & Perels, 2011). Self-monitoring and its relationship to academic achievement in traditional classrooms has been documented, however, this relationship in blended learning environments, particularly in the online portion of a course, is just beginning to be researched (Schmitz & Perels, 2011).

Statement of the Problem

The purpose of this study was to investigate student use of a self-monitoring instrument when working online in a university developmental mathematics course, Intermediate Algebra, which blended online learning and face-to-face instruction. Comparisons of achievement and self-regulated learning levels were made between students using a self-monitoring instrument while working online and those that did not use this instrument for self-monitoring when working online. Further, relationships between students' levels of self-regulation and their final course grades scaled as percents were investigated.

Research Questions

This study was designed to answer the following research questions:

1. Was there a statistically significant difference in student achievement, indicated by mean scores on three unit exams, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
2. Was there a statistically significant difference in students' levels of self-regulation, indicated by mean scores gathered from a questionnaire completed four different times throughout the semester, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
3. Was there a statistically significant relationship between a student's perceived level of self- regulation and final course grade?

To answer the research questions, this study used a nonequivalent-control-group experimental design with repeated measures (Shavelson, 1996) over one semester to investigate student use of the self-regulatory strategy of self-monitoring during online work with students in a developmental mathematics course, Intermediate Algebra. The beginning sample included 661 students attending 36 different sections, 18 sections in the control group and 18 sections in the experimental group. The control group initially included 336 students and the experimental group initially included 325 students.

All participants completed a questionnaire after each unit exam to measure each individual's level of self-regulation of online learning. All participants were required to complete the same lessons and assignments in class, out of class, and online throughout the semester. Comparisons about the groups were made using self-regulation scores, scores on four unit exams and a final course grade.

All students were given credit for completing an online record form regardless of which group they were in and so two different forms were used. Students in the experimental group filled out a self-monitoring form which asked them to record their name, if the assignment was completed by the due date, how many sessions were used (times they had logged in) to complete the assignment, where most of the online work was completed (e.g. dormitory, library, apartment, other), and any distractions while working online. They were also asked to record any help-seeking actions they considered such as getting help from the instructor or a peer. Finally this form asked students to make a judgment on the quality of the work they did to complete the assignment. Students in the control group filled out an abbreviated record form which did not include any questions regarding self-regulated learning attributes. Their form asked them to record their name, if the assignment was completed by the due date, and how many sessions were used (times they had logged in) to complete the assignment.

The students completed their appropriate online record form after every online assignment during the first phase, after every other online assignment during the next phase, and none during the last phase. It was intended that students completed the self-monitoring form more often at the beginning of the semester and then requirements tapered off, referred to as fading, so that no requirement to complete the self-monitoring form was present at the end of the semester. This allowed the researcher to examine if the strategy use of self-monitoring had any effect on students' levels of self-regulation of online learning in the experimental group after fading.

Rationale for the Study

Developmental Mathematics

For most undergraduate degrees, students are required to fulfill a baseline of mathematics requirements, however some students must begin coursework in a developmental mathematics course (Bettinger & Long, 2009). Developmental mathematics, sometimes referred to as remedial mathematics, mathematics skills courses, or college preparatory mathematics courses, at postsecondary institutions have been described as non-credit prerequisite courses designed to strengthen the computational skills as well as conceptual understanding of students who are unprepared for college-level mathematics (Attewell et al., 2006). These courses are intended to help students gain the knowledge and understanding required to be successful in subsequent credit-bearing college-level mathematics courses (Attewell et al., 2006; Hammerman & Goldberg, 2003). Success in a developmental mathematics course is mandatory in order for the student to continue in subsequent mathematics courses that are credit bearing to fulfill degree requirements (Collins, 2010; Duranczyk & Higbee, 2006; Smittle, 2003).

Research has indicated that students who attain college-level mathematics skills, regardless of their initial skill deficiency in mathematics, by successfully completing a developmental program, experience long-term academic outcomes that are similar to their college-ready counterparts (Bahr, 2008, 2010; Bettinger & Long, 2009). However, a large number of students are not successful in completing a developmental mathematics course (Bahr, 2008). Research has also indicated that "in the absence of successful remediation, declining math skills foreclose academic opportunities" (Bahr, 2008, p. 440). Therefore, identifying ways to increase the student success rate in developmental mathematics courses is an important issue faced by many postsecondary institutions (Bahr, 2008).

Blended Learning

Research suggests that a course completed online is as effective as one taught face-to-face and that a blended course shows higher gains in student performance than either type of instruction alone (Means et al., 2010; Underwood, 2009). There are some perceived benefits of integrating online learning with face-to-face instruction including an increase in learning time (Garrison & Kanuka, 2004; Vaughan, 2007), flexibility of time and space (Garrison & Kanuka, 2004; Vaughan, 2007; Yen & Lee, 2011), instructional richness (Wu et al., 2010), enhanced teacher-student interactions (Vaughan, 2007), and increased motivation (Garrison & Kanuka, 2004; López-Pérez, Pérez-López, & Rodríguez-Ariza., 2011). Some challenges have also been identified with the blended learning experience (Garrison & Kanuka, 2004; Lust et al., 2011; Lust, Collazo, Elen, & Clarebout, 2012; Paechter & Maier, 2010; Stacey & Gerbic, 2008; Vaughn, 2007; Yen & Lee, 2011). Researchers have reported that there is a complexity in dealing with two environments for both students and instructors (Stacey & Gerbic, 2008) and oftentimes both groups lacked adequate support (Vaughn, 2007).

"With the rapid development of online instruction, our understanding of teaching and learning in this new environment is lagging behind" (Barnard, Lan, To, Paton, & Lai, 2009, p.1). Few research studies have focused on how successful students maximize learning when working in online environments (Winters et al., 2008). Research is needed to identify aspects of online learning and practices with online learning that increase student achievement (Underwood, 2009; Winters et al., 2008).

Self-regulated Learning

Online learning provides a learning environment that gives students more autonomy with regard to when, what and where to study by removing limitations of time, materials, and place (Barnard et al., 2009) and therefore, requires students to be self-directed (Wang, 2011) and self-motivated (Yen & Lee, 2011). Researchers recommend that students be trained in using self-regulated strategies, particularly self-motivation strategies, when working in blended environments (Kim & Bonk, 2006; Yen & Lee, 2011). Further, Pintrich (1999) recommended that training on the use of self-regulated strategies should be integrated into content-specific instruction. Several studies have suggested that developmental mathematics students would benefit from instruction on self-regulated learning strategies (Kinney, 2001; Smittle, 2003; Wambach, Brothen, & Dickel, 2000).

There is a growing body of research on self-regulated learning in online environments (Kauffman et al., 2011; Winters et al., 2008). A meta-analysis conducted by Winters, Greene, and Costich (2008) separated the studies into two groups: 1) The relationship between characteristics of learners (e.g. prior knowledge, self-efficacy, goal orientation, interest) or tasks (e.g. goal structure, learner control, collaboration) and students' self-regulated learning in online environments and 2) The relationship between available learning supports (note-taking, highlighting, prompts) and students' self-regulated learning in online environments. Yet, this report concluded that none of the studies reviewed in the second group had reduced the learning support, fading, that was being evaluated. "Without the key aspect of fading, it is not clear whether what is supported is truly *self*-regulated learning …or *other*-regulated learning" (Winters et al., 2008, p. 442).

This study contributes to the current research in identifying ways to improve student learning when working in an online environment. This study implemented a support, a self-monitoring tool, when students worked online as a way to develop self-regulated learning strategies when working in this type of environment. This study includes fading out the prompts to use the self-monitoring tool to identify if any effects exist even after removing the treatment.

Definitions of Terms

For the purpose of the study, the following definitions were used.

Kansas Algebra Program (KAP) is a coordinated program at the University of Kansas that serves students enrolled in Intermediate Algebra (Math 002) and College Algebra (Math 101).

Face-to-face instruction is the traditional mode of delivery of instruction where students physically meet with the instructor and their classmates at a particular time and space (López-Pérez et al., 2011; Vaughan, 2007; Wu et al., 2010).

Online Learning or e-learning is the use of the Internet to deliver learning content (Derntl & Motschnig-Pitrik, 2005).

Blended learning is the integration of face-to-face classroom instruction with online learning experiences (Allen & Seaman, 2011; Bluic et al., 2007; Kim & Bonk, 2006; Lust et al., 2011; Means et al., 2010; Picciano et al., 2012; Vaughan, 2007; Wu et al., 2010; Yen & Lee, 2011). In this study, the face-to-face instruction was delivered during 150 minutes per week of class meetings and the online experiences included homework assignments and quizzes delivered and completed through MyMathLab.

MyMathLab (MML) is software that was developed by Pearson Education, a textbook publishing company, to serve as an online learning and assessment tool (Law, Sek, Ng, Goh, & Tay, 2012; Stewart, 2012) to complement students' textbooks. As students work through exercises for each lesson, the program provides immediate feedback on submitted answers and offers a variety of tools to support learning such as an electronic textbook and tutorials (Law et al., 2012; Stewart, 2012).

Self-regulated Learning (SRL) is described as an active process of learning comprised of metacognitive, motivational and behavioral constructs (Elliott et al., 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008).

Self-monitoring, a self-regulated learning strategy, is the act of recording one's own behaviors (Schmitz & Perels, 2011).

Assumptions

As a coordinated course, it was assumed that all Intermediate Algebra sections would be on the same schedule so that on any given day, relevant and similar material would be presented in all classes meeting that day. It was assumed that all students would have the same resources available to them through the Kansas Algebra Program. It was also assumed that students possessed basic computer knowledge and skills, were familiar with the Internet, and had access to the online portion of the course either at the program's computer lab and/or a site outside of the program's facilities.

It was assumed that instructors would administer and collect from all students the study's questionnaire about self-regulated learning four times during the semester as scheduled. It was assumed that all subjects understood the statements and responded honestly.

It was assumed that all students had access to the self-monitoring record form and that these students understood the questions on the self-monitoring record form. It was assumed that students completed it consistently, accurately, and honestly.

The researcher developed all mathematics assessments used in the study and it was assumed that these instruments were constructed to reliably measure student achievement in common topics of Intermediate Algebra. It was assumed that all students gave their best effort when completing the four unit assessments, as well as the final examination. It was also assumed the assessments were graded consistently and accurately following the grading guidelines established by the KAP Assistant Director.

Limitations

Based on the nature of the study, some limitations were identified. Generalization of the findings is limited as the data came from a developmental mathematics program at a Midwestern university and all participating students were enrolled in an Intermediate Algebra course. The report of findings may not represent other developmental mathematics students in different geographical areas, in other developmental mathematics courses such as Basic Math and Elementary Algebra, or at other types of postsecondary institutions**.**

The variability of student access to online materials, as well as augmented experiences such as being involved in a tutor group or having an individual tutor outside of the program may have influenced the results. Some students were repeating the course and had some familiarity with the course, including the structure of the program, the content, the assignments, and assessments which may have affected the results. There were some students who did not participate consistently during the course so consequently some of their data were used while other data from these students were not which may have influenced the results. Also, there were students who had data recorded but since they did not consent to participate, the data could not be used which could have influenced results.

There could have been differences in student scores attributed to the differences in the questions on the exams and not necessarily due to a difference in students' abilities. Since the exams were algorithmically generated, every student did not take the same exam; some randomized items may have been perceived by some students as more difficult than an alternate exercise for that question or a variation could have more easily managed numbers than another. Further, the exam may not have measured everything students knew about those topics.

Another possible limitation was the day and time of day a student took an exam. Dependent on the time of day, the testing room may have been less or more crowded which could have affected students' performances on the exam. Students were assigned a testing day, either the first day or second day of testing, therefore students did not complete the exam on the same day. Students also had an opportunity to retake an exam and some students may have chosen not to take an exam in the original testing window but during the retake window which may have affected the mean scores for that exam.

The sample included 36 sections of a developmental mathematics course taught by 29 different instructors and offered throughout the day either meeting two or three times per week. The differences in instructors' styles and variance among instructors' levels of experience may have affected the results. The frequency of meeting times per week and the time of day a class met may also have had an effect on results. There were also some inconsistencies in data gathering as some instructors were diligent in administering the in-class questionnaires on the designated days while a few had to be reminded to do so.

The in-class questionnaires included questions about attributes of self-regulated learning which may have had the same effect as the self-monitoring record form used as the treatment of the experiment on scores. There were also some in-class questionnaires on which the individual did not complete the backside and so these scores were unusable.

Although the online forms were delivered by email to all students, some students did not check their email regularly and therefore did not complete the self-monitoring forms. Further, the data collected from the self-monitoring instrument as well as the self-regulated learning questionnaire was self-reported. Responses of self-reports are subject to various sources of inaccuracy such as self-deception, self-enhancement, and memory (Paulhus & Vazire, 2007).

Overview

The first chapter offers an introduction to the problem that was investigated by this study. The second chapter presents a review of the literature relevant to this study. The topics include developmental mathematics in postsecondary education, the emerging trend of blended learning, students' use of tools in this environment, the benefits and challenges associated with blended learning environments, the use of self-regulated learning and finally research results about self-regulated learning in developmental mathematics as well as blended learning environments. The third chapter offers a discussion of the methodology used for this study, including a timeline of the study and descriptions of the instruments that were used to collect data. The fourth chapter presents the results of the study. The fifth chapter presents the conclusion of the study and offers recommendations for educators as well as suggestions for future research.

CHAPTER 2

Review of Literature

Introduction

Developmental education is a significant element in postsecondary education as evidenced by developmental programs present at postsecondary institutions, journals and organizations dedicated to the field, and research conducted on this topic. Since many postsecondary institutions provide developmental courses as a way to prepare students who are not ready for college-level work, finding ways to build student success in these courses is an important issue. The following review of literature will guide this study. The literature review will begin with a discussion of developmental mathematics and then follow with a discussion of blended learning, a course format which blends physical class meetings with online work, and its impact on developmental mathematics. The review will continue with the topic of self-regulated learning and how self-regulated learning is related to developmental mathematics and blended learning. Finally, the review will discuss self-regulated learning of developmental mathematics students in blended learning settings.

Developmental Mathematics

Developmental mathematics, also referred to as remedial mathematics, at postsecondary institutions has been described as the non-credit prerequisite courses designed to strengthen the computational skills as well as conceptual understanding of students who are unprepared for college-level mathematics (Bahr, 2008, 2010; Bettinger & Long, 2009; Bonham & Boylan, 2011; Brothen & Wambach, 2004; Donovan & Wheland, 2008; Gerlaugh, Thompson, Boylan, & Davis, 2007; Kinney, 2001; Martorell & McFarlin, 2011; Parsad, Lewis, & Greene, 2003). Oftentimes, institutions offer supplemental services in conjunction with the remediated courses such as free tutoring, academic advising, study skills workshops, and study centers (Breneman, 1998; Gerlaugh et al, 2007; Martorell & McFarlin, 2011). Postsecondary institutions vary in which, if any, developmental mathematics courses are offered and can include courses such as Basic Math, Elementary Algebra, Introductory Algebra, Intermediate Algebra, and Geometry (Bahr, 2008; Breneman, 1998; Donovan & Wheland, 2008; Parsad et al., 2003; Post, Medhanie, Harwell, Norman, Dupuis, Muchlinski, Anderson, & Monson, 2010).

The students enrolled in developmental mathematics courses are a part of a large sector of the student population enrolled in postsecondary institutions (Bettinger & Long, 2009; Bonham & Boylan, 2011; Breneman, 1998; Donovan & Wheland, 2008; Duranczyk & Higbee, 2006; Golfin, Jordan, Hull, & Ruffin, 2005; Martorell & McFarlin, 2011; Parsad et al., 2003). Parsad, Lewis, and Greene (2003) reported that in the fall of 2000, 71% of all US degree-granting postsecondary institutions offered at least one remedial course in mathematics with an average of 2.5 remedial mathematics courses offered by an institution. It was also reported that a larger portion of incoming freshmen enrolled in a developmental mathematics course (22%) than a developmental course in writing (14%) or reading (11%) (Parsad et al., 2003).

There are several reasons why students are unprepared to take college-level mathematics courses which may include not completing relevant courses in high school, not mastering the content in relevant courses, or forgetting the content that they had previously mastered (Boylan, 2009; Kinney, 2001; Levin & Calcagno, 2008). Some students are entering college several years after finishing high school and they may need a developmental mathematics course to ease back into the content and classroom (Attewell, Lavin, Domina, & Levey, 2006; Breneman, 1998; Golfin et al., 2005; Levin & Calcagno, 2008; Zavarella & Ignash, 2009). Other students may not have had formal schooling in the U.S. and they may need remediation (Breneman, 1998).

Regardless of the reason, students who are deemed unprepared for postsecondary mathematics courses are required to take one or more developmental courses. Success in these courses is a prerequisite for subsequent credit-bearing mathematics courses and therefore the completion of the developmental course becomes a gateway for attaining a postsecondary degree for students enrolled in these courses (Bettinger & Long, 2009; Boylan, 2009; Collins, 2010; Duranczyk & Higbee, 2006; Hall & Ponton, 2005; Levin & Calcagno, 2008; Noel-Levitz, 2006; Smittle, 2003).

> Studies show that the failure to pass developmental math courses before progressing to college-level study presents one of the greatest single stumbling blocks to educational persistence and success. Conversely, increasing the percentage of students who pass developmental mathematics courses offers the potential for a marked improvement in postsecondary graduation rates, especially among minority and low-income students." (Noel-Levitz, 2006, p.2)

Placement into a Developmental Mathematics Course

American College Testing (ACT) reports that of the students who took the exam in 2012, 46% scored 22 or higher on the mathematics portion of the exam (ACT, 2012). The benchmark score of 22 on the mathematics portion of the ACT represents "the level of achievement required for students to have a 50% chance of obtaining a B or higher or about 75% chance of obtaining a C or higher in" a credit bearing first-year mathematics college course (ACT, p. 29, 2012). Although there is variance among institutions in their policies in placing students into developmental programs (Akst & Hirsch, 1991; Attewell et al., 2006; Bettinger & Long, 2009; Gerlaugh et al., 2007; Levin & Calcagno, 2008; Martorell & McFarlin, 2011; Parsad et al., 2003), it is common for postsecondary institutions to use the ACT benchmark scores (Boylan, 2009; Donovan & Wheland, 2008; Parsad et al., 2003) to place students in appropriate mathematics courses, suggesting that possibly 54% of incoming freshmen will be placed in a developmental mathematics course (ACT, 2012).

Students can also be placed in developmental courses based on an SAT mathematics score (Gerlaugh et al., 2007; Martorell & McFarlin, 2011), a state's high school exit exam (Martorell & McFarlin, 2011), or in some cases a statewide college readiness exam (Martorell & McFarlin, 2011). For example, as described by Martorell and McFarlin (2011), "Students who have sufficiently high scores on the state's high school exit exam, the SAT or the ACT were exempt from the TASP (Texas Academic Skills Program) testing requirement" (p.7). If a student's ACT or SAT mathematics score places him/her in a mathematics course below the entry-level course, a common procedure at many universities is to give the student another opportunity to complete a cognitive placement exam to identify where in the institution's mathematics sequence the student should be placed (Bettinger & Long, 2009; Boylan, 2009; Donovan & Wheland, 2008; Gerlaugh et al., 2007; James, 2006; Kinney, 2001; Martorell & McFarlin, 2011).

Different placement exams have been used; these include an institution's own placement exam (Gerlaugh et al., 2007; Levin & Calcagno, 2008; Martorell & McFarlin, 2011), the ACCUPLACER published by College Board, the COMPASS (Boylan, 2009; Donovan & Wheland, 2008; Gerlaugh et al., 2007; James, 2006; Levin & Calcagno, 2008), or the ASSET both published by ACT, Inc. (Bettinger & Long, 2009; Boylan, 2009; Donovan & Wheland, 2008; Gerlaugh et al., 2007). The ACCUPLACER and COMPASS exams are computer-adaptive multiple-choice tests while the ASSET exam is a written exam, and all are cognitive instruments intended to measure the individual's skill level in certain domains including mathematics (Boylan, 2009; Gerlaugh et al., 2007). Occasionally, students are placed in a developmental course after successfully completing prior courses in the sequence (Donovan & Wheland, 2008) or through recommendations from an advisor (Martorell & McFarlin, 2011) or a combination of the previously mentioned methods of placement (Ley & Young, 1998).

Using the data (N=1694*)* collected over a period of six semesters at a single university, researchers Donovan and Wheland (2008) observed a strong relationship between the ACT mathematics score and a student's final course grade in Intermediate Algebra and a COMPASS score and a student's final course grade in Intermediate Algebra. They found that students who earned a course grade of A or B had significantly higher mean ACT scores than those students who earned a grade of C or D. Similar results were found in relation to COMPASS scores and students' final course grades. Also, James' (2006) research indicated that the ACCUPLACER *Online Arithmetic* and *Elementary Algebra* scores were good predictors of student success in developmental mathematics.

Some researchers suggest that a score from a single cognitive exam may not be sufficient information (Bonham & Boylan, 2011; Boylan, 2009; Brothen & Wambach, 2004; Fowler & Boylan, 2010) and that institutions should also account for non-cognitive student factors when placing students in developmental courses (Bonham & Boylan, 2011; Boylan, 2009; Fowler & Boylan, 2010). Affective, or non-cognitive, factors such as attitude, confidence, motivation, self-concept, time-management, and personality have been shown to influence academic success (Bonham & Boylan, 2011; Boylan, 2009; Duranczyk & Higbee, 2006; Fowler & Boylan, 2010). Nolting (Boylan, 2009) pointed out Bloom's (1976) notion that predictors of student achievement can be viewed as 50% cognitive ability, 25% instruction, and 25% affective student characteristics. However, few institutions use non-cognitive assessments during the placement process (Gerlaugh et al., 2007).

Prior Research on the Effectiveness of Developmental Mathematics Education

Studies (Bahr, 2008, 2010; Bettinger & Long, 2009; Gerlaugh et al., 2007; Martorell & McFarlin, 2011) have documented the effectiveness of developmental mathematics education using a variety of research methods. Some studies have reported findings in which students who successfully completed the developmental process had positive outcomes such as better long term attainment than those students who were skills deficient and chose not to complete the process (Bahr, 2008, 2010; Bettinger & Long, 2009). Yet some studies found no positive effects of remediation (Levin & Calcagno, 2008; Matorell & McFarlin, 2011).

Gerlaugh, Thompson, Boylan, and Davis (2007), using data collected from 29 different 2-year institutions, reported an 80% average of student retention in a developmental mathematics course throughout the term. Of these students, 68% obtained a C or better for their final course grade. This study also measured student success rate in a college-level mathematics course after successfully completing a developmental mathematics course. It was reported that 58% were successful, receiving a grade of C or higher.

Bahr (2008) conducted a multi-institutional comprehensive study to evaluate the effectiveness of remedial programs in California using extensive data from 85,894 freshmen enrolled in 107 community colleges throughout the state. The researcher tracked the students' mathematics progress for six years and academic attainment for eight years. He reported that students who were successful in remedial mathematics, regardless of their initial mathematics deficiency, experienced similar outcomes of attainment of an associate's degree and transfer to a 4-year college as their college-ready counterparts. Yet he found that 74.5% of the students in remediation did not remediate successfully and of these students, less than 20% completed a degree or transferred to a four-year postsecondary institution. His conclusion was that when remediation works it is extremely effective, but that a substantial number of students enrolled in developmental mathematics were unsuccessful and had less favorable outcomes.

Similar results were reported by Bettinger and Long (2009). They analyzed data gathered by the Ohio Board of Regents of traditional-aged freshmen attending public colleges in Ohio tracked over a period of six years to examine the impact of remediation on college persistence and degree completion. The results of their research reflect a positive impact that remediation has on college outcomes of students who are underprepared for college-level work. They found that students who were placed in remediation had better long term attainment and were more likely to complete a degree than those students who were skills deficient and chose not to complete the process.

On the contrary, some studies did not find positive results of remediation (Levin & Calcagno, 2008; Martorell & McFarlin, 2011). Martorell and McFarlin (2011) gathered data on students in postsecondary institutions across Texas who were placed in remediation based on their TASP scores, the state's placement exam, and followed their movement for seven years. Using administrative data, the researchers found little evidence to support the academic benefits of remediation as their results indicated that "remediation had little effect on eventual degree attainment" (p. 18). Further, they found "no evidence that remediation confers longer run economic benefits in the form of higher earnings" (p.3). Similarly, Levin and Calcagno (2008) conducted a review of literature and concluded that the evidence was not convincing to show that remediation had a positive effect on outcomes such as retention, success in subsequent courses, and grade point average.

Building Student Success in Developmental Mathematics

Many postsecondary institutions are implementing research-based best practices and progressive methods of teaching and learning to strengthen their developmental programs in order to increase student retention (Bonham & Boylan, 2011; Fowler & Boylan, 2010; Goldstein, Burke, Getz, & Kennedy, 2011; Golfin et al., 2005; Hall & Ponton, 2005; Kinney, 2001; Levin & Calcagno, 2008; Zavarella & Ignash, 2009). In particular, research has identified ways to improve student success in developmental mathematics courses (Bonham & Boylan, 2011; Golfin et al., 2005; Hall & Ponton, 2005; Kinney, 2001; Sierpinska, Bobos, & Knipping, 2008; Smittle, 2003; Spradlin & Ackerman, 2010; Wambach, Brothen, & Dickel., 2000; Zavarella & Ignash, 2009). Many of the best practices suggested by researchers have focused on teaching and learning strategies (Bonham & Boylan, 2011; Goldstein et al., 2011; Golfin et al., 2005; Hall & Ponton, 2005; Kinney, 2001; Levin & Calcagno, 2008; Sierpinska et al., 2008; Smittle, 2003; Spradlin & Ackerman, 2010; Wambach et al., 2000), the learning environment (Bonham & Boylan, 2011; Golfin et al., 2005; Hall & Ponton, 2005; Kinney, 2001; Levin & Calcagno, 2008; Sierpinska et al., 2008; Smittle, 2003; Wambach et al., 2000), delivery and content of the course (Bonham & Boylan, 2011; Goldstein et al., 2011; Golfin et al., 2005; Levin & Calcagno, 2008; Zavarella & Ignash, 2009), and structure of the developmental program (Bonham & Boylan, 2011; Duranczyk & Higbee, 2006; Fowler & Boylan, 2010; Golfin et al., 2005; Levin & Calcagno, 2008; Wambach et al., 2000).

Teaching and learning. In traditional lecture courses, where rote memorization and recall of facts and procedures are emphasized, students have viewed mathematics as a static body of knowledge (Ernest, 1988; Hammerman & Goldberg, 2003; Handal, 2003; Thompson, 1984). Levin and Calcagno (2008) argued that “many remedial students face serious attitudinal obstacles that prevent them from learning in this way" (p. 185). Further, they asserted that this style of teaching is the kind most remedial students have likely had exposure to which may play a factor in their weak mathematical understanding. To promote change, studies suggest that teachers utilize a variety of teaching methods to support different learning styles (Goldstein et al., 2011; Golfin et al., 2005; Hall & Ponton, 2005; Levin & Calcagno, 2008; Smittle, 2003; Spradlin & Ackerman, 2010; Wambach et al., 2000). Teaching should be an engaging and exploratory process allowing students to create their own mathematical knowledge (Ernest, 1988; Handal, 2003). Instructors should actively engage students in discussions and activities, and provide opportunities for collaborative work (Golfin et al., 2005; Hall & Ponton, 2005; Levin & Calcagno, 2008; Smittle, 2003; Spradlin & Ackerman, 2010; Wambach et al., 2000).

Wambach and colleagues (2000) recognize that for many developmental students "their lack of ability to provide their own feedback" (p. 9) may be a reason for their weak performance in mathematics. Researchers have recommended that instructors offer students frequent feedback (Goldstein et al., 2011; Kinney, 2001; Sierpinska et al., 2008; Smittle, 2003; Spradlin & Ackerman, 2010; Wambach et al., 2000; Zavarella & Ignash, 2009) so that students are aware of their progress. Feedback should be clear, noting difficulties and suggesting ways to improve comprehension and achievement (Goldstein et al., 2011; Wambach et al., 2000), and timely (Wambach et al., 2000). Communication with students should be clear and consistent about requirements, expectations, and deadlines (Hall & Ponton, 2005; Smittle, 2003).

Researchers have identified independent learners as students who are self-directed and take responsibility for their own learning (Kinney, 2001; Smittle, 2003; Wambach et al., 2000; Zimmerman, 1994, 2002, 2008), often referred to as self-regulated (Kinney, 2001; Wambach et al., 2000; Zimmerman, 1994, 2002, 2008), and that these learners are more likely to have academic success (Lan, 1996; Perels, Dignath, & Schmitz, 2009; Pintrich, 1999; Pintrich & De Groot, 1990; Pintrich & Zusho, 2002). Therefore it is important that instructors help students develop into independent learners (Goldstein et al., 2011; Hall & Ponton, 2005; Kinney, 2001; Levin & Calcagno, 2008; Smittle, 2003; Wambach et al., 2000). Instructors can help cultivate learner independence by helping students set short-term and long-term goals (Smittle, 2003), by having students self-monitor their progress (Wambach et al., 2000), and by requiring students to work outside of class, particularly on challenging problems (Goldstein et al., 2011).

Experiences with positive outcomes have been shown to bolster motivation (Hammerman & Goldberg, 2003; Levin & Calcagno, 2008; Wambach et al., 2000) and self-efficacy (Hall & Ponton, 2005; Hammerman & Goldberg, 2003; Smittle, 2003; Wambach et al., 2000). It has been suggested that instructors create opportunities for success in small increments (Hall & Ponton, 2005) and to "do whatever is necessary to aid students in increasing their perception of actual ability" (p. 28) to improve a student's self-efficacy. To increase motivation, researchers (Hammerman & Goldberg, 2003; Smittle, 2003) suggested that instructors make the material relevant, build upon prior knowledge, and build understanding of the concepts of mathematics rather than mere memorization of a set of rules. Students have acknowledged that having opportunities to control their own learning and being able to work independently enhanced their attitude towards and confidence in doing mathematics (Acelajado, 2011).

Learning environment. The classroom environment plays an important role in the effectiveness of a developmental mathematics course (Kinney, 2001; Wambach et al., 2000) by supporting student success. A smaller class size allows instructors and students to more readily form relationships and allows instructors to offer more frequent and individualized feedback (Smittle, 2003; Wambach et al., 2000). Research indicates that "students with less academic ability may require more structure to help them increase time on task and succeed" (Burlison, Murphy, & Dwyer, 2009, p.1321). Therefore, recommendations include that the learning environment be highly structured (Burlison et al., 2009; Mireles, Offer, Ward, & Dochen, 2011), rigorous, and demanding (Burlison et al., 2009; Hall & Ponton, 2005; Kinney, 2001; Wambach et al., 2000). A demanding environment has been described (Burlison et al., 2009; Kinney, 2001; Wambach et al., 2000) as one which requires regular attendance and completion of assignments, with expectations for students to participate in classroom activities and discussions. The learning environment should be open and connected (Sierpinska et al., 2008; Smittle, 2003) where students are encouraged to work collaboratively and comfortably in sharing their ideas (Smittle, 2003).

Integrating technology into practice helps to transition classrooms from teacher-centered to student-centered (Golfin et al., 2005; Milou, 1999; Monaghan, 2004; Tharp, Fitsimmons, & Ayers, 1997) and helps to deepen students' conceptual understanding of the mathematics (Brown, 2004; Burrill, Allison, Breaux, Kastberg, Leatham, & Sanchez, 2002; Dugdale, 1993; Rider, 2007). The National Council of Teachers of Mathematics (2005) has recommended the integration of technology to connect student knowledge to a variety of contexts as stated in its position paper that, "Technology is an essential tool for teaching and learning mathematics effectively; it extends the mathematics that can be taught and enhances students' learning" (p. 1). Educators should provide opportunities for students to practice using various technologies to develop them into adept users, particularly using technology as a vehicle to solve real-world problems (International Society for Technology in Education [ISTE], 2008). Technology can help to strengthen students' conceptual understanding of mathematics by shifting the focus from computations and towards analysis of realistic and complex problems (Dugdale, 1993;

Yerushalmy & Shternberg, 2001). Yerushalmy and Shternberg (2001) asserted that "technologies eliminate algebraic symbols as the sole channel into mathematical representation and motivate students to experiment with the situation-to analyze and reflect on it-even when it is too complicated for them to approach symbolically" (p. 252).

Course delivery. The use of digital media, such as audio-conferencing, video-conferencing, and online learning platforms, in teaching and learning has become common in postsecondary education (Holmes & Gardner, 2006; Paechter & Maier, 2010; Renes & Strange, 2011). The technology removes physical limitations making it possible for classroom interactions to move beyond a face-to-face meeting at a particular time and in a physical space (Renes & Strange, 2011). Research suggests that a course completed online is as effective as one taught face-to-face (Means, Toyama, Murphy, Bakia, & Jones, 2010; Underwood, 2009) and that a blended course, one that includes aspects of both online learning and face-to-face instruction, shows higher gains in student performance than either type of instruction alone (Means et al., 2010; Underwood, 2009). Researchers have recommended that developmental programs offer students a choice in instructional format (e.g. online, face-to-face, or blended) to help meet students' needs and preferences (Golfin et al., 2005; Zavarella & Ignash, 2009). Zavarella and Ignash (2009) reported that developmental mathematics students who chose, based on personal factors, to enroll in a course with a specific instructional format were more likely to complete the course.

Redesigning an Intermediate Algebra course was shown to have a positive effect on the subsequent mathematics course success (Goldstein et al., 2011). Goldstein, Burke, Getz, and Kennedy (2011) developed and investigated a pilot course which redesigned the structure, content and assessment of the original Intermediate Algebra course at their institution. The key elements of the redesign, “collaborative, problem-based learning along with a capstone project,” (p. 27) were used to make the mathematics more meaningful and connected, to engage students in demanding tasks, and to increase students’ self-efficacy. Using final grades, comparisons between the redesigned and original courses revealed no significant differences in performance or achievement.   Yet, the following semester, for Intermediate Algebra students who continued on and successfully completed College Algebra, the most common subsequent mathematics course, students who were enrolled in the pilot course earned a higher grade, almost a full letter grade, than the students who were enrolled in the original course.

Program structure. Researchers have identified some characteristics of effective developmental programs (Collins, 2010; Duranczyk & Higbee, 2006; Fowler & Boylan, 2010; Golfin et al., 2005; Levin & Calcagno, 2008; Mireles et al., 2011; Zavarella & Ignash, 2009) to help reduce withdrawal and failure rates. Developmental programs which are centrally organized (Collins, 2010) and offer opportunities for students to become connected with the institution (Duranczyk & Higbee, 2006), offer comprehensive learning assistance and support services (Brothen & Wombach, 2004; Fowler & Boylan, 2010; Wambach et al., 2000; Zavarella & Ignash, 2009), and integrate study strategies with the course curriculum (Brothen & Wombach, 2004; Levin & Calcagno, 2008) have been shown to generate increased student success rates. Developmental programs which develop students’ content knowledge as well as basic skills and offer support have better outcomes than those programs that focus solely on content knowledge (Engstrom & Tinto, 2008) and can at least improve students’ “ likelihood of employment and responsible citizenship” (Brothen & Wombach, 2004, p.18).

Developmental programs which encourage students to connect with the institution can help improve students’ satisfaction with the college experience (Duranczyk & Higbee, 2006;

Engstrom & Tinto, 2008). This can be accomplished by having courses that are centrally located and organized rather than being dispersed through various departments. Centrally located courses allow students to gain comfort in their environment and program (Boylan, 2002). Learning communities can also help develop students' sense of community and belonging (Duranczyk & Higbee, 2006; Engstrom & Tinto, 2008; Levin & Calcagno, 2008). Learning communities have been described as small cohorts of students who take the same or similar schedule (Engstrom & Tinto, 2008; Levin & Calcagno, 2008) and are provided with additional supports that "integrate the social and academic sides of college participation" (Levin & Calcagno, 2008, p. 188) such as tutoring, study groups, and interaction with faculty in and out of the classroom. Students have viewed these communities as "safe places to learn" (Engstrom & Tinto, 2008, p. 47). The support and validation they received from faculty and peers helped boost their confidence in their ability to succeed (Engstrom & Tinto, 2008). Engstrom and Tinto's (2008) research included 19 institutions of almost 6,000 under-prepared students who were enrolled in learning community classrooms or traditional classrooms. Comparisons revealed that students in the learning community classes had a higher retention rate than the groups of students in the traditional classes.

Many developmental programs provide additional services (Breneman, 1998; Gerlaugh et al, 2007; Martorell & McFarlin, 2011) such as free tutoring, organized study groups, access to technology, academic advising, study skills workshops, and study centers. These supplemental services in conjunction with the remediated courses allow students to receive additional help in safe environments (Engstrom & Tinto, 2008) and can help students develop basic skills (Brothen & Wombach, 2004). Yet academic assistance is voluntary and only some underprepared students take advantage of these services (Brothen & Wambach, 2004).

Research has shown that more frequent use of study strategies resulted in higher academic performance (Yin, 2007 as cited in Mireles et al., 2011). Developmental programs have done this by directly integrating strategy instruction in the course or through a supplemental course such as supplemental instruction (Levin & Calcagno, 2008; Wadsworth, Husman, Duggan, & Pennington., 2007; Wambach et al., 2000; Wright, Wright, & Lamb, 2002). Researchers Wright, Wright, and Lamb (2002) described Supplemental Instruction (SI) as a form of group tutoring designed to support enrolled students with the content, critical thinking and study skills. The SI leader, typically a paid undergraduate student who has successfully completed the course, attends class, completes assignments, and helps to facilitate classroom activities. The SI leader also leads additional scheduled study groups. SI has been identified as a way to positively impact effectiveness in developmental courses and specifically in developmental mathematics (Wadsworth et al., 2007; Wambach et al., 2000; Wright et al., 2002).

Blended Learning

Many definitions of blended learning have been proposed, but in general it is described as a learning experience which combines physical and virtual environments typically by blending face-to-face interactions with online learning activities (Acelajado, 2011; Allen & Seaman, 2011; Allen, Seaman, & Garrett, 2007; Barnard, Lan, To, Paton, & Lai, 2009; Bluic, Goodyear, & Ellis, 2007; Chen, Lambert, & Guidry, 2010; Dziuban, Hartman, & Moskal, 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Kim & Bonk, 2006; López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011; Lust, Vandewaetere, Ceulemans, Elen, & Clarebout, 2011; Lust, Collazo, Elen, & Clarebout, 2012; Lynch & Dembo, 2004; Means et al., 2010; Paechter & Maier, 2010; Picciano, Seaman, Shea & Swan, 2012; Renes & Strange, 2011; Stacey & Gerbic, 2008; Vaughan, 2007; Wu, Tennyson & Hsia, 2010; Yen & Lee, 2011). Wu, Tennyson, and Hsia

(2010) described blended learning as an integration of classroom teaching with "any form of instructional technology" (p.156). Similarly, the Babson College Survey Research Group defined a blended, or hybrid, course as one "that blends online and face-to-face delivery, and where a substantial proportion of the content is delivered online, sometimes uses online discussions and typically has few face-to-face meetings" (Picciano et al., 2012, p.128). Further, Allen and Seaman (2011) defined a blended learning environment as one where 30 to 80% of the course content is delivered online mixed with more traditional learning experiences, typically in a classroom setting. The online activities are not just added to the current course but rather the blended or hybrid course is thoughtfully redesigned to combine the best features of both the online and classroom environments (Dziuban et al., 2004; Garrison & Kanuka, 2004; Vaughan, 2007).

Blended learning is becoming an emergent trend in higher education (Allen et al., 2007; Barnard et al., 2009; Bluic et al., 2007; Chen et al., 2010; Dziuban et al., 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Lust et al., 2011; Lust et al. 2012; Lynch & Dembo, 2004; Means et al., 2010; Stacey & Gerbic, 2008; Vaughn, 2007; Wu et al., 2010). Most students enter college with the knowledge and skills to use digital technologies and expect to use these technologies in their learning experiences to share and access knowledge (Garrison & Kanuka, 2004; Holmes & Gardner, 2006). In response to this demand and the changing needs of students, many institutions of higher education are integrating technology into the college experience (Barnard et al., 2009; Chen et al., 2010; Dziuban et al., 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; López-Pérez et al., 2011). Using data from the 2008 National Survey of Student Engagement (NSSE), Chen, Lambert, and Guidry (2010) reported that 69.6% of the 17,818 students who responded to the survey were enrolled in at least one hybrid course during the 2008 academic year. Allen, Seaman, and Garrett (2007) reported that 79% of public institutions of higher education offered at least one blended course.

While the concept of blended learning can seem simple, it can also be a complex endeavor (Bluic et al., 2007; Dziuban et al., 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Lust et al., 2011; Lust et al. 2012; Stacey & Gerbic, 2008; Vaughn, 2007). Garrison and Kanuka (2004) acknowledged the "complexity of its implementation with the challenges of virtually limitless design possibilities and applicability to so many contexts" (p. 96). Many elements of blended learning environments can vary including the amount as well as types of digital resources, or tools, which are used and for what purposes (Dziuban et al., 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Lust et al., 2011; Lust et al. 2012; Stacey & Gerbic, 2008; Vaughn, 2007). The digital technologies range from providing access to resources used to gain information and improve understanding to engaging individuals in complex interactions with other learners (Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Holmes & Gardner, 2006; Lust et al., 2011; Lust et al. 2012; Vaughn, 2007). These technologies include but are not limited to communication tools such as email and Skype, video communications, online discussions, role playing games, virtual learning environments, simulations, and learning management systems and are used formally and informally to gather information and to "support, create and deliver an educational experience" (Holmes & Gardner, 2006, p. 10).

The online learning environment is often referred to as computer-based learning environments (CBLE) (Azevedo, 2007; Winters, Greene, & Costich, 2008). "The computer technology can afford several different representations of information including text, diagrams, and graphs, among others" (Winters et al., 2008, p.430). A multimedia learning environment is a CBLE that uses multiple representations of information, a hypermedia learning environment is one that provides links between different representations of information, and a simulation or microworld is a CBLE that allows for direct manipulation of representations (Winters et al., 2008).

Ellis, Ginns, and Piggott (2009) identified four different dimensions of the online context of a blended course: *e-teaching, design, workload,* and *interactivity*. In regards to their research, they described *e-teaching* as key teaching strategies in an e-learning environment initiated by the instructor which includes communication with students in online discussions, providing individual feedback to students in regards to their work, and relaying important course information. They considered the *design* of the course to refer to connections between the face-to-face and online environments so that "the design of the online materials and activities help the students to learn and understand the whole experience" (p. 306). *Workload* was depicted as the amount of online work required supplemental to the in-class work. Finally, *interactivity* was considered to be the interaction between students. Evidence from this study suggested that students with a generally negative opinion of the quality of these four factors (e-teaching, design, workload, and interactivity) typically had a surface approach to learning and performed comparatively lower on the online portion of the course than students who rated these features higher.

Interactions in a Blended Learning Environment

Adding to the complexity of the blended learning environment, a blended, or hybrid, course provides various "opportunities for students to interact with their peers, faculty, and content, inside and outside of the classroom" (Vaughan, 2007, p. 81). Ellis, Ginns, and Piggott (2009) identified four different interactions that occur in a blended learning environment, both in an online environment as well as a classroom setting: between learner and content, learner and instructor, learner and learner, and learner and interface. Likewise, Paechter and Maier (2010) identified these same interactions and, with data collected in their research, were able to identify students' preferences of setting, online or face-to-face, which they felt could most effectively meet learning outcomes. In regards to learner and content, they reported that students in their study preferred face-to-face meetings for the acquisition of knowledge and skills, both conceptual and methodological, but preferred online learning to practice these skills. For the interactions between learner and instructor and learner and learner, the researchers reported similarities in students' preferences which were that students preferred face-to-face contact with their instructors and peers when "ideas are exchanged and knowledge is developed" (p. 296) and to develop interpersonal relationships. Students preferred the online setting to communicate with other learners and instructors for quick exchanges of information as well as timely feedback from the instructor. Finally, in regards to the interaction between learner and interface, the researchers reported that students valued the flexibility of the online environment both in when and where they could work as well as having opportunities to apply their knowledge and skills independently in online exercises.

Nature of Students' Technology Use

Studies have documented the diversity of technology use, or tool use, of students in a blended course (Lust et al., 2011; Lust et al., 2012; Yen & Lee, 2011). In Yen and Lee's (2011) experiment, the undergraduate blended course included lecture, Web-based scenarios, and digital technologies in the form of PDAs (personal digital assistant), electronic notebook, and accompanying software. Using a combination of cluster analysis and content analysis of collected student data, the researchers were able to categorize students into three groups according to their use of the in-class and online resources: hybrid-oriented, technology-oriented, and efficiency-oriented. The hybrid-oriented group was described as attending to all components of the course in equal degrees, working passively step-by-step through problems, and showing lower levels of achievement. The technology-oriented group was described as attending to the web and mobile technologies more frequently, demonstrating implementation but less evaluation and reflection, and showing varying degrees of achievement. Finally, the efficiency-oriented group was described as attending to all components of the course as was intended and although logging in the least amount of learning time, demonstrated deeper thinking and self-reflection, and showed higher levels of achievement.

Lust, Vandewaetere, Ceulemans, Elen, and Clarebout (2011) further investigated students' tool use, both face-to-face and with online tools, in a blended undergraduate course in the Educational Sciences program at a Flemish university. Face-to-face resources included organized learning support sessions which were voluntary for students to attend. The online support resources, through Blackboard, were resources that were linked to the face-to-face context such as general course information which included announcements and the syllabus, basic course materials such as web lectures and assignments, and supplementary materials such as scaffolds and other digital tools not linked to the face-to-face context which included communication tools such as discussion boards, external links, and opportunities to apply knowledge through quizzes.

Lust et al. (2011) identified usage patterns of three groups: no-users, incoherent users, and intensive users. Students in the no-user group did not attend any of the learning sessions and used the online tools at a minimum (low frequency). Students in the incoherent user group only attended the learning sessions and used some face-to-face context resources, namely the material outlines and online scaffold tools. Finally, students in the intensive user group attended the learning sessions and used the online tools with a high frequency. These researchers also identified that within the intensive user group, a variability of activeness in using different tools was evident. In regards to course achievement, this research found a significant difference in course grade between students in the no-user group and both the incoherent and intensive user groups. Though students in the intensive user group performed the best on all performance measures, there was not a significant difference between the incoherent users and the intensive users.

Similarly, Lust, Collazo, Elen, and Clarebout (2012) conducted a comprehensive review of the literature to examine Content Management Systems (CMSs), such as BlackBoard, WebCT and Moodle, and students' use of the online tools that were available. Thirty-four studies were included in their review. Findings indicated that CMSs offer a variety of tools to students in the online environment and that students managed the tools differently and oftentimes inadequately. The online tools were classified into types. Information tools were described as those that were linked to course requirements such as outlines. Knowledge modeling tools, communication tools, and scaffolding tools were considered exploratory tools used for deepening understanding such as discussion boards. Results indicated that students used the information tools more frequently than the other kinds of tools.

Benefits of Blended Learning Environments

Research suggests that a course completed online is as effective as one taught face-to-face (Dziuban et al., 2004; López-Pérez et al., 2011; Means et al., 2010; Underwood, 2009; Vaughan, 2007) and that a blended course shows higher gains in student performance than either type of instruction alone (López-Pérez et al., 2011; Means et al., 2010; Underwood, 2009; Vaughan, 2007). López-Pérez, Pérez-López, and Rodríguez-Ariza (2011) reported that during a three year period after a general accounting course became blended, the student dropout rate decreased and the pass rate increased each year. Research has shown that classroom interaction is an important element of a blended learning environment (Kauffman, Zhao, & Yang, 2011; López-Pérez et al., 2011; Yen & Lee, 2011) and that students prefer using digital technologies to complement rather than replace content delivered in the classroom setting (López-Pérez et al., 2011; Paechter & Maier, 2010).

Many features contribute to the increased adoption of a blended learning approach, particularly in institutions of higher education, as the Internet is able to cost effectively meet the needs of a large group of students and enhance their educational experience by extending learning time by offering opportunities for meaningful learning to take place outside of class (Barnard et al., 2009; Dziuban et al., 2004; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Picciano et al., 2012; Vaughan, 2007). The technology removes physical limitations making it possible for learning to take place without restrictions to time or place (Barnard et al., 2009; Garrison & Kanuka, 2004; Ginns & Ellis, 2007; Holmes & Gardner, 2006; Picciano et al., 2012; Renes & Strange, 2011; Vaughan, 2007) and offers interactive opportunities between students and their peers, their instructor, and the interface outside of the classroom (Dziuban et al., 2004; Garrison & Kanuka, 2004; Holmes & Gardner, 2006; Picciano et al., 2012; Renes & Strange, 2011; Vaughan, 2007). Garrison and Kanuka (2004) pointed out that blended learning can effectively facilitate "a community of inquiry" (p. 97). These features of blended learning, increase in learning time, flexibility of time and space, and increased interactions in class and online, have been shown to increase student motivation, engagement, satisfaction (Chen et al., 2010; López-Pérez, et al., 2011) and information literacy (Dziuban et al., 2004). Blended learning has also been shown to strengthen student understanding and increase student achievement (López-Pérez, et al., 2011).

Students indicated that the flexibility in both pace and location in completing online assignments and activities (Vaughn, 2007), and the immediate feedback that was available (Paechter & Maieer, 2010) were positive aspects. Some students believed that a blended learning course allowed them to be more active in the learning process (Dziuban et al., 2004) and provided a variety of communication opportunities (Paechter & Maier, 2010). Instructors indicated that students were more engaged in the learning process of a blended course including improved interactions, both in quality and quantity, in the classroom (Vaughn, 2007). Instructors also felt more connected with the students and viewed the flexibility of time and of the use of a variety of online resources in a blended course, in both teaching and learning, as benefits (Vaughn, 2007).

Challenges Associated with Blended Learning Environments

Although research has identified many educational benefits associated with integrating digital technologies in a course, some challenges have also been identified with the blended learning experience (Garrison & Kanuka, 2004; Lust et al., 2011; Lust et al., 2012; Paechter & Maier, 2010; Stacey & Gerbic, 2008; Vaughn, 2007; Yen & Lee, 2011). Researchers have reported that there is a complexity in dealing with two environments for both students and instructors (Stacey & Gerbic, 2008) and oftentimes both groups lacked adequate support (Vaughn, 2007).

Some students had difficulty managing their time spent on online activities (Paechter & Maier, 2010; Vaughn, 2007), maintaining motivation, and learning to use the technology (Vaughn, 2007). Online learning environments offer rich toolsets to support student learning, yet it is up to the individual learner to decide which tools to use and in which manner (Winters et al., 2008). Researchers conjectured that some students may not be good judges of their own learning or the functionalities of the various tools (Lust et al., 2011; Lust et al., 2012; Yen & Lee, 2011; Winters et al., 2008). Research also indicates not all students used the technology nor profited from the technology in the same ways (Lust et al., 2011; Lust et al., 2012; Yen & Lee, 2011) and many students failed to take full advantage of available tools (Winters et al., 2008). Students are required to be active learners when working online and some students perceived this accountability as challenging (Vaughn, 2007).

A primary challenge for instructors to implement effective blended learning was the increase in time commitment needed to redesign a course (Garrison & Kanuka, 2004; Vaughan, 2007) and to learn new technical and pedagogical skills (Garrison & Kanuka, 2004; Vaughn, 2007). Further, instructors emphasized a need for support to redesign a course and to use the technology (Vaughan, 2007). Instructors also reported risk factors they perceived when teaching a blended course which included an inability to maintain control of the course structure and poorer student evaluations (Vaughan, 2007).

Building Student Success in Blended Learning Environments

Researchers have identified some factors that could potentially bolster student success in blended learning environments (Chen et al., 2010; Dziuban et al., 2004; Ellis et al., 2009; Garrison & Kanuka, 2004; Spradlin & Ackerman, 2010; Stacey & Gerbic, 2008; Wu et al., 2010). Instructors should be given opportunities to experiment with the technology (Acelajado, 2011; Spradlin & Ackerman, 2010) and adequate support in using the technology (Chen et al., 2010; Dziuban et al., 2004; Garrison & Kanuka, 2004; Spradlin & Ackerman, 2010; Wu et al., 2010). Instruction must specifically attend to the technology and available tools and instructors must support students' use of these (Lust et al., 2012; Spradlin & Ackerman, 2010). Instructors should be mindful of the design of activities and resources which help students go beyond surface learning (Chen et al., 2010; Dziuban et al., 2004; Ellis et al., 2009; Spradlin & Ackerman, 2010), clearly communicate to students the nature, purpose, and benefits of online assignments and activities (Chen et al., 2010; Ellis et al., 2009; Wu et al., 2010; Zavarella & Ignash, 2009) and make students aware of all resources which are available to them (Chen et al., 2010; Zavarella & Ignash, 2009).

Instruction should offer opportunities for self-regulated learning (Means et al., 2010; Paechter & Maier, 2010) specifically "to incorporate mechanisms that promote student reflection on their level of understanding" (Means et al., 2010, p.48), and offer frequent feedback on student work (Ellis et al., 2009; Paechter & Maier, 2010) to enhance the student learning experience. Further, instructors should use teaching strategies which are learner-centered (Dziuban et al., 2004; Ginns & Ellis, 2007) and which facilitate interactions both in the classroom and the online setting (Dziuban et al., 2004; Ginns & Ellis, 2007; Paechter & Maier, 2010; Wu et al., 2010) and convey the value of those interactions (Dziuban et al., 2004; Wu et al., 2010).

Research has also identified steps students can take to bolster their success in blended learning environments. Students need to understand the structure of the blended course and have an understanding of necessary skills that are needed to succeed in a blended learning environment (Garrison & Kanuka, 2004). The online environment in a blended learning experience offers learners autonomy and requires students to take more responsibility in their learning and develop necessary time management (Stacey & Gerbic, 2008; Vaughan, 2007; Zavarella & Ignash, 2009). Students need support in how to use and access the technology

(Garrison & Kanuka, 2004) and must learn to use available tools adequately (Lust et al., 2012). Finally, students should be encouraged to reflect on their work and modify learning strategies if and when necessary (Chen et al., 2010; Means et al., 2010).

Developmental Mathematics and the Blended Learning Context

Little research has been done on blended learning in developmental mathematics (Acelajado, 2011; Ashby, Sadera, & McNary, 2011; Spradlin & Ackerman, 2010) . However, existing research indicates mixed results regarding the effectiveness of a blended learning environment in developmental mathematics. Acelajado (2011) and Ashby, Sadera, and McNary (2011) examined developmental mathematics student achievement in different learning environments and found statistically significant differences in mean achievement scores. The results of the studies were contradictory as Acelajado (2011) found the blended learning environment favorable, Ashby, Sadera, and McNary (2011) found the face-to-face learning environment favorable, and Spradlin and Ackerman (2010) observed no difference in achievement between the two learning environments.

Acelajado (2011) investigated levels of student success in a bridging program, comparable to a developmental mathematics course, offered in two different learning environments: face-to-face and blended. The researcher used a pretest/posttest repeated measures cross over design with two groups alternating experience with a blended learning format and a traditional face-to-face learning format after five weeks. Students also completed a perceptions inventory related to the use of blended learning. Findings indicated that there was a significant difference in mean achievement scores between the two groups supporting the blended learning environment. Further, students in general responded favorably to the blended learning environment and indicated that they appreciated a variety of learning opportunities and a chance to be more independent in their studies.

Ashby, Sadera, and McNary (2011) investigated levels of student success in a developmental mathematics course offered in three different learning environments: face-to-face, online, and blended. They collected data over the course of a semester from quantitative instruments (unit exams and a standardized Intermediate Algebra Competency Exam) and attrition rates. The researchers concluded from their findings that there were significant mean differences in several measures of student achievement among the three groups. They reported that based on final course average including data from students who had withdrawn, students in the face-to-face environment had a higher achievement mean (68.1%) and lower attrition rate (7%) than those in the online (63.9%, 24%) and blended (54.5%, 30%) environments. Their rationale for using results before taking attrition into account was that course completion is also an important factor to consider in developmental courses. These results are contradictory to the findings of others that report students in a blended course show higher gains in achievement than either solely face-to-face or online courses (Means et al., 2010; Underwood, 2009; Vaughan, 2007). The researchers explained that their conflicting findings might be due to population differences between developmental mathematics students and traditional university students and also that prior research reported results which excluded data from students who had withdrawn from the course. They also calculated mean scores taking attrition into account. When examining the data of only students who completed the course, results indicated different achievement rates for online (78.1%), blended (73.1%), and face-to-face (71.6%) learning environments.

Spradlin and Ackerman's (2010) study compared academic performance between developmental mathematics, Intermediate Algebra, students enrolled in either a course with a traditional or a blended learning structure. Both groups received the same in-class instruction through lecture. The difference existed in what occurred outside of class; the control group worked from a textbook and turned in written homework whereas the experimental group used a computer learning system as an added resource and completed assignments online. The researchers used a nonrandomized control group pretest-posttest design over the course of a semester. Quantitative instruments included a pretest which consisted of five questions taken from the final exam and a posttest which was the final exam. Findings indicated that there were no statistically significant differences in posttest scores between the two groups suggesting that developmental students work equally well in either environment.

Self-regulated Learning

For over two decades educational researchers have sought to understand the process and effects of self-regulated learning as a way to explain learning effectiveness (Elliott, Hufton, Illushin, & Willis, 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008). Self-regulated learning (SRL) is described as an active process of learning comprised of metacognitive, motivational and behavioral constructs (Elliott et al., 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008). Self-regulated learners, influenced by their beliefs, orient their behaviors and adjust their efforts to accomplish goals that they have set (Elliott et al., 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008), transforming "their mental abilities into academic skills" (Zimmerman 2002, p. 65). These learners are described as confident and strategic (Zimmerman, 1994), with an ability to self-start and persist in completing tasks (Cervone, Jiwani, & Wood, 1991; Zimmerman, 1994). They are self-evaluative

(Zimmerman, 1994, 2002), able to seek help if needed (Newman, 2002; Zimmerman, 1994), and modify their environment to accomplish tasks (Zimmerman, 1994, 2002).

Self-regulated learning is not a skill that an individual possesses but rather the ability to select, use, evaluate and modify strategies flexibly to accomplish specific learning tasks (Zimmerman, 2002). Zimmerman (2002) has identified key self-regulatory processes to include:

> a) setting proximal *goals* for oneself, (b) adopting powerful *strategies* for attaining the goals, (c) *monitoring* one's performance selectively for signs of progress, (d) *restructuring* one's physical and social context to make it compatible with one's goals, (e) managing one's *time use* efficiently, (f) *self-evaluating* one's methods, (g) attributing causation to results, and (h) *adapting* future methods. (p.66)

Further, self-efficacy and intrinsic interest influence choices that self-regulated learners make in regards to actions, effort, and perseverance in completing tasks (Cervone et al., 1991; Pajares, 2002; Zimmerman, 2002).

The Self-regulatory Process

Though there are many theoretical models of academic self-regulation (Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 2002), all describe the act of self-regulating as a cyclical process through different phases, relating prior learning to current and future learning (Schmitz & Perels, 2011). Zimmerman's (2002) theoretical model presented self-regulated learning (SRL) as a recursive learning process that occurs in three cyclical phases: forethought, performance, and self-reflection.

The forethought phase occurs before a learning activity when the learner sets goals and develops a plan of action to accomplish a task (Perels et al., 2009; Zimmerman, 2002). During this planning phase, prior knowledge and skills help the learner to analyze the task demands in interpreting the assignment and identifying performance criteria (Butler, 2002; Perels et al., 2009; Pintrich, 1999; Zimmerman 2002). Subsequently, a plan is developed and strategies are chosen in order to meet objectives (Butler, 2002; Perels et al., 2009; Zimmerman 2002). These decisions, such as which strategies to use or when and where to complete the task, are influenced by prior experiences, personal attitude towards the task, self-motivation, as well as the learner's self-efficacy (Butler, 2002; Perels et al., 2009; Pintrich, 1999; Zimmerman 2002).

The performance phase occurs during the learning activity where the developed plan is implemented (Butler, 2002; Perels et al., 2009; Zimmerman, 2002). Important aspects of this phase are actual time dedicated to the task (Perels et al., 2009), employment of internal resources, such as concentration and attention focusing (Perels et al., 2009; Zimmerman 2002), effort and perseverance (Cervone et al. 1991; Perels et al., 2009), ability to restructure the learning environment (Pintrich, 1999; Zimmerman, 2002), and employment of strategies both cognitive and metacognitive (Butler, 2002; Perels et al., 2009; Zimmerman, 2002). Cognitive strategies include repetition, rehearsal, elaboration, and organization (Pintrich, 1999) and metacognitive strategies include planning, monitoring, and regulation (Perels et al., 2009; Pintrich, 1999). Students who had higher levels of self-efficacy "were more likely to be cognitively involved in trying to learn the material" (Pintrich, 1999, p. 465) and research has documented a positive relation between self-efficacy and certain self-regulatory attributes such as effort and persistence (Cervone et al., 1991; Zimmerman, 2002), and strategies such as planning, monitoring, and regulating (Pintrich, 1999).

The self-reflection phase begins after the task is completed. During this phase, the learner evaluates the outcomes of his/her efforts in completing the task (Perels et al., 2009; Pintrich, 1999; Zimmerman, 2002) based on some standard "such as one's prior performance, another person's performance, or an absolute standard of performance" (Zimmerman, 2002, p. 68). The learner also forms judgments about strategies that were used as well as effort made (Cervone et al. 1991; Perels et al., 2009; Pintrich, 1999; Zimmerman, 2002). It is important for the success of this process that judgments which are made are attributed to internal factors such as effort (Perels et al., 2009) so that the individual takes responsibility and senses self-control over final outcomes (Perels et al., 2009). Judgments made during this phase of the effectiveness of strategies used in meeting goals forces the learner to possibly modify strategies for future learning and/or to use different strategies in future tasks (Cervone et al. 1991; Perels et al., 2009).

Measuring Self-regulated Learning

A number of instruments have been developed which have been shown to reliably measure students' levels of self-regulated learning (Zimmerman, 2008) including the Learning and Study Strategies Inventory (LASSI) (Weinstein, Schulte, & Palmer, 1987), the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993), and the Self-Regulated Learning Interview Scale (SRLIS) (Zimmerman & Martinez-Pons, 1986, 1988). These instruments focus on identifying students' levels of metacognition (or skill), motivation (or will), and behavior (or self-regulation) (Zimmerman, 2008) which are all constructs of self-regulated learning.

The Learning and Study Strategies Inventory (LASSI) (Weinstein et al., 1987) is an 80 Likert-item questionnaire that uses a scale of 1 – 5 for responses ranging from "not at all typical of me" to "very much typical of me". It has been used in postsecondary education to assess students' perceptions of their skill, will, and self-regulation (Mireles et al., 2011; Wadsworth et al., 2007). It focuses "on both covert and overt thoughts, behaviors, attitudes, motivations and beliefs that relate to successful learning in postsecondary educational and training settings that can be altered through educational interventions" (Weinstein & Palmer, 2002, as cited in Mireles et al., 2011, p. 22). The LASSI provides a diagnostic measure of a student's learning strategies indicating strengths and weaknesses compared to a standardized norm (Mireles et al., 2011; Wadsworth et al., 2007). There are 10 subscale constructs: concentration, selecting main ideas, information processing, motivation, attitude, anxiety, time management, study aids, self-testing, and testing strategies. The last four constructs, time management, study aids, self-testing, and testing strategies are considered to be measures of self-regulation strategy use.

The Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993) is an 81 Likert-item questionnaire that uses a scale of 1 – 7 for responses ranging from "not at all true of me" to "very true of me". The MSLQ is intended to measure students' motivation and self-regulated learning in classroom settings which are content specific rather than students' global motivation and self-regulated learning in general (Pintrich, 1999). It consists of two major sections, Motivation and Learning Strategies, which include 15 subscale constructs. The motivation subscales include: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning performance, and test anxiety. The learning strategies subscales include: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment management, effort regulation, peer learning, and help-seeking. The questionnaire subscales can be used jointly or singly (Duncan & McKeachie, 2005).

Another instrument used to measure self-regulation is the Self-Regulated Learning Interview Scale (SRLIS) (Zimmerman & Martinez-Pons, 1986, 1988). It is a structured interview consisting of six different problem contexts that are presented to students who are asked to respond to subsequent open-ended questions. The interviewers use a script which they read verbatim to students, record students' responses verbatim, and then code the responses. The open-ended questions are designed to draw out the self regulated learning behaviors which students engage in to complete the tasks.

Self-regulated Learning and Academic Achievement

A substantial body of research indicates that students who are self-regulated are more likely to have academic success (Lan, 1996; Perels et al., 2009; Pintrich, 1999; Pintrich & De Groot, 1990; Pintrich & Zusho, 2002). Correlation studies have identified variables related to self-regulated learning indicating a positive correlation between (a) self-regulation and academic achievement (Lan, 1996; Perels et al., 2009; Pintrich, 1999; Pintrich & De Groot, 1990; Pintrich & Zusho, 2002), (b) self-regulation and self-efficacy (Cervone et al., 1991; Hall & Ponton, 2005; Pintrich, 1999), and (c) self-regulation and motivational beliefs (Pintrich, 1999; Pintrich & De Groot, 1990). In experimental studies (Kaufman et al., 2011; Lan, 1996; Ley & Young, 1998, 2001; Perels et al., 2009; Pintrich, 1999; Schmitz & Perels, 2011; Zimmerman, 2008), investigators have tested specific intervention effects and identified relationships between self-regulated learning and other learning variables. Self-monitoring (Kaufman et al., 2011; Ley & Young, 1998, 2001), organizing (Ley & Young, 2001), self-evaluation (Ley & Young, 2001), and goal setting (Pintrich, 1999; Zimmerman, 2008) are a few strategies that have been found to increase student achievement.

Schmitz and Perels (2011), sampling 195 8^{th} grade math students in Germany, conducted research on the use of daily diaries as a self-monitoring tool to see if self-regulation was enhanced. For seven weeks, students in the experimental group completed daily diaries composed of questions regarding self-efficacy and some main components of self-regulation:

motivation and planning (forethought phase); resource-management strategies and volition (performance phase); and self-reflection and goal attainment (self-reflection phase). If a student in the experimental group was working on homework that day, s/he answered a group of questions before attempting the homework which dealt with the forethought phase and self-efficacy. Other questions were answered after completing the homework assignment relating to the performance and reflection phases of self-regulation. If a student in the experimental group was not working on homework that day, s/he completed a set of questions which related to her/his current mood and reason for not learning that day.

The data collected from the daily diaries were used to measure changes in the use of self-regulated strategies and levels of self-efficacy across a time period of 49 days (Schmitz & Perels, 2011). The researchers collected pre-test and post-test scores from all students to measure changes in both self-regulation and math achievement. The results indicated that there were differences between the control and experimental groups in levels of self-regulation, self-efficacy, and math scores with improved scores from the experimental group. Similarly, there were improved levels of self-regulation and self-efficacy for the experimental group during the intervention period and the researchers noted from the data collected that the time-series design was “more sensitive to detect changes than the pre-post comparison” (p. 268). The results suggested that the self-monitoring intervention enhanced self-regulated learning for this group of students.

Lan (1996) examined the effects of self-monitoring on academic performance and self-regulated learning strategies in a graduate level statistics course. He assigned 72 students to one of three groups: a self-monitoring group, an instructor-monitoring group, or a control group. Students in the self-monitoring group completed a self-monitoring protocol during the semester which included a list of 75 statistical concepts included in the course. Specific for each concept, students recorded how much time and how often they used the text, how long it took to complete the assignment, how much time they participated in voluntary discussions outside of class, time spent on additional experiences such as being involved in a tutor group or having an individual tutor, and finally to rate their self-efficacy, on a scale of 1-10, of completing a problem related to the topic. Students in the instructor-monitoring group completed an instructor-monitoring protocol during the semester which included a list of 75 statistical concepts included in the course. Specific for each concept, students evaluated the instructor's activities by rating the following on a scale of 1-10: pace, sufficient amount of examples included in the lesson, enough time allowed for students' questions, and sufficient number of assignments. Students in the control group had no treatment.

Lan (1996) used mean scores from four exams as well as final course grade and composite scores as well as individual items on a self-regulated learning strategies instrument and examined the relationships. He reported that the self-monitoring group had higher scores for each exam and average of exams and used more self-regulated learning strategies than either of the other groups. When students in the self-monitoring group were engaged in the process of self-monitoring, "the frequency with which they used other self-regulated strategies, such as self-evaluation, environmental structuring, rehearsal and memorization, and reviewing previous tests and assignments for testing, also increased" (p. 112).

Research has specifically investigated the differences between developmental students and regular admission students and results suggested that these groups of students may differ "in the way they plan, organize, monitor, evaluate, and even think about the learning process" (Ley & Young, 1998, p.47). These findings imply that developmental students are less self-regulated than their college-ready counterparts. Ley and Young (1998) interviewed developmental and regular admission students using the Self-Regulated Learning Interview Scale (SRLIS) (Zimmerman & Martinez-Pons, 1986, 1988) with very few modifications. Subjects individually participated in the interview. Six learning scenarios were described and open-ended questions asked each student to describe strategies he or she would hypothetically use. The open-ended questions required students to generate their own strategies rather than rating predefined strategies. Findings indicated that compared to regular admission students, developmental students used less variety of self-regulated strategies, and used strategies less frequently and less consistently. Further, the researchers reported that with this sample, self-evaluation had the strongest relationship to self-regulation and goal setting had the weakest relationship.

Researchers Burlison, Murphy, and Dwyer (2009) examined the relationship between motivation, self-regulation, and academic performance. The study used MSLQ and ACT scores from a sample of college psychology students to identify subscale predictors of achievement. They reported that for the high (ACT score > 22) and mid range (20 ≤ ACT score ≤ 22) achievers, Self-efficacy and Time and Study Environment subscale scores were significant predictors of achievement but for low (ACT score < 20) achievers, only the Time and Study Environment subscale score was a significant predictor of achievement.

Enhancing Self-regulated Learning

"Self-regulated learning is neither easy nor automatic" (Pintrich, 1999, p. 467). As described, it is a multidimensional process, requiring the use of several strategies, cognitive as well as metacognitive, which can be demanding (Pintrich, 1999; Pintrich & Zusho, 2002; Zimmerman, 1994). Research suggests that self-regulated learning is not an ability but a process that can be taught (Perels et al., 2009; Zimmerman, 2002) yet educating students about self-regulated learning and training them to use strategies is rarely included in instruction (Perels et al., 2009; Zimmerman, 2002); often times the focus of instruction is on what to learn and less on how to learn (Perels et al., 2009). Further, Pintrich (1999) maintained that developing these strategies and learning to use them appropriately can be difficult for students, thus instruction and scaffolding are necessary.

Research has identified ways to enhance students' self-regulated learning (Ley & Young, 2001; Perels et al., 2009). Recommendations have focused on aspects of teaching and learning (Perels et al., 2009), learning environments, specific strategies such as self-monitoring, and the use of instructional models (Butler, 2002).

Teaching and learning. Research has recommended that training in the use of self-regulated strategies should be integrated into content-specific instruction to strengthen the direct transfer of the use of self-regulated strategies to specific course tasks (Butler, 2002; Ley & Young, 2001; Perels et al., 2009; Pintrich, 1999; Pintrich & De Groot, 1990). Specifically, Ley and Young (1998) recommended training developmental students in using self-regulated strategies to help them become independent learners. The instructor should explain what the specific strategy is, how to apply the strategy, as well as when the strategy should be used (Pintrich & De Groot, 1990; Schmitz & Perels, 2011). It is also important for the instructor to explain how a strategy can benefit student learning and understanding (Schmitz & Perels, 2011). For example, Schmitz and Perels (2011) suggested that one should explain to students how to self-monitor and why it should be done so that students will understand the possible benefits of the procedure.

Self-regulated capabilities increase as a student gains experience and expertise in doing a task (Butler, 2002; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 2002). Yet researchers have cautioned that self-regulated learning strategies should not be applied formally for too lengthy a time as students may become bored with the procedure (Schmitz & Perels, 2011). To be truly self-regulated, the processes and strategies of self-regulation should become automated (Schmitz & Perels, 2011).

Research has suggested that teachers encourage students to set specific goals (Zimmerman, 2002). In the presence of well-defined goals, positive self-evaluations paired with high levels of self-efficacy, can bolster motivation and subsequently performance (Cervone et al., 1991; Pajares, 2002; Pintrich, 1999). Motivational beliefs have been shown to support and sustain students' use of self-regulatory strategies when learning (Cervone et al. 1991; Newman, 2002; Pintrich, 1999; Pintrich & De Groot, 1990). Therefore, to increase motivation, research has suggested (Cervone et al. 1991; Newman, 2002; Pintrich, 1999; Pintrich & De Groot, 1990) that students should be encouraged to adopt a mastery goal orientation rather than perform tasks based on extrinsic goals and that tasks should be viewed by students as interesting, important, and useful.

Ley and Young (1998) suggested that instructors should informally assess students' level of self-regulation and develop individualized plans to improve self-regulation. The researchers offered specific ways to encourage self-regulation: improving academic time management by offering a printed schedule to study for a future test; encouraging help-seeking by reminding students of when and where they can receive additional help outside of class; increasing self-monitoring skills by prompting students "to observe and record whether or not they have completed interim activities required to produce a more complex assignment" (p. 98); promoting self-evaluation by requiring students to correct exam questions or by suggesting ways to improve responses to graded homework or exam questions.

Learning environment. Learning environments that encourage and support students to use self-regulated learning strategies, promote learning goals, and establish patterns of open discourse, can increase learner motivation to effectively perform tasks (Perels et al., 2009; Pintrich 1999). Classroom goals that emphasize learning over performance can encourage students to seek help (Newman, 2002), a self-regulatory strategy. "In this environment, students truly interested in understanding ask the teacher for task-related information that helps resolve difficulties" (Newman, 2002, p. 135).

Research (Burlison et al., 2009; Wambach et al., 2000) has suggested that lower performing students would benefit from more structured classroom environments that require frequent interactions and assessments and encourage more time-on-task activities. Wambach and colleagues (2000) asserted that classroom environments which are demanding and responsive encourage students to develop self-regulated learning. The researchers described demanding classes as ones which required students to meet high expectations for student work and behavior by completing assignments on time, actively engaging in class, demonstrating competence, and following rules. They described responsive classes where students were given timely, useful, and frequent feedback. "Feedback should identify what the student knows and can do and where the student needs to focus additional practice" (Wambach et al., 2000, p. 8).

Ley and Young (2001) suggested that students should be advised on how to structure a study environment to maximize learning which includes identifying potential distractions and removing or decreasing them when studying. This could be accomplished by requiring or encouraging students to "complete an environmental structuring checklist that establishes the characteristics of an effective distraction-free study environment" (Ley & Young, 2001, p. 95).

They also proposed that self-monitoring could be reinforced by requiring students to complete records of the time they spent on learning activities.

Self-monitoring. Self-monitoring, which was introduced as a data recording technique, was found to transform an individual's behaviors; the mere act of recording one's own behaviors could change behaviors (Lan, 1996; Ley & Young, 2001; Schmitz & Perels, 2011). Self-monitoring as a self-regulated learning strategy has been described as a conscious awareness of one's behaviors; the individual evaluates the effectiveness of his/her behaviors and makes decisions about subsequent actions based on these judgments (Lan, 1996) which can happen during a specific phase or throughout the complete cycle of self-regulation (Schmitz & Perels, 2011). Various monitoring strategies, such as self-testing and tracking of attention, can inform the learner about his/her level of attention, comprehension of and how to complete the task, and ability to complete the task (Pintrich, 1999). Any perceived breakdowns and/or obstacles can then be managed using regulation strategies (Pintrich, 1999).

The act of recording behavior, mentally paying attention to the behavior and/or physically recording the behavior, has been shown to affect changes in the behavior, referred to as reactivity effects (Schmitz & Perels, 2011). Schmitz and Perels (2011), through their literature review, were able to identify explanations for reactivity to self-monitoring: attention focusing, reminder/checklist, and self-reflection. Asking and answering questions in regards to specific behaviors focuses attention and often will lead to changes in those behaviors. Similarly, a checklist instrument acts as a reminder providing cues for important topics which can alter behavior. Self-reflection stimulates more focused attention on the behavior and provides opportunities to consider changing behavior if needed to reach goals.

Instructional models. Butler (2002) described an instructional model, Strategic Content Learning (SCL), used to enhance self-regulated learning within one-on-one, small group, and whole class instruction. In this model, instructors and students work collaboratively on authentic tasks where self-regulated constructions are embedded in completing the tasks. Embedding strategy instruction allows the student to be immersed in the problem solving process and learn "how to construct personally effective strategies for meeting varying task demands" (p. 84). The process is cyclical and highly interactive; the instructor provides guidance and support to students as they proceed through the process of analyzing tasks, using effective strategies, and monitoring progress and goal attainment. Teachers also support the development of self-regulation in this model by helping students develop positive self-perceptions of their abilities to successfully complete tasks. This is accomplished by offering frequent feedback.

Self-regulated Learning and Developmental Mathematics

Students in developmental mathematics courses have not mastered prerequisite skills needed for college level mathematics. Research has identified developmental students as lacking in self-regulated learning strategies (Kinney, 2001; Wambach et al., 2000) and so have positioned self-regulation as a goal of developmental education (Kinney, 2001; Wambach et al., 2000).

Wambach and colleagues' (2000) developmental education theory suggested that a demanding and responsive environment could enhance students' self-regulated learning. Kinney (2001) applied their theory to developmental mathematics in particular. The courses in the developmental program used in Kinney's (2001) research were considered to be demanding and responsive. Kinney (2001) described a demanding developmental mathematics class as one which requires regular attendance and participation during class discussions, completion of assignments on scheduled due dates, and using necessary resources as needed such as the tutoring center. Further, Kinney (2001) described a responsive developmental mathematics class as one in which students are provided with frequent, prompt, personal, and clear feedback on their work. This feedback is designed to guide students to take actions to master the content. Kinney (2001) maintained that self-regulation and student outcomes are fostered through the structure, support, encouragement, and guidance that this environment provides.

Kinney (2001) conducted his research at a two-year college, in which two formats of the developmental mathematics course were offered to students: lecture or computer-mediated instruction. The schedule and exams were the same for all students. Whether assignments were completed online or written, all assignments had firm due dates. In the lecture course, instructors presented the lesson, led discussions, actively engaged the students in working together, and provided frequent feedback to students. In the computer-mediated course, students worked in the computer lab where lessons were delivered through interactive multimedia software which explained the concepts and skills, provided exercises for students to complete, and offered immediate feedback on their work. The instructor in the lab was a monitor who offered assistance to students when needed but did not deliver the lesson. Data were examined and course formats were compared. Results revealed that there were no significant differences in mean scores of common final exams, completion rates, and pass rates between the two groups. The researcher suggested that since both courses offered environments that were demanding, responsive, and encouraged self-regulated learning, no significant differences in outcomes were identified.

Smith (Pape & Smith, 2002) conducted a case study consisting of 19 developmental math students during a 10-week period where several strategies, including self-regulated learning strategies, were embedded into the content of the course. Besides learning to take notes, read a mathematics textbook, study for and take an exam, and explore additional resources, students were also guided to use self-regulated learning strategies. Some of these strategies included setting goals for themselves, monitoring progress of their goals, and revising, if necessary, their approach to attaining their goals. Self-regulated learning strategies were required for a portion of the course and then eventually only encouraged. For example, at the beginning of the study students analyzed and corrected examinations as graded assignments and as the term progressed, they were encouraged to continue but not required. After successfully completing this course, eight of these students continued the mathematics sequence and enrolled in a college-level mathematics course. They were interviewed five times throughout the semester to gather data on their learning strategies. The researcher documented that the subjects exhibited use of mathematics specific learning strategies. Further, the students believed they had control in the outcomes of learning tasks, displaying ownership of their work.

Wadsworth, Husman, Duggan, and Pennington (2007) conducted a study which examined the relationship between learning strategies, motivation, self-efficacy, and student achievement in a developmental mathematics course delivered online. Students' learning strategies scores, collected from the LASSI, and self-efficacy scores from a departmental developed instrument, were compared with their final course letter grade. Results indicated that a student's final grade could be significantly predicted by self-efficacy coupled with four learning strategies: motivation, concentration, information processing, and self-testing strategies. Attitude, time management, anxiety, selecting the main idea, use of supporting materials, and self-testing strategies were not significant factors in predicting final grade. The researchers further observed that all of the students in the sample scored below the 50th percentile in anxiety and use of supporting materials, explaining that skill deficiencies were expected from this group since past academic failure was likely.

Self-regulated Learning and Online Learning in a Blended Learning Environment

There is a growing body of research focused on examining students' self-regulated learning in blended learning environments (Azevedo, 2005; Barnard et al., 2009; Kim & Bonk, 2006; Lust et al., 2011; Lust et al., 2012; Lynch & Dembo, 2004; Means et al., 2010; Wadsworth et al., 2007; Wang, 2011; Winters, Greene, & Costich, 2008; Yen & Lee, 2011). Much research focuses on the online component of a blended learning course since working in online environments requires students to be self-directed and self-motivated (Lust et al., 2011; Lust et al., 2012; Lynch & Dembo, 2004; Wang, 2011; Yen & Lee, 2011). This autonomy is a facet of online learning and therefore, self-regulation becomes an important element for success in learning in this type of environment (Lust et al., 2011; Lust et al., 2012).

Means, Toyama, Murphy, Bakia, and Jones (2010) conducted a comprehensive meta-analysis of online learning studies. They were able to identify studies which explored components of self-regulation used by online learners. The researchers concluded that

> Overall, the available research evidence suggests that promoting self-reflection, self-regulation and self-monitoring leads to more positive online learning outcomes. Features such as prompts for reflection, self-explanation and self-monitoring strategies have shown promise for improving online learning outcomes. (p.45)

Azevedo's (2005) study examined the relationship between different scaffolding conditions and students' self-regulatory behavior while working online in a blended undergraduate science course. Three different groups were included in the study: no scaffolding, fixed scaffolding (a list of domain specific subgoals), and adaptive scaffolding (a human tutor). Results indicated that the use of SRL varied by scaffolding condition. Students who were not provided with scaffolds tended to use less self-regulatory processes when working online. Students who were given fixed scaffolds tended to show interest in the topics, use several effective and ineffective strategies, and monitor activities that dealt with the online environment to regulate their learning. Students who had a human tutor that offered adaptive scaffolding, tended to activate prior knowledge, create sub-goals, monitor their learning, and use a variety of strategies such as "summarizing, making inferences, drawing, and engaging in knowledge elaboration, and not surprisingly, engaging in an inordinate amount of help seeking from the human tutor" (p. 204). Yet it was reported that all groups made significant pretest-posttest achievement gains.

Lynch and Dembo (2004) examined the relationship between course performance and self-regulated learning in a blended learning environment by correlating a student's final grade with five self-regulatory attributes: intrinsic goal orientation, self-efficacy for learning and performance, time and study environment management, help seeking, and Internet self-efficacy. The researchers used a sample of 94 undergraduate students in a marketing course with a blended format. MSLQ scores and final grades were collected and analyzed for all subjects. Only a significant relationship between self-efficacy and final grade could be identified. They concluded that the nature of the blended format most likely contributed to the results. Since students had regular interactions with the class instructor, lab instructor, and peers, many topics that students had questions about may have been addressed in class and so seeking help outside of class may not have been necessary. Similarly, the blended nature of the class included on-campus sessions and may have reduced the need for students to manage their time and/or study environment since some of that was built into the class. Finally, the blended format did not require students to be solely dependent on the Internet and therefore there was not a significant relationship between Internet self-efficacy and final grades.

Through their meta-analysis of 33 empirical studies which investigated students' self-regulated learning in computer-based learning environments, Winters, Greene, and Costich (2008) reported that students with high prior knowledge made larger gains between pretest and posttest, used higher-level self-regulated processes such as planning, making inferences, and elaborating, and used active self-regulated strategies such as monitoring while working in the online environment. On the other hand, students with low prior knowledge made smaller gains, used lower-level self-regulated processes such as help seeking and controlling the environment, and used a few specific strategies more frequently such as note taking and summarizing while working in the online learning environment.

Measuring Self-regulated Learning in the Online Learning Environment

The Online Self-regulated Learning Questionnaire (OSLQ) (Barnard et al., 2009; Barnard, Paton, & Lan, 2008) is a 24 Likert-item questionnaire that uses a scale of 1 – 5 for responses ranging from "strongly disagree" to "strongly agree". The instrument measures "a student's ability to self-regulate their learning in environments that are wholly or partially web-based" (Barnard et al., 2008, p. 2). A higher summed score on this questionnaire suggests better self-regulation when working online (Barnard et al., 2009). There are six subscale constructs, self-regulated learning attributes, which make up the OSLQ: goal setting, environment structuring, task strategies, time management, help seeking, and self evaluation. A higher summed score on a subscale suggests better self-regulation for that specific construct while working online (Barnard et al., 2009).

Enhancing Self-regulated Learning in Blended Learning Environments

Researchers have recommended that students should be trained in using self-regulated strategies when working in blended environments to improve learners' success (Kim & Bonk, 2006; Wadsworth et al., 2007; Yen & Lee, 2011). Research has suggested that features of blended learning environments should be utilized to maximize the potential to buttress students' self-regulation such as providing students with quality opportunities for interaction (Barnard et al., 2009; Wang, 2011) and additional support (Azevedo, 2005; Barnard et al., 2009). It has been suggested that "enabling learners to interact with computers and adding more strategies to increase human-machine interaction" could improve self-regulated learning in the online environment (Wang, 2011, p.1810). Azevedo (2005) suggested that aids inside or outside the online learning environment could encourage students' use of self-regulatory processes. Azevedo (2005) also observed that learning supports such as online prompts could act as a scaffold by providing support and guidance to help students regulate their learning. Human tutors, considered external regulating agents, could also assist students in planning, monitoring, and evaluating self-regulatory strategy use (Azevedo, 2005).

Self-regulation and Online Learning in a Blended Learning Environment and Developmental Mathematics

Wadsworth et al.'s (2007) study examined the relationship among learning, motivation, and self-regulatory strategies of developmental mathematics students in online courses. Yet no research studies were identified that focused on the relationship between self-regulated learning of developmental mathematics students and the work they do online in a blended course. Research has suggested that success in a developmental mathematics class where some of the instruction is delivered online is dependent to some extent on students' uses of a variety of learning strategies (Wadsworth et al., 2007). To improve transfer of strategies to an online environment, research has suggested that developmental mathematics students are taught strategies important to the online environment and given real examples and ample opportunities to practice those strategies online (Wadsworth et al., 2007).

CHAPTER 3

Methods

Introduction

The purpose of the study was to investigate students' level of self-regulation when learning in an online environment. This study used a nonequivalent-control-group experimental design with repeated measures (Shavelson, 1996) over a semester to investigate the use of the self-regulatory strategy of self-monitoring during online work with students in a developmental mathematics course, Intermediate Algebra.

This study was designed to answer the following research questions.

1. Was there a statistically significant difference in student achievement, indicated by mean scores on three unit exams, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
2. Was there a statistically significant difference in students' levels of self-regulation, indicated by mean scores gathered from a questionnaire completed four different times throughout the semester, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
3. Was there a statistically significant relationship between a student's perceived level of self- regulation and final course grade?

Setting of the Study

The Kansas Algebra Program (KAP) is a coordinated program at the University of Kansas that serves students enrolled in Intermediate Algebra (Math 002) and College Algebra (Math 101). Combined, approximately 2000 students are enrolled in this program each fall semester and approximately 1200 students are enrolled in the spring semester. Students who score lower than 22 on the math portion of the ACT or 540 on the math portion of the SAT are placed in Math 002. Although it is suggested that students who score lower than 16 on the math portion of the ACT or 440 on the math portion of the SAT should take a beginning Algebra course, there is no minimum requirement to enroll in Math 002. Placement into Math 101 is determined by courses completed in high school in conjunction with the score from the math portion of either the ACT (scores in the range of 22-25) or SAT (scores in the range of 540-590) or successful completion of Math 002 or an equivalent course. Should a student question his/her placement in either course based on his/her ACT or SAT score, the option of completing a departmental mathematics placement exam at the university is given several times prior to the semester of enrollment.

Math 002 is considered a developmental mathematics course since successful completion of the course does not carry credit towards a degree, and is intended to prepare students to take subsequent college-level mathematics courses. Intermediate Algebra covers topics that are generally covered in two years of high school algebra (American Mathematical Association of Two-Year Colleges [AMATYC], n.d.). In postsecondary education, Intermediate Algebra has been defined by the American Mathematical Association of Two-Year Colleges (n.d.) as the culminating course of developmental mathematics and is seen as a benchmark of a student reaching a certain level of "mathematical maturity". This level of maturity includes a level of understanding of topics and acquired skills necessary to think mathematically, preparing a student to continue in subsequent mathematics courses (AMATYC, n.d.).

Kansas Algebra Program Structure

KAP is staffed with approximately 75 employees who are undergraduate students, graduate students, or lecturers. They serve in various roles to assist students enrolled in both

Math 002 and Math 101. All who are employed with KAP have responsibilities as tutors in the Help Room, monitors during examinations in the common testing room, and graders who grade the exams. In addition, most employees are also classroom instructors and/or study group leaders.

Together the Director and the Assistant Director develop the curriculum, organize the schedule, define examinations, and construct Student Notes, Instructor Notes, and other materials for each unit. As a coordinated program with approximately 38 instructors teaching 47 sections of Math 101 and 28 instructors teaching 34 sections of Math 002 during the fall semester, the Director and Assistant Director lead several weekly sessions with the instructors to help maintain consistency in the classrooms. Classroom instructors are required to meet weekly with their respective course Lead Instructor, either the Director or Assistant Director, to discuss content, pedagogy, and other issues in the classroom, as well as practice delivery of instruction.

Math 101 sections have a maximum enrollment of 26 students and Math 002 sections have a maximum enrollment of 24 students. The small class size allows for more individualized instruction and feedback. In addition to small class size, there are several other features KAP offers to students enrolled in these courses which have been suggested as best practices in developmental mathematics. The Help Room, which is open 64 hours a week, offers free tutoring and access to a computer lab dedicated to access to the online platform on a walk-in basis. Students can access their online assignments and other online resources in the computer lab. Students can also sign up for a study group which is comprised of up to 4 students, meets on a weekly basis, and is led by a KAP tutor. Common exams are administered in the testing room, outside of class time, and are untimed with retake options available. Both courses are calculator based and use the Texas Instruments TI-83 and TI-84 families.

Exams are developed by the Director and Assistant Director and are algorithmically generated with randomization of parameters. For example, every Intermediate Algebra student will be required to solve a quadratic equation by factoring on the Unit 4 exam. There are multiple variants which are randomized so that typically, students will have a unique problem to solve. Employees grade all exams by hand, based on a grading guide defined by the Director or Assistant Director, allowing partial credit for adequate work shown.

Math 002 Course Structure

Math 002 is a semester course that includes five units of study. Unit 1 topics include: solving linear equations and inequalities in one variable, solving absolute value equations and inequalities, using formulas, and solving applications. Unit 2 topics include: using exponent rules to simplify expressions, polynomial operations of addition, subtraction, multiplication, and division, and factoring polynomials. Unit 3 topics include: operations on rational and radical expressions, using rational exponent rules to simplify expressions, operations with complex numbers, the distance formula, and solving rational and radical equations. Unit 4 topics include: graphing and identifying characteristics of functions such as domain and range, identifying slopes and intercepts of linear functions, writing equations of lines, and solving polynomial functions using the Zero-Factor Property and the quadratic equation. Unit 5 topics include: solving systems of linear equations and inequalities, applications of systems, and graphing linear inequalities in two variables.

Math 002 has a blended format which integrates face-to-face settings via classes and tutoring which take place on campus and in online settings using Internet technology through the use of *My Math Lab* (MML), educational software developed by Pearson Inc. Each class section meets 150 minutes a week during two or three class periods with the classroom instructor who provides in-class instruction. Students have access to a set of *Student Notes* for each unit. These are skeletal notes, created by the lead instructor and available on the KAP website, which help in maintaining consistency in all sections. Instruction is guided by the *Student Notes* and instructors are encouraged to create active classroom environments where students have opportunities to practice processes as well as apply knowledge. A sample of the Unit 1 Student Notes is located in Appendix I.

Work in this course includes written assignments, in-class assignments, and on-line assignments. During most class periods, students are assigned written homework which is due the following class period. Attendance is required and students are encouraged to attend class since completion of in-class assignments and/or in-class activities as well as attendance results in points toward the unit grade. Formal assessments include nine online quizzes, four unit exams, and a comprehensive final.

In addition to meeting face-to-face in class, students are required to spend some time online as well. The online portion of the course, delivered through *MyMathLab* (MML), is intended to provide supplemental practice, feedback, and support to the student. The online component of this course includes homework assignments and one or two quizzes for each of the five units. Several online homework assignments are included in each unit, for a total of 20 assignments throughout the semester. Students are able to attempt each homework problem an unlimited number of times, with or without the use of online help tools (Help Me Solve This, View an Example, Video, Textbook, and Calculator). If a student chooses to use the online help tool “Help Me Solve This”, step-by-step help is given to the student to complete the problem. It is interactive and requires input from the student until the exercise is completed. Once finished, a question similar to the current question will also need to be completed to receive credit for that exercise. If a student chooses the online help tool "Show Me an Example", step-by-step help is given to the student to complete a similar problem. It is also interactive, requiring student input to complete the exercise. Once finished, the original question will also need to be answered to receive credit for that exercise. Students are not required to complete an assignment during one session; they can work for the amount of time that they choose, save their work and then return later and continue their assignment. Students are required to submit their assignments by a due date to receive full credit. If a student should not complete the assignment by the given due date, the portion that has been completed will be scored at full weight. They can still submit the uncompleted portion of the assignment with a 50% deduction in the score of the late work until the final deadline. Each online quiz has 5 questions which are pooled from approximately 15 questions. The nine quizzes can each be taken up to 10 times, without the use of any online tools, and with the best score recorded. Students must complete the quiz in one session. There is not an option to take quizzes for partial credit after the due date.

Subjects

During the fall of 2013, Math 002 was offered at nine different times, seven on a Tuesday/Thursday (T/R) schedule and two on a Monday/Wednesday/Friday (M/W/F) schedule. There were 36 sections of Math 002 which were included in the beginning of the study. These sections were taught by 29 different instructors. There were 26 (89.7%) undergraduate teaching assistants (UTAs), 13 who were new to KAP and 13 who were returning, two (6.9%) graduate teaching assistants (GTAs) who were new to KAP, and one lecturer (the investigator) who was returning. There were 19 (66%) male instructors and 10 (34%) female instructors. The mean age of instructors, not including the investigator, was 21 years. Twenty-three (79.3%) of the TAs were White, 1 (3.4%) was Hispanic, 2 (6.9%) were Asian, and 3 (10.4%) were from multiple races. Of the UTAs, there were three who were pursuing a non-STEM degree, 23 who were pursuing a STEM degree, and six who were double majoring.

Seven instructors were assigned to teach two sections each; these included five UTAs who were returning to KAP, and both GTAs. One of the UTAs had classes which met on the Monday/Wednesday/Friday schedule and the other six met their classes on the Tuesday/Thursday schedule.

Sections were selected to be either in the control or experimental group using random assignment where possible, while also maintaining balance among several factors. The number of classes a TA was assigned, the days and time the classes met, and whether the instructor assigned to teach the section was new or returning to KAP, were all considered in selecting sections for assignment into the control or experimental groups. When used, a random generator assigned “0” as a control group section and “1” as an experimental section.

Selection began with instructors who were assigned to teach two sections each. The first section of the first GTA was assigned by a random generator to the experimental group and the second section was assigned by the investigator to the control group. The second GTA’s sections were assigned in the opposite order of the first GTA’s to maintain balance and so the first section was assigned to the control group and the second to the experimental group. The classes taught by the UTA which met M/W/F were then selected. The first section in regards to sequence was assigned by the random generator to the control group and so the second section was assigned by the investigator to the experimental group. The four UTAs’ sections which met on the T/R schedule were then considered. The first UTA’s first section was randomly selected and the second assigned; the second UTA’s sections were assigned in reversed order of the first. The third UTA's first section was randomly selected and the second assigned; the fourth UTA's sections were assigned in reversed order of the third.

For the remaining 22 sections of TAs teaching only one section, a teaching schedule listing all 36 sections by day and time was used (Appendix J). Each remaining section was assigned to be included either in the experimental group or the control group in different ways. Beginning with the first time slot, Tuesday/Thursday (T/R) 8:00-9:15 a.m., there were three sections, one of which had already been assigned to the experimental group because the instructor was teaching two sections. The other two sections were each taught by a returning and a new TA therefore the first section in the list was selected by the random generator into the control group and the second was selected by the investigator into the experimental group.

There were six sections in the next time slot on the schedule, Monday/Wednesday/Friday (M/W/F) 9:00 – 9:50 a.m., one which had already been assigned to the control group because the instructor was teaching two sections. Of the other five sections, the random generator was used and assigned two sections, each taught by a new UTA to the control group, and the remaining three sections were assigned to the experimental group, two sections which were taught by returning UTAs and one section taught by a new UTA.

There were five sections in the T/R 9:30-10:45 a.m. meeting time. Two of these had already been assigned, one each to the control group and experimental group, since the instructors were each teaching two sections. The remaining three sections were placed using the random generator: two sections to the control group, one taught by a returning UTA and the other taught by a new UTA, and the other section taught by a new UTA to the experimental group.

The next time slot meeting on T/R at 11:00 a.m.-12:15 p.m. had five sections, three which had already been assigned, one to the control group and two to the experimental group, since the instructors were teaching two sections each. The remaining two sections, one taught by the returning lecturer and the other by a new UTA, were placed in the control group by the random generator process.

The next time slot T/R 1:00-2:15 p.m. had five sections, one which had been already assigned to the control group since it was taught by an instructor who was teaching two sections. The next four were chosen to be in the experimental group by the random generator but to maintain balance the researcher decided to do two more rounds with the random generator and used the majority value. Using this method, two sections were placed in the control group, one taught by a returning UTA and the other taught by a new UTA, and the other two were placed in the experimental group, one taught by a returning UTA and the other taught by a new UTA. This process was continued for the remaining three time slots.

Group selection concluded with 18 sections in the control group, two sections taught by new GTAs, nine sections taught by returning UTAs, and seven sections taught by new UTAs. Similarly, there were 18 sections in the experimental group, two sections taught by new GTAs, eight sections taught by returning UTAs, seven sections taught by new UTAs, and one section taught by a returning lecturer.

There were 841 students who were enrolled in 36 sections of Math 002 in the fall of 2013. There were 18 sections which included 422 (50.2%) students who began in the control group and 419 (49.8%) students who began in the experimental group. There were 75 (8.9%) students without consent forms and 105 (12.5%) students without adequate data for comparisons since they did not have scores from at least two unit exams or two in-class questionnaires, who were removed as subjects from the data analysis. The beginning sample included 661 (78.6%) students with 336 students who were initially in the control group and 325 students who were initially in the experimental group. These students completed at least two unit exams or at least two in-class questionnaires of self-regulated learning.

The sample consisted of 661 Math 002 students of which 287 (43.4%) were male and 374 (56.6%) were female. The mean age of students was 19.2 years. Most of the students were 18 or 19 years old (81.3%) with a range of 18-41 years. The majority of students were freshmen (83.8%), taking this course for the first time (80.2%), and considered in-state residents (62.7%). Slightly over 68% of the study participants were White, 12.2% were Black, 6.3% were Hispanic, 2.1% were Asian, 6.9% were from multiple races, and 1.4% were categorized as “Other”. Almost all students (94.9%) had access to the Internet outside of KAP, approximately 88% of students had previously completed some or numerous online assignments, and of these students almost 87% had previously completed some or numerous online mathematics assignments.

There were three different phases during the study that were considered. During Unit 2, identified as Phase 1, students in the experimental groups were asked to complete a self-monitoring record form after the due date of each corresponding online assignment for a total of four times. Included in this phase were students in both the control group and the experimental group who completed the Unit 1 and Unit 2 exams, and/or the first and second administration of the in-class questionnaires of SRL. During Unit 3, identified as Phase 2, students in the experimental group were asked to complete an online self-monitoring form after the due date of every other online assignment for a total of two additional occurrences. Included in Phase 2 were students in both the control group and the experimental group who completed the Unit 2 and Unit 3 exams, and/or the first and third administration of the in-class questionnaires of SRL.

During Unit 4, identified as Phase 3, students in either the control group or experimental group were not required to complete any self-monitoring record forms. Included in Phase 3 were students in both the control group and the experimental group who completed the Unit 3 and Unit 4 exams, and/or the first and fourth administration of the in-class questionnaires of SRL.

Instruments

Demographics

The researcher-developed Student Questionnaire (Appendix A) consisted of 14 questions and was administered to all students included in the study at the beginning of the semester. This questionnaire was used to collect descriptive data on the individuals including name, gender, age, ethnicity, year graduated from high school, declared in-state or out-of-state residency, academic year in school, declared major, last math course completed, what type of institution (high school, 2-year or 4-year post secondary institution) where it was completed as well as semester and year it was completed, first time taking the course or repeating the course, availability of internet access outside of KAP, and number of online/blended courses completed or currently taking.

The researcher-developed Instructor Questionnaire (Appendix B) consisted of eight questions and was used to collect descriptive data on the classroom instructors including name, gender, age, ethnicity, teaching assistant category (undergraduate student, graduate student, or lecturer), number of semesters teaching Math 002 or equivalent, and a description of other teaching experiences and duration if applicable. Further, for the teaching assistant category, if the instructor was an undergraduate student, then s/he also identified academic year and declared major; if the instructor was a graduate student, then s/he also identified undergraduate degree and /or master's degree; if the instructor was a lecturer, then s/he also identified undergraduate degree, master's degree, and/or doctoral degree.

Measure of Self-regulation

The Online Self-regulated Learning Questionnaire (OSLQ) (Barnard, Lan, To, Paton, & Lai, 2009; Barnard, Paton, & Lan, 2008) was adapted for use in this study (see Appendix C for a copy of this questionnaire). The OSLQ was a 24 Likert-item questionnaire that used a scale of 1 – 5 for response choices where a choice of (1) indicated the respondent strongly disagreed with the given statement and a choice of (5) indicated that the respondent strongly agreed with the given statement. A higher summed score on this questionnaire suggested better self-regulation in online learning (Barnard et al., 2009).

There are six subscale constructs, self-regulated learning attributes, which make up the OSLQ: goal setting, environment structuring, task strategies, time management, help seeking, and self evaluation (Barnard et al., 2008). Goal setting, items 1-5, accounts for an individual's ability to set individual goals. Environment structuring, items 6-9, refers to a student's awareness of and ability to manipulate the studying environment if necessary when working online. Task strategies, items 10-13, give a description of four different strategies that a student might use when studying online. Time management, items 14-16, denotes the student's ability to manage learning time when working online. Help seeking, items 17-20, corresponds to a student's ability to know when and how to seek academic help when necessary. Finally, self evaluation, items 21-24, focuses on some strategies a student uses to monitor and evaluate her/his progress. A higher summed score on a subscale suggests better self-regulation for that specific construct while working online (Barnard et al., 2009).

Research done by Barnard, Lan, To, Paton, and Lai (2009) established the reliability and validity of this instrument with respect to students enrolled in a blended course format. Confirmatory factor analysis was used to establish validity of the measure and five statistics were reported which reflected fit: the chi-square goodness of fit statistic as $\chi^2(246) = 758.79,\ p <$ .05; the ratio of chi-square statistic to degrees of freedom (χ^2/df) was 3.08; the root mean square error of approximation (RMSEA) was 0.04; the Tucker Lewis Index (TLI) was .95; and the Comparative Fit Index (CFI) was .96. Further, the researchers used Cronbach's alpha to examine the scores obtained from the measure and established reliability of this instrument, $\alpha = .90$, noting that a reliability score of .70 or higher is indicative of internal consistency. Subscale scores were also examined for internal consistency and α scores ranged from .67 to .90, also implying internal consistencies.

For the present study, the revised instrument, the Kansas Algebra Program Questionnaire of Online Self-regulated Learning (KAPQOSL) (see Appendices D & E), was used to measure a student's ability to self-regulate his/her learning in a blended learning environment, particularly in the online portion of the course. The KAPQOSL included 22 Likert-items which used a scale of 1-5. For the purposes of this study, the researcher revised the OSLQ in the following way. Items 2, 5, 6, 7, 11, 17, 19, 20, and 24 were retained in their original form. Items 1, 3, 4, 8, 9, 10, 13, 14, 15, 16, 18, 21, and 22 were revised to fit the current study. Most revisions were word or phrase changes: in item 1 the phrase "assignments in online courses" was changed to "online assignments;" in items 4, 14, and 15, the word "courses" was changed to "assignments;" in item 16 the phrase "daily classes" was changed to "classes daily;" in item 18, the word "online" was deleted; and all other revised items, 3, 8, 9, 10, 13, 21, 22 had changes that generally replaced the phrase "online courses" with the phrase "when working online." Item 12 seemed inappropriate for the current study and item 23 seemed repetitious and so both were deleted from the original questionnaire. The alignment of the original items and revised items is presented side-by-side in Appendix F. Cronbach's alpha was used to examine the reliability of the instrument. The scores obtained from the KAPQOSL suggested good internal consistency, $\alpha = .90$. Subscale scores were also examined for internal consistency and α scores ranged from .65 to .83, also implying internal consistencies.

Measures of Student Achievement

All instruments used to measure student achievement were constructed prior to the beginning of the semester. Each instrument was defined by the researcher and algorithmically generated by the mathematics department's test generator program.

Four unit examinations were administered during the semester, one at the completion of each of the first four units of instruction. Each unit exam had a value of 100 points and was similar in format including both multiple choice questions and exercises requiring short answer responses.

The final course grade was scaled as a percent of earned points out of points possible for the course. A student's final course grade included attendance, in-class assignments and quizzes, online assignments and quizzes, 4 unit exam scores, and the final exam score.

Procedures

Informed consent procedures were administered to all participants. At the beginning of the term, during Week 1, all subjects were asked to complete the Student Consent Form and Student Questionnaire during class so that background information could be collected. Instructors also completed the Instructor Questionnaire at the beginning of the study. The semester schedule is included in Appendix G. During the semester, all participants had similar classroom and online experiences; they were required to complete the same lessons and assignments in class, out of class, and online, take the same unit exams, and use the same materials. All students had access to the same materials.

After the completion of Unit 1, during Week 4, students were asked to complete the first in-class questionnaire, the KAPQOSL, during a class period. Students had the opportunity to work online throughout Unit 1 and responses to the KAPQOSL at this time helped to establish each student's perceived level of self-regulated learning in an online environment. During this week, students completed the Unit 1 Exam and scores were collected from students who had completed this exam to help establish a baseline of student achievement in both the experimental and control groups.

During Unit 2, Weeks 5-7, all students, regardless of which group they were in, were asked to complete an online record after every online assignment in this unit for a total of four times. To keep total points possible in the course consistent, students were awarded points for completing an online survey. Therefore, two different forms were used for the experimental and control groups and were distributed to the participants through email using a survey engine. The researcher-developed Self-monitoring Record A (see Appendix H) is an instrument completed online by a student in the experimental group to record details about the work that was done to complete the assignment. The student recorded her/his name, if the assignment was completed by the due date, and how many times s/he logged in to complete the assignment. The student answered questions about the environment(s) in which the assignment was completed including the location where most of the online work occurred (e.g. dormitory, library, apartment, other), any distractions in the work environment while working online, and online resources that were used. The student also recorded any help-seeking actions s/he considered such as getting help from the instructor or a peer. Finally, the student was asked to evaluate the quality of the work that was done to complete the assignment (i.e. good, adequate, or needs improvement). A modified version of the Self-monitoring Record A (see Appendix H) which included only the first three questions, was intended to be completed online by a student in the control group to record details about the work that was done to complete the assignment. This form did not include any questions regarding self-regulated learning attributes but asked the student to record her/his name, if the assignment was completed by the due date, and how many sessions were used (times they had logged in) to complete the assignment. At the end of Unit 2, during Week 7, all subjects were asked to complete the KAPQOSL for a second time during a class period. Scores were collected from all subjects who completed this questionnaire. Scores were also collected from all students who took the Unit 2 Exam.

During Unit 3, Weeks 9 and 10, all students were asked to complete their respective online record form after every other online assignment for a total of two additional times. The decrease in the prompts, presented as the self-monitoring record forms, can be described as fading (Winters et al., 2008). Midway through the unit during Week 9, students had the opportunity to retake either Exam 1 or Exam 2. For all students who chose to retake an exam, exam numbers and scores were collected. At the end of Unit 3, during Week 10, all subjects were asked to complete the KAPQOSL for a third time during a class period. Scores were collected from all subjects who completed this questionnaire. Scores were also collected from all students who took the Unit 3 Exam.

For the remaining weeks, students in either group were not required to complete the online record forms. Both groups completed the same online assignments. At the end of Unit 4, during week 13, all students in both the experimental and control groups were asked to complete the KAPQOSL for the fourth time during a class period. The Unit 4 Exam was administered during this week and scores were collected for all subjects who completed this exam.

During Week 16, students had the opportunity to retake either Exam 3 or Exam 4. For all students who chose to retake an exam, exam numbers and scores were collected.

At the completion of the semester, students who had withdrawn from the course were identified. Final grades were calculated and recorded for those students who were still enrolled in the course. For all students who retook an exam, the higher score of either the original or the retake was used to calculate their final grades.

Data Analysis

A mixed design was chosen because repeated measures were gathered from two or more independent groups (Shavelson, 1996). This section presents information about the variables in this study, the descriptive statistics calculated, and the statistical analyses conducted.

Variables

There were several variables included in this study. The independent variable for this study was the presence or absence of a self-monitoring form for subjects to complete in regards to the online work that they did. The experimental group completed a self-monitoring form which included questions associated with self-regulated learning attributes while the control group completed a generic record form online which did not include any questions related to self-regulated learning. The dependent variables for this study were the sample mean scores on the measure of self-regulation in an online environment collected from the second, third, and fourth administration of the KAPQOSL. Another set of dependent variables included the sample mean scores from unit exams 2, 3, and 4. The student's final course grade, scaled as a percent, was also a dependent variable.

Descriptive Statistics

Sample sizes for all groups in all phases were reported. After each administration of the KAPQOSL, the mean score, standard deviation, and median were calculated for the sample, the control group, the experimental group, and each modified experimental group. Similarly, after each unit exam, the mean score, standard deviation, and median were calculated for all groups. Final grades were calculated as a percent of the total points possible.

Statistical Analyses

Student achievement comparisons. An analysis of covariance (ANCOVA), which is appropriate to use for repeated measures (Shavelson, 1996), was conducted to determine whether statistical differences in mathematics achievement existed between groups across time. Prior to completing the analysis, statistical tests were run to screen for the underlying assumptions of normality, homogeneity of variance, and homogeneity of regression slopes. Necessary transformations were made to correct all data sets. Procedures were used again to assess and confirm the normality of the transformed data sets. ANCOVA was used with the transformed exam data to determine whether there were any statistical differences in mathematics achievement when students' completion of a self-monitoring record form was considered. For each ANCOVA, the previous exam score was used as the covariate. Group assignment based on the number of self-monitoring record forms completed was the independent variable and transformed Exam score was the dependent variable. The level of significance used for the analyses was set at $\alpha = .05$.

Self-regulated learning levels comparisons. A *t*-test for independent means was conducted on the sample mean scores from the first KAPQOSL to identify if there was an initial statistical difference in levels of self-regulated learning in an online environment between the control and experimental groups. No statistical difference existed. Further, statistical measures were used to assess the underlying assumptions and all data sets were found to meet the underlying assumptions of normality, homogeneity of covariance, and sphericity. Therefore a mixed analysis of variance (ANOVA) (Shavelson, 1996) was conducted to compare sample mean scores of the first, second, third, and fourth administration of the KAPQOSL to identify any statistical differences in levels of self-regulation in an online environment between groups across time. Group assignment based on the number of self-monitoring record forms completed was the independent variable. The within-subject variable was self-regulated learning, measured by KAPQOSL scores, and the between-subjects variable was group assignment which was determined by level of treatment. The level of significance used for the analyses was set at $\alpha = .05$. Paired sample *t*-tests using Bonferonni adjustments were conducted to follow up interaction effects that were significant.

Correlation between student achievement and self-regulated learning. Relationships between students' composite as well as subscale scores on the fourth KAPQOSL and students' final course grades, scaled as percents, were analyzed. Scatter plots were constructed to identify general trends and possible outliers in the data. The Pearson product-moment correlation coefficient was calculated and used to measure the strength of each relationship, which was appropriate since all categories that were compared used scores that were measured at the scale level (Shavelson, 1996). The level of significance used for the analyses was set at $\alpha = .05$.

CHAPTER 4

Results

Introduction

The main purpose of this study was to investigate the effects of students' use of a self-monitoring record form when working online on academic achievement and self-regulated learning. This study was designed to answer the following research questions.

1. Was there a statistically significant difference in student achievement, indicated by mean scores on three unit exams, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
2. Was there a statistically significant difference in students' levels of self-regulation, indicated by mean scores gathered from a questionnaire completed four different times throughout the semester, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
3. Was there a statistically significant relationship between a student's perceived level of self-regulation and final course grade?

This chapter summarizes the data analysis. The SPSS statistical package (version 22) was used to analyze the student data. Included in the analysis are the quantitative results of each of the three phases in this study: In Phase 1 students received the most intense treatment; during Phase 2, the treatment was moderate; and in Phase 3 the treatment was removed.

There were 841 students who were enrolled in Math 002 in the fall of 2013. There were 422 (50.2%) students who began in the control group and 419 (49.8%) students who began in the experimental group. There were 75 (8.9%) students without consent forms and 105 (12.5%) students without adequate data for comparisons since they did not have scores from at least two unit exams or two in-class questionnaires, who were removed as subjects from the data analysis. The beginning sample included 661 (78.6%) students with 336 students who were initially in the control group and 325 students who were initially in the experimental group.

Phase 1

During Unit 2, identified as Phase 1, students were asked to complete an online self-monitoring record form after every online assignment for a total of four times. Included in Phase 1 were students in both the control group and the experimental group who completed the Unit 1 and Unit 2 exams, and/or both of the in-class questionnaires of self–regulated learning, KAPQOSL1 and KAPQOSL2, and up to four online self-monitoring record forms (SMR). The analyses in this phase examined two situations: Phase 1 Inclusive included the 32 students who withdrew later in the semester but had enough data for comparison and Phase 1 Exclusive included only the students who had enough data for comparison in this phase and completed the course.

For Phase 1 Inclusive, there were 661 (78.6%) students included in this sample with 336 (50.8%) students who were initially in the control group and 325 (49.2%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring record forms they had completed: Group 1 consisted of 48 (14.8%) students who completed one of the four record forms; Group 2 included 48 (14.8%) students who completed two of the four record forms; Group 3 included 66 (20.3%) students who completed three of the four record forms; and Group 4 contained 112 (34.4%) students who completed all four record forms. The remaining 51 (15.7%) students who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus, for analyses purposes, the control group had 387 (58.5%) participants and the experimental group had 274 (41.5%) participants. Out of this sample of 661 students, scores from 655 (99.1%) students who completed both Exam 1 and Exam 2 and scores from 512 (77.5%) students who completed both KAPQOSL1 and KAPQOSL2 were explored and analyzed.

For Phase 1 Exclusive, after removing the 32 (3.8%) subjects who had withdrawn during the course of the semester, there were 629 (74.8%) students included in this sample with 314 students who were initially in the control group and 315 students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring record forms they had completed: Group 1 consisted of 47 (14.9%) students who completed one of the four record forms; Group 2 included 46 (14.6%) students who completed two of the four record forms; Group 3 included 64 (20.3%) students who completed three of the four record forms; and Group 4 contained 110 (34.9%) students who completed all four record forms. The remaining 48 (15.2%) students who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus, for analyses purposes, the control group had 362 (57.6%) participants and the experimental group had 267 (42.4%) participants. Out of this sample of 629 students, scores from 623 (99.0%) students who completed both Exam 1 and Exam 2 and scores from 493 (78.4%) students who completed both KAPQOSL1 and KAPQOSL2 were explored and analyzed.

Descriptive Statistics

The means, standard deviations, and medians for achievement scores, Exam 1 and Exam 2, and self-regulated learning scores, KAPQOSL1 and KAPQOSL2, are presented in Table 1 for the sample, the control group, the experimental group, and each modified experimental group in Phase 1 Inclusive and Table 2 includes similar information for the groups in Phase 1 Exclusive. Each exam score was based on 100 points and the score for each KAPQOSL was out of 110 points.

Phase 1 Inclusive. When considering mathematics achievement, all groups except the experimental group which completed one of the four self-monitoring record forms had higher mean scores for Exam 2 than Exam 1. The modified experimental group which completed two of the four online self-monitoring record forms had the largest gain in mean score from Exam 1 (2.19%). In regards to self-regulated learning, the control group had the highest mean score for KAPQOSL1 of all the groups. Of the modified experimental groups, the group which completed three of the four online self-monitoring record forms had the highest mean score for KAPQOSL1 and the group which completed only two self-monitoring record forms had the lowest mean score of self-regulated learning. When comparing the mean scores for KAPQOSL1 and KAPQOSL2, all groups generally had similar scores but the group which completed all of the online self-monitoring record forms had the largest increase in mean score (3.1%).

Table 1
Phase 1 Inclusive: Means, Standard Deviations, and Medians

				Modified Experimental Groups			
	Sample *N*= 661	Control *N*= 387	Experimental *N*= 274	1 SMR *N*= 48	2 SMRs *N*= 48	3 SMRs *N*= 66	4 SMRs *N*= 112
Exam 1	77.02 (*14.40*)	75.56 (*14.78*)	79.09 (*13.90*)	81.59 (*11.13*)	78.71 (*12.60*)	77.58 (*14.37*)	79.12 (*14.47*)
(100 pts)	*N*= 655	*N*= 383	*N*= 272	*N*= 46	*N*= 48	*N*= 66	*N*= 112
	median =80	median= 78	median= 83	median= 84	median= 81.5	median= 80.5	median= 83.5
Exam 2	78.52 (*16.10*)	77.64 (*16.37*)	79.75 (*15.66*)	79.89 (*12.49*)	80.90 (*12.76*)	78.05 (*17.20*)	80.21 (*17.06*)
(100 pts)	*N*= 655	*N*= 383	*N*= 272	*N*= 46	*N*= 48	*N*= 66	*N*= 112
	median =83	median= 82	median= 84	median= 82.5	median=85.5	median= 83.5	median= 85
KAPQOSL 1	77.42 (*14.28*)	78.35 (*14.57*)	76.13 (*13.81*)	75.67 (*12.38*)	75.32 (*15.43*)	78.22 (*13.18*)	75.53 (*14.09*)
(110 pts)	*N*= 512	*N*= 297	*N*=215	*N*= 36	*N*=37	*N*= 49	*N*= 93
	median=77	median=78	median=76	median=76	median=75	median=80	median=76
KAPQOSL 2	77.79 (*15.23*)	77.91 (*15.64*)	77.63 (*14.69*)	76.14 (*14.29*)	75.60 (*13.79*)	77.74 (*14.75)*	78.95 (*15.22)*
(110 pts)	*N*= 512	*N*= 297	*N*=215	*N*= 36	*N*=37	*N*= 49	*N*= 93
	median=77	median=78	median=77	median=74	median=75	median=79	median=79

Note. SMR=Self monitoring record administered online. KAPQOSL= In-class questionnaire of self-regulated learning with possible score of 110 points. Standard deviations are given in parentheses next to mean scores.

Phase 1 Exclusive. After removing the data of students who had withdrawn from the course, the data analysis showed that all groups except the experimental group which completed one of the four self-monitoring record forms had higher mean scores for Exam 2 than Exam 1. The modified experimental group which completed two of the four online self-monitoring record forms had the largest gain in mean score from Exam 1 (3.33%). The results concerning self-regulated learning indicated that the control group had the highest mean score for KAPQOSL1 of all the groups. Further, the modified experimental group which completed all four online self-monitoring record forms had the largest increase in mean scores from KAPQOSL1 (3.1%).

Table 2
Phase 1 Exclusive: Means, Standard Deviations, and Medians

				Modified Experimental Groups			
	Sample *N*= 629	Control *N*= 362	Experimental *N*= 267	1 SMR *N*= 47	2 SMRs *N*= 46	3 SMRs *N*= 64	4 SMRs *N*= 110
Exam 1 (100 pts)	78.07 (*13.43*) *N= 623* median=81	77.01 (*13.50*) *N*= 358 median=80	79.51 (*13.50*) *N*= 265 median=83	81.89 (*11.06*) *N*= 45 median=84	78.78 (*12.58*) *N*= 46 median=81.5	77.92 (*14.33*) *N*= 64 median=81	79.76 (*13.66*) *N*= 110 median=84
Exam 2 (100 pts)	79.9 (*14.76*) *N= 623* median=83	79.30 (*14.90*) *N*= 358 median=82	80.71 (*14.55*) *N*= 265 median=85	80.53 (*11.84*) *N*= 45 median=83	82.11 (*11.56*) *N*= 46 median=86	79.14 (*16.06*) *N*= 64 median=84.5	81.45 (*15.80*) *N*= 110 median=85
KAPQOSL 1 (110 pts)	77.61 (*14.20*) *N*= 493 median= 77	78.59 (*14.41*) *N*= 282 median= 78	76.31 (*13.84*) *N*= 211 median= 77	76.29 (*11.97*) *N*= 35 median= 76	75.54 (*15.84*) *N*=35 median= 76	78.22 (*13.18*) *N*= 49 median= 80	75.60 (*14.15*) *N*= 92 median= 76
KAPQOSL 2 (110 pts)	78.27 (*14.97*) *N*= 493 median= 78	78.50 (*15.30*) *N*= 282 median= 78	77.95 (*14.56*) *N*= 211 median= 77	76.54 (*14.29*) *N*= 35 median= 76	76.17 (*13.68*) *N*=35 median= 75	77.74 (*14.75)* *N*= 49 median= 79	79.28 (*14.97)* *N*= 92 median= 79

Note. SMR=Self monitoring record administered online. KAPQOSL= In-class questionnaire of self-regulated learning with possible score of 110 points. Standard deviations are given in parentheses next to mean scores.

Inferential Statistics

A series of ANCOVAs were conducted to investigate the impact of the completion of self-monitoring record forms on students' mathematics achievement. Prior to completing the analysis, statistical tests were run to screen for underlying assumptions for the data from Exam 1 and Exam 2 scores. The data were found to meet the assumptions of homogeneity of variance and homogeneity of regression slopes. Yet *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics revealed that the assumption of normality had been violated in both Phase 1 Inclusive and Phase 1 Exclusive, for the control and experimental groups as well as the four subsets of the experimental group. As the mean scores from Exam 1 and Exam 2 were slightly to moderately negatively skewed, as recommended (Tabachnick & Fidell, 2001), the scores were transformed by reflecting and then taking the square root to normalize the distribution. Procedures were used again to assess the normality of the transformed data set and all calculations reflected acceptable measures. Typically achievement scores are viewed as higher scores reflecting better performance but since the transformed data included a reflection, lower transformed scores now indicated higher performance on the exam.

Phase 1 Inclusive achievement data. The data analysis was conducted using group assignment based on the completion of self-monitoring record forms as the independent variable, transformed Exam 2 scores as the dependent variable, and transformed prior Exam 1 scores as the covariate. The following tables present the transformed and adjusted mean scores for Exam 2 and results of the ANCOVA comparing the control group and the experimental group (Table 3) and then comparing the control group and the four modified experimental groups (Table 4). The results of these analyses showed that there was not a statistically significant effect of the completion of self-monitoring record forms on achievement after controlling for the effect of scores on the prior exam, when comparing the control group and the experimental group $F(1, 652) = .14$, $p = .705$, $\eta_p^2 < .001$, or when comparing the control group and the modified experimental groups, $F(4, 649) = .79$, $p = .531$, $\eta_p^2 = .005$.

Table 3

Phase 1 Inclusive Control Group and Experimental Group: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

Group	Achievement			
	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.55	4.43	1.64	383
E: Completed at least 1 SMR	4.30	4.47	1.66	272

Source	*SS*	*df*	*MS*	*F*
Exam 1	806.74	1	806.74	541.65*
Group Assignment	.21	1	.21	.14
Error	971.10	652	1.49	

Note. C=Control Group. E=Experimental Group. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .46, Adj. R^2 = .46, adjustments based on Transformed Exam 1 mean = 4.68. Homogeneity of regression tested and not significant: F = .19, p > .05. Transformed Exam 1 regression coefficient = .77*.
* p < .05.

Table 4

Phase 1 Inclusive Control and Modified Experimental Groups: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

Group	Achievement			
	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.55	4.43	1.64	383
E_1: Completed 1 SMR	4.40	4.73	1.33	46
E_2: Completed 2 SMRs	4.25	4.36	1.44	48
E_3: Completed 3 SMRs	4.45	4.50	1.78	66
E_4: Completed 4 SMRs	4.19	4.38	1.81	112

Source	*SS*	*df*	*MS*	*F*
Exam 1	807.77	1	807.77	542.36*
Group Assignment	4.72	4	1.18	.79
Error	966.59	649	1.49	

Note. C=Control Group. E_1= Experimental Group 1. E_2= Experimental Group 2. E_3= Experimental Group 3. E_4= Experimental Group 4. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .46, Adj. R^2 = .46, adjustments based on Transformed Exam 1 mean = 4.68. Homogeneity of regression tested and not significant: F = 1.72, p > .05. Transformed Exam 1 regression coefficient = .77*.
* p < .05.

Phase 1 Exclusive achievement data. The following tables present the transformed and adjusted mean scores of Exam 2 and results of the ANCOVA comparing the control group and the experimental group (Table 5) and then comparing the control group and the four modified experimental groups (Table 6). The results of these analyses showed similar results in that there was not a statistically significant effect of the completion of self-monitoring record forms on achievement after controlling for the effect of scores on the prior exam, when comparing the control group and the experimental group $F(1, 620) = .07$, $p = .799$, $\eta_p^2 < .001$, or when comparing the control group and the modified experimental groups, $F(4, 617) = .92$, $p = .452$, $\eta_p^2 = .006$.

Table 5
Phase 1 Exclusive Control Group and Experimental Group: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

	Achievement			
Group	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.40	4.31	1.54	358
E: Completed at least 1 SMR	4.22	4.33	1.59	265

Source	*SS*	*df*	*MS*	*F*
Exam 1	656.69	1	656.69	472.67*
Group Assignment	.09	1	.09	.07
Error	861.38	620	1.39	

Note. C=Control Group. E=Experimental Group. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. $R^2 = .43$, Adj. $R^2 = .43$, adjustments based on Transformed Exam 1 mean = 4.58. Homogeneity of regression tested and not significant: $F = .23$, $p > .05$. Transformed Exam 1 regression coefficient = .74*.
* $p < .05$.

Table 6

Phase 1 Exclusive Control and Modified Experimental Groups: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

	Achievement			
Group	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.40	4.31	1.54	358
E_1: Completed 1 SMR	4.34	4.61	1.28	45
E_2: Completed 2 SMRs	4.14	4.18	1.35	46
E_3: Completed 3 SMRs	4.36	4.36	1.72	64
E_4: Completed 4 SMRs	4.11	4.27	1.73	110
Source	*SS*	*df*	*MS*	*F*
Exam 1	658.31	1	658.31	474.30**
Group Assignment	5.10	4	1.28	.92
Error	856.37	617	1.39	

Note. C=Control Group. E_1= Experimental Group 1. E_2= Experimental Group 2. E_3= Experimental Group 3. E_4= Experimental Group 4. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .44, Adj. R^2 = .43, adjustments based on Transformed Exam 1 mean = 4.58. Homogeneity of regression tested and not significant: F = 1.45, p > .05. Transformed Exam 1 regression coefficient = .74*.
* p < .05, ** p < .01.

A series of mixed ANOVAs were conducted to identify any significant relationships between completion of self-monitoring record forms and levels of self-regulated learning with a within-subject variable of self-regulated learning, measured by KAPQOSL1 and KAPQOSL2 scores, and a between subjects variable of group assignment which was determined by level of treatment. Statistical measures were used to assess the underlying assumptions. All data sets were found to meet the assumptions of normality using *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics and homogeneity of covariance matrices using Box's M statistics. Further, since the repeated measure variable of self-regulated learning, KAPQOSL scores, had only 2 levels, the assumption of sphericity was met (Field, 2005).

Phase 1 Inclusive SRL data. The results of the mixed ANOVA (Table 7, Figure K1) show the comparison of the control group and the experimental group. There was not a significant main effect of self-regulated learning, $F(1, 510) = .941$, $p=.332$, $\eta_p^2=.002$, indicating scores from the two KAPQOSLs did not significantly vary over time. Neither was there a significant main effect of group assignment, $F(1, 510) = 1.08$, $p=.299$, $\eta_p^2=.002$, which indicated that the groups did not score statistically different from one another regardless of time. Further, there was not a statistically significant interaction effect, $F(1, 510) = 3.10$, $p = .079$, $\eta_p^2=.006$, suggesting that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning in the two groups over time.

The analysis was conducted again comparing the control group and the four modified experimental groups (Table 8, Figure K2). Similar results were found. There was not a significant main effect of self-regulated learning, $F(1, 507) = .789$, $p=.121$, $\eta_p^2=.002$, indicating scores from the two KAPQOSLs did not significantly vary over time. Neither was there a significant main effect of group assignment, $F(4, 507) = .52$, $p=.722$, $\eta_p^2=.004$, which indicated that the groups did not score statistically different from one another regardless of time. Further, there was not a statistically significant interaction effect, $F(4, 507) = 1.84$, $p = .121$, $\eta_p^2=.014$, suggesting that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning in the five groups over time.

Table 7

Phase 1 Inclusive Control and Experimental Group: Mixed ANOVA Results for Self-regulated Learning Measurement by Completion of a Self-monitoring Record Form

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL2	n
C: Completed 0 SMRs	78.35 (*14.57*)		77.91 (*15.64*)	297
E: Completed at least 1 SMR	76.13 (*13.81*)		77.63 (*14.69*)	215
Source	*SS*	*df*	*MS*	*F*
SRL	70.42	1	70.42	.941
Group Assignment	195.15	1	195.15	1.08
SRL * Group Assignment	231.80	1	231.80	3.10
Error	38163.07	510	74.83	

Note. C=Control Group. E= Experimental Group. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.

Table 8

Phase 1 Inclusive Control and Modified Experimental Groups: Mixed ANOVA Results for Self-regulated Learning Measurement by Treatment

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL2	n
C: Completed 0 SMRs	78.35 (*14.57*)		77.91 (*15.64*)	297
E_1: Completed 1 SMR	75.67 (*12.38*)		76.14 (*14.29*)	36
E_2: Completed 2 SMRs	75.32 (*15.43*)		75.60 (*13.79*)	37
E_3: Completed 3 SMRs	78.22 (*13.18*)		77.74 (*14.75)*	49
E_4: Completed 4 SMRs	75.53 (*14.09*)		78.95 (*15.22)*	93
Source	*SS*	*df*	*MS*	*F*
SRL	58.93	1	58.93	.79
Group Assignment	375.44	4	93.84	.52
SRL * Group Assignment	548.05	4	137.01	1.84
Error	37846.82	507	74.65	

Note. C=Control Group. E_1= Experimental Group 1. E_2= Experimental Group 2. E_3= Experimental Group 3. E_4= Experimental Group 4. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.

Phase 1 Exclusive SRL data. The following table presents the results of the mixed ANOVA comparing the control group and the experimental group (Table 9, Figure K3). There was not a significant main effect of self-regulated learning, $F(1, 491) = 1.97$, $p=.161$, $\eta_p^2=.004$, indicating mean scores from the two KAPQOSLs did not significantly vary over time. Neither was there a significant main effect of group assignment, $F(1, 491) = 1.37$, $p=.242$, $\eta_p^2=.003$, which indicated that the groups did not score statistically different from one another regardless of time. Further, there was not a statistically significant interaction effect, $F(1, 491) = 2.41$, $p = .121$, $\eta_p^2=.005$, suggesting that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning in the two groups over time.

The analysis was conducted again comparing the control group and the four modified experimental groups (Table 10, Figure K4). Similar results were found. There was not a significant main effect of self-regulated learning, $F(1, 488) = 1.17$, $p=.279$, $\eta_p^2=.002$, indicating mean scores from the two KAPQOSLs did not significantly vary over time. Neither was there a significant main effect of group assignment, $F(4, 488) = .51$, $p=.728$, $\eta_p^2=.004$, which indicated that the groups did not score statistically different from one another regardless of time. Further, there was not a statistically significant interaction effect, $F(4, 488) = 1.80$, $p = .127$, $\eta_p^2=.015$, suggesting that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning in the five groups over time.

Table 9

Phase 1 Exclusive Control and Experimental Groups: Mixed ANOVA Results for Self-regulated Learning Measurement by Completion of a Self-monitoring Record Form

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL2	n
C: Completed 0 SMRs	78.59 (*14.41*)		78.50 (*15.30*)	282
E: Completed at least 1 SMR	76.31 (*13.84*)		77.95 (*14.56*)	211
Source	*SS*	*df*	*MS*	*F*
SRL	145.75	1	145.75	1.97
Group Assignment	241.21	1	241.21	1.37
SRL * Group Assignment	178.69	1	178.69	2.41
Error	36391.90	491	74.12	

Note. C=Control Group. E= Experimental Group. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.

Table 10

Phase 1 Exclusive Control and Modified Experimental Groups: Mixed ANOVA Results for Self-regulated Learning Measurement by Treatment

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL2	n
C: Completed 0 SMRs	78.59 (*14.41*)		78.50 (*15.30*)	282
E_1: Completed 1 SMR	76.29 (*11.97*)		76.54 (*14.29*)	35
E_2: Completed 2 SMRs	75.54 (*15.84*)		76.17 (*13.68*)	35
E_3: Completed 3 SMRs	78.22 (*13.18*)		77.74 (*14.75)*	49
E_4: Completed 4 SMRs	75.60 (*14.15*)		79.28 (*14.97)*	92
Source	*SS*	*df*	*MS*	*F*
SRL	86.64	1	86.64	1.17
Group Assignment	359.91	4	89.98	.51
SRL * Group Assignment	532.50	4	133.13	1.80
Error	36449.85	488	74.39	

Note. C=Control Group. E_1= Experimental Group 1. E_2= Experimental Group 2. E_3= Experimental Group 3. E_4= Experimental Group 4. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.

Phase 2

During Unit 3, identified as Phase 2, students were asked to complete an online self-monitoring record form after the due date of every other online assignment for a total of two additional occurrences. Included in Phase 2 were students in both the control group and the experimental group who completed the Unit 2 and Unit 3 exams, and/or the in-class questionnaires KAPQOSL1 and KAPQOSL3, and up to six online self-monitoring records.

From the 629 students in the Phase 1 Exclusive sample, an additional 15 (2.4%) students who did not have enough data for comparisons, i.e. no scores for Exam 2 and Exam 3 or KAPQOSL1 and KAPQOSL3, were removed which resulted in a sample of 614 (97.6%) students in Phase 2 with 302 (49%) students who were initially in the control group and 312 (51%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring records they had completed: Group 1 consisted of 77 (24.7%) students who completed one or two of the six forms; Group 2 included 74 (23.7%) students who completed three or four of the six forms; and Group 3 included 132 (42.3%) students who completed five or six of the forms. The remaining 29 (9.3%) students in the experimental group who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus for analysis purposes, the control group had 331 (53.9%) participants. Out of this sample of 614 students, scores from 610 (99.3%) students who completed both Exam 2 and Exam 3 and scores from 464 (75.6%) students who completed both KAPQOSL1 and KAPQOSL3 were explored and analyzed.

Descriptive Statistics

The means, standard deviations, and medians for achievement scores on Exam 2 and Exam 3 and self-regulated learning scores from KAPQOSL1 and KAPQOSL3 are presented in Table 11 for the sample, the control group, the experimental group, and the modified experimental groups in Phase 2. The scores for the exams were based on 100 points and the scores for the KAPQOSLs were out of 110 points possible.

When considering mathematics achievement, overall the means on Exam 3 were lower than the means on Exam 2 suggesting that Exam 3 was more difficult. The experimental group which completed one or two of the six online self-monitoring record forms had the lowest mean score for Exam 3 while the group which completed three or four of the six online self-monitoring record forms had the highest mean score for this exam. In regards to self-regulated learning, the experimental group which completed one or two of the six online self-monitoring record forms had the highest mean score for KAPQOSL1. Of the modified experimental groups, the group which completed three or four online self-monitoring record forms had the lowest mean score for KAPQOSL1 but the highest mean score for KAPQOSL3, resulting in the largest increase (4.2%) in mean score.

Table 11

Phase 2: Means, Standard Deviations, and Medians

	Sample	Control	Experimental	Modified Experimental Groups		
				1-2 SMRs	3-4 SMRs	4-5 SMRs
	N= 614	*N*= 331	*N*= 283	*N*= 77	*N*= 74	*N*= 132
Exam 2 (100 pts)	80.26 (*14.41*) *N*= 610 median=83	79.47 (*14.63*) *N*= 329 median=82	81.18 (*14.13*) *N= 281* median=85	81.35 (*11.14*) *N*= 77 median=82	81.84 (*12.50*) *N*= 73 median=85	80.72 (*16.73*) *N*= 131 median=85
Exam 3 (100 pts)	71.94 (20.19) *N*=610 median= 77	72.08 (20.10) *N*=329 median= 77	71.77 (20.33) *N*=281 median= 77	68.32 (20.50) *N*=77 median= 73	73.47 (17.58) *N*=73 median= 77	72.85 (22.28) *N*=131 median= 79
KAPQOSL 1 (110 pts)	77.69 (13.66) *N*= 464 median= 77	78.35 (13.63) *N*= 245 median= 77	76.95 (13.68) *N*= 219 median= 77	79.30 (14.23) *N*= 54 median= 81	75.49 (13.63) *N*= 61 median= 77	76.59 (13.40) *N*= 104 median= 77
KAPQOSL 3 (110 pts)	78.62 (*14.98*) *N*= 464 median= 80	77.92 (*15.43*) *N*= 245 median= 79	79.41 (*14.46*) *N*= 219 median= 80	79.23 (*15.43*) *N*= 54 median=80	80.11 (*12.89*) *N*= 61 median= 81	79.09 (*14.93*) *N*= 104 median= 80

Note. SMR=Self monitoring record administered online. KAPQOSL= Questionnaire of self-regulated learning with possible score of 110 points. Standard deviations are given in parentheses next to mean scores.

Inferential Statistics

A series of ANCOVAs were conducted to investigate the impact of the completion of self-monitoring record forms on students' mathematics achievement. Prior to completing the analysis, statistical tests were run to screen for underlying assumptions. The data were found to meet the assumptions of homogeneity of variance and homogeneity of regression slopes. Yet *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics revealed that the assumption of normality had been violated in all data sets. As the mean scores from Exam 2 and Exam 3 were slightly to moderately negatively skewed, as recommended (Tabachnick & Fidell, 2001), the scores were transformed by reflecting and then taking the square root to normalize the distribution. Procedures were used again to assess the normality of the transformed data sets and all calculations reflected acceptable measures.

The data analysis was conducted using group assignment based on the completion of self-monitoring record forms as the independent variable, transformed Exam 3 scores as the dependent variable, and transformed prior Exam 2 scores as the covariate. The transformed and adjusted mean scores and ANCOVA results using the control and experimental groups in Phase 2 are presented in Table 12. The results showed that there was a statistically significant effect of the completion of self-monitoring record forms on Exam 3 scores after controlling for the effect of scores on the prior exam $F(1, 607) = 4.20$, p=.041, η_p^2=.007, indicating that the control group performed significantly better on Exam 3 than the experimental group. Yet the effect size of 0.7% for this situation was small which indicated that group assignment accounted for less than one percent in the variance in scores.

Table 12
Phase 2 Control Group and Experimental Group: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

	Achievement			
Group	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	5.03	4.94	1.91	329
E: Completed at least 1 SMR	5.06	5.16	1.90	281
Source	*SS*	*df*	*MS*	*F*
Exam 2	1129.75	1	1129.75	633.97*
Group Assignment	7.48	1	7.48	4.20*
Error	1081.70	607	1.78	

Note. C=Control Group. E= Experimental Group. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .51, Adj. R^2 = .51, adjustments based on Transformed Exam 2 mean = 4.29. Homogeneity of regression tested and not significant: F< .001, p > .05. Transformed Exam 2 regression coefficient = .89*.
* p < .05.

The data analysis was conducted again comparing the control group and the three modified experimental groups. The transformed and adjusted mean scores and results of this analysis (Table 13) indicated that at least one group's mean score was statistically significantly different from the others on Exam 3 after controlling for the effect of scores on the prior exam $F(3, 605) = 3.49$, p=.016, η_p^2=.017, but the effect size of 1.7% was also small, indicating that group designation accounted for a small amount of variance in scores. The adjusted means showed that the control group performed better than all other groups. Subsequent comparisons (Table 14) indicated that the experimental group which completed one or two self-monitoring record forms performed statistically significantly lower on Exam 3 when compared to both the control group which completed no self-monitoring record forms and the experimental group which completed five or six self-monitoring forms.

Table 13

Phase 2 Control and Modified Experimental Groups: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

	Achievement			
Group	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	5.03	4.94	1.91	329
E_5: Completed 1-2 SMRs	5.44	5.48	1.76	77
E_6: Completed 3-4 SMRs	5.00	5.09	1.61	73
E_7: Completed 5-6 SMRs	4.87	5.02	2.10	131

Source	*SS*	*df*	*MS*	*F*
Exam 2	1124.71	1	1124.71	653.53*
Group Assignment	18.50	3	6.17	3.49*
Error	1070.67	605	1.77	

Note. C=Control Group. E_5= Experimental Group 5. E_6= Experimental Group 6. E_7= Experimental Group 7. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .52, Adj. R^2 = .51, adjustments based on Transformed Exam 2 mean = 4.29. Homogeneity of regression tested and not significant: F = .74, p > .05. Transformed Exam 2 regression coefficient = .89*.

* p < .05.

Table 14

Phase 2 Control and Modified Experimental Groups: Follow-up Comparison and Mean Difference in Achievement by Completion of a Self-monitoring Record Form

Comparison	Mean Difference	s.e.	Bonferroni Adjusted 95% CI
C: Completing 0 vs. E_5: Completing 1-2 SMRs	-.51**	.17	-.87, -.21
C: Completing 0 vs. E_6: Completing 3-4 SMRs	-.15	.17	-.48, .19
C: Completing 0 vs. E_7: Completing 5-6 SMRs	-.08	.14	-.35, .19
E_5: Completing 1-2 vs. E_6: Completing 3-4 SMRs	.40	.22	-.03, .82
E_5: Completing 1-2 vs. E_7: Completing 5-6 SMRs	.46*	.19	.09, .84
E_6: Completing 3-4 vs. E_7: Completing 5-6 SMRs	.07	.19	-.31, .45

Note. C=Control Group. E_5= Experimental Group 5. E_6= Experimental Group 6. E_7= Experimental Group 7.SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. Comparisons based on ANCOVA adjusted means controlling for Exam 2 mean of 4.29.

* $p < .05$, ** $p < .01$, where *p*-values were adjusted using the Bonferroni Method.

A series of mixed ANOVAs were conducted to identify any significant relationships between completion of self-monitoring record forms and levels of self-regulated learning with a within-subject variable of self-regulated learning, measured by KAPQOSL1 and KAPQOSL3 scores, and a between-subjects variable of group assignment which was determined by level of treatment. Since the repeated measure variable, KAPQOSL, had only 2 levels, the assumption of sphericity was met (Field, 2005). The data analysis was conducted comparing the control group and the experimental group. The results are presented in Table 15 and Figure K5. There was not a significant main effect of self-regulated learning, $F(1, 462) = 2.89$, $p=.09$, $\eta_p^2=006$, indicating mean scores from the two KAPQOSLs did not significantly vary over time. Neither was there a significant main effect of group assignment, $F(1, 462) = .001$, $p=.97$, $\eta_p^2<.001$, which indicated that the groups did not score statistically different from one another regardless of time. Yet there was a statistically significant interaction effect, $F(1, 462) = 5.82$, p=.016, η_p^2=.012, suggesting that having an experience completing a self-monitoring record form had a different effect on levels of self-regulated learning in the two groups over time.

To follow up the statistical significant interaction indicated by the analysis between self-regulated learning and treatment group, two paired sample *t*-tests were performed. Using a Bonferonni adjustment for Type 1 error, results identified that the experimental group significantly increased its level of self-regulated learning from the beginning of the study, $t(218)$=-2.96, p=.003, indicating that having at least one experience of completing a self-monitoring record form online significantly increased students' level of self-regulated learning over time.

Table 15
Phase 2 Control Group and Experimental Group: Mixed ANOVA Results for Self-regulated Learning Measurement by Completion of a Self-monitoring Record Form

	Self-regulated Learning			
Group	KAPQOSL1	KAPQOSL3	n	
C: Completed 0 SMRs	78.35 (*13.63*)	77.92 (*15.43*)	245	
E: Completed at least 1 SMR	76.95 (*13.68*)	79.41 (*14.46*)	219	
Source	*SS*	*df*	*MS*	*F*
SRL	238.76	1	238.76	2.89
Group Assignment	.477	1	.477	.001
SRL * Group Assignment	479.94	1	479.94	5.82*
Error	38113.60	462	82.50	

Note. C=Control Group. E= Experimental Group. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.
* $p < .05$

The data analysis was conducted again comparing the control group and the three modified experimental groups (Table 16, Figure K6). There was a significant main effect of self-regulated learning, $F(1, 460) = 5.50$, p=.019, η_p^2=.012, indicating scores from the two

KAPQOSLs were statically different across time but there was not a significant main effect of group assignment, $F(3, 460) = .172$, p=.916, η_p^2=.001which indicated that the groups did not score statistically different from one another regardless of time. Yet there was a statistically significant interaction effect, $F(3, 460) = 3.22$, p=.023, η_p^2=.021 indicating that having an experience completing a self-monitoring record form had a different effect on levels of self-regulated learning in the groups over time.

To follow up the statistical significant interaction indicated by the analysis between self-regulated learning and treatment group, four paired sample *t*-tests were performed. Using a Bonferonni adjustment for Type 1 error, results indicated that the only difference in levels of self-regulated learning over time found to be statistically significant occurred in the modified experimental group which completed three or four of the six self-monitoring records, $t(60)=-3.19$, p=.002.

Table 16

Phase 2 Control and Modified Experimental Groups: Mixed ANOVA Results for Self-regulated Learning Measurement by Treatment

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL3	n
C: Completed 0 SMRs	78.35 (*13.63*)		77.92 (*15.43*)	245
E_5: Completed 1-2 SMRs	79.30 (*14.23*)		79.23 (*15.43*)	54
E_6: Completed 3-4 SMRs	75.49 (*13.63*)		80.11 (*12.89*)	61
E_7: Completed 5-6 SMRs	76.59 (*13.40*)		79.09 (*14.93*)	104
Source	*SS*	*df*	*MS*	*F*
SRL	451.53	1	451.53	5.50*
Group Assignment	84.79	1	28.26	.001
SRL * Group Assignment	793.74	3	264.58	3.22*
Error	37799.79	460	82.17	

Note. C=Control Group. E_5= Experimental Group 5. E_6= Experimental Group 6. E_7= Experimental Group 7. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online. * $p < .05$

Phase 3

During Unit 4, identified as Phase 3, no students were required to complete any self-monitoring record forms. Included in Phase 3 were students in both the control group and the experimental group who completed the Unit 3 and Unit 4 exams, and/or the in-class questionnaires KAPQOSL1 and KAPQOSL4, and up to six online self-monitoring records.

From the 629 students in the Phase 1 Exclusive sample, an additional 31 (4.9%) students who did not have enough data for comparisons, i.e. no scores for Exam 3 and Exam 4 or KAPQOSL1 and KAPQOSL4, were removed which resulted in data from 598 (95.1%) students in Phase 3 with 295 (49.3%) students who were initially in the control group and 303 (50.7%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring records they had completed: Group 1 consisted of 75 (24.8%) students who completed one or two of the six forms; Group 2 included 72 (23.8%) students who completed three or four of the six forms; and Group 3 included 131 (43.2%) students who completed five or six of the forms. The remaining 25 (8.2%) students in the experimental group who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus for analyses purposes, the control group had 320 (53.5%) participants. Of the 598 students included in the sample, scores from 597 (99.8%) students who completed both Exam 3 and Exam 4 and scores from 449 (75.1%) students who completed both KAPQOSL1 and KAPQOSL4 were explored and analyzed.

Descriptive Statistics

The means, standard deviations, and medians for achievement scores on Exam 3 and Exam 4 and self-regulated learning scores from KAPQOSL1 and KAPQOSL4 are presented in

Table 17 for the control group, the experimental group, and the modified experimental groups in Phase 3. The scores for the exams were based on 100 points and the scores for the KAPQOSLs were out of 110 points possible.

When considering mathematics achievement, data analysis showed that overall the means on Exam 4 were higher than the means on Exam 3 suggesting that Exam 4 was less difficult. The experimental group as a whole, as well as each modified experimental group, had higher mean scores for Exam 4 than the control group. Of the modified experimental groups, the group which completed one or two of the six online self-monitoring record forms had the lowest mean score for Exam 4. The results concerning self-regulated learning indicated that the control group had the highest mean score for KAPQOSL1 of all the groups. Of the modified experimental groups, the group which completed one or two of the six online self-monitoring record forms had the highest mean score for KAPQOSL1. The mean scores for KAPQOSL4 showed that the experimental group as a whole had a larger increase in self-regulated learning mean score than the control group. Further examination of the modified experimental groups separately showed that each group increased their score but the group which completed 1 or 2 of the six online self-monitoring record forms had the largest gain in mean score (3.1%).

Table 17
Phase 3: Means, Standard Deviations, and Medians

				Modified Experimental Groups		
	Sample *N*= 598	Control *N*= 320	Experimental *N*= 278	1-2 SMRs *N*= 75	3-4 SMRs *N*= 72	5-6 SMRs *N*= 131
Exam 3 (100 pts)	72.50 (*19.80*) *N*=597 median= 77	72.76 (*19.56*) *N*=319 median= 77	72.18 (*20.16*) *N*=276 median= 77.5	68.68 (*20.60*) *N*=75 median= 73	73.94 (*17.45*) *N*=71 median= 78	73.23 (*21.17*) *N*=130 median= 79
Exam 4 (100 pts)	74.56 (18.22) *N*= 597 median= 79	73.73 (17.98) *N*=319 median= 78	75.60 (20.16) *N*=276 median= 80	73.79 (17.14) *N*=75 median= 79	76.00 (15.21) *N*=71 median= 79	76.43 (20.81) *N*=130 median= 82.5
KAPQOSL 1 (110 pts)	77.31 (*13.75*) *N*= 449 median= 77	78.25 (*13.59*) *N*= 235 median= 77	76.29 (*13.88*) *N*= 214 median= 76	76.83 (*14.02*) *N*= 52 median= 77	75.68 (*14.21*) *N*= 57 median= 76	76.34 (*13.76*) *N*= 105 median= 76
KAPQOSL 4 (110 pts)	78.93 (*15.84*) *N*= 449 median= 79	78.77 (*15.84)* *N*= 235 median= 79	79.11 (*15.87*) *N*= 214 median= 78	80.22 (*16.88*) *N*= 52 median= 81	78.07 (*12.98*) *N*= 57 median= 77	79.11 (*16.86*) *N*= 105 median= 77

Note. SMR=Self monitoring record administered online. KAPQOSL= In-class questionnaire of self-regulated learning with possible score of 110 points. Standard deviations are given in parentheses next to mean scores.

Inferential Statistics

A series of ANCOVAs were conducted to investigate the impact of the completion of self-monitoring record forms on students' mathematics achievement. Prior to completing the analysis, statistical tests were run to screen for underlying assumptions. The data were found to meet the assumptions of homogeneity of variance and homogeneity of regression slopes. Yet *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics revealed that the assumption of normality had been violated for the control and experimental groups as well as the subsets of the experimental group. As the mean scores from Exam 3 and Exam 4 were slightly to moderately negatively skewed, as recommended (Tabachnick & Fidell, 2001), the scores were transformed by reflecting and then taking the square root to normalize the distribution. Procedures were used again to assess the normality of the transformed data set and all calculations reflected acceptable measures.

The data analysis was conducted using group assignment based on the completion of self-monitoring record forms as the independent variable, transformed Exam 4 scores as the dependent variable, and transformed prior Exam 3 scores as the covariate. The transformed and adjusted mean scores and ANCOVA results for Phase 3 are presented in Table 18. The results showed that the experimental group performed statistically better than the control group on Exam 4 after controlling for the effect of scores on the prior exam $F(1, 592) = 6.87$, p=.009, η_p^2=.01. Yet the effect size for this situation was small which indicated that group assignment accounted for one percent in the variance in scores.

Table 18

Phase 3 Control Group and Experimental Group: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

	Achievement			
Group	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.93	4.95	1.73	319
E: Completed at least 1 SMR	4.71	4.69	1.80	276
Source	*SS*	*df*	*MS*	*F*
Exam 3	997.21	1	997.21	702.82**
Group Assignment	9.76	1	9.76	6.87**
Error	841.17	592	1.42	

Note. C=Control Group. E= Experimental Group. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .54, Adj. R^2 = .54, adjustments based on Transformed Exam 3 mean = 5.00. Homogeneity of regression tested and not significant: F = .24, p > .05. Transformed Exam 3 regression coefficient = .69*.
* p < .05. , ** p < .01

The data analysis was conducted again comparing the control group and the three modified experimental groups. The results of this analysis (Table 19) indicated that there was not a statistically significant effect of the completion of self-monitoring record forms on Exam 4 scores after controlling for the effect of scores on the prior exam $F(3, 590) = 2.57$, p =.054, η_p^2=.013.

Table 19

Phase 3 Control and Modified Experimental Groups: Descriptive Statistics for Achievement by Completion of a Self-monitoring Record Form and ANCOVA Results

Group	Achievement			
	Observed Mean	Adjusted Mean	SD	n
C: Completed 0 SMRs	4.93	4.95	1.73	319
E_5: Completed 1-2 SMRs	4.96	4.68	1.61	75
E_6: Completed 3-4 SMRs	4.77	4.80	1.52	71
E_7: Completed 5-6 SMRs	4.53	4.64	2.02	130
Source	*SS*	*df*	*MS*	*F*
Exam 3	989.12	1	989.12	694.77**
Group Assignment	10.97	3	3.66	2.57
Error	839.77	590	1.42	

Note. C=Control Group. E_5= Experimental Group 5. E_6= Experimental Group 6. E_7= Experimental Group 7. SMR= Self-monitoring record form administered online. Scores were transformed by reflecting and taking the square root of original scores. R^2 = .54, Adj. R^2 = .54, adjustments based on Transformed Exam 3 mean = 5.00. Homogeneity of regression tested and not significant: F = 1.12, $p > .05$. Transformed Exam 3 regression coefficient = .69*.
* $p < .05$.

A series of mixed ANOVAs were conducted to identify any significant relationships between completion of self-monitoring record forms and levels of self-regulated learning with a within-subject variable of self-regulated learning, measured by KAPQOSL1 and KAPQOSL4 scores, and a between subjects variable of group assignment which was determined by level of treatment. Since the repeated measure variable, KAPQOSL scores, had only 2 levels, the assumption of sphericity was met (Field, 2005). The data analysis was conducted comparing the control group and the experimental group. The results are presented in Table 20 and Figure K7. There was a significant main effect of self-regulated learning, $F(1, 447) = 6.77$, p=.01, η_p^2=.015 indicating that mean scores from the two KAPQOSLs varied significantly as a function of time but there was not a significant main effect of group assignment, $F(1, 447) = .427$, p=.514, η_p^2=.001,which indicated that the groups did not score statistically different from one another regardless of time. Further, there was a not a statistically significant interaction effect, $F(1, 447)$

= 3.17, p =.075, η_p^2=.007, indicating that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning between the two groups over time.

Table 20

Phase 3 Control Group and Experimental Group: Mixed ANOVA Results for Self-regulated Learning Measurement by Completion of a Self-monitoring Record Form

	Self-regulated Learning			
Group	KAPQOSL1		KAPQOSL4	n
C: Completed 0 SMRs	78.25 (*13.59*)		78.77 (*15.84*)	235
E: Completed at least 1 SMR	76.29 (*13.88*)		79.11 (*15.87*)	214
Source	*SS*	*df*	*MS*	*F*
SRL	627.64	1	627.64	6.77*
Group Assignment	74.11	1	74.11	.427
SRL * Group Assignment	294.31	1	294.31	3.17
Error	41443.95	447	92.72	

Note. C=Control Group. E= Experimental Group. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.

* $p < .05$

The data analysis was conducted again comparing the control group and the three modified experimental groups. The results are presented in Table 21 and Figure K8. There was a significant main effect of self-regulated learning, $F(1, 445) = 8.76$, p=.003, η_p^2=.019, indicating mean scores from the two KAPQOSLs varied significantly over time but there was not a significant main effect of group assignment, $F(3, 445) = .283$, p=.837, η_p^2=.002, which indicated that the groups did not score statistically different from one another regardless of time. Further, there was a not a statistically significant interaction effect, $F(3, 445) = 1.10$, p = .347, η_p^2=.007, suggesting that having an experience completing a self-monitoring record form did not have a statistically significant effect on levels of self-regulated learning in the different groups over time.

Table 21

Phase 3 Control and Modified Experimental Groups: Mixed ANOVA Results for Self-regulated Learning Measurement by Treatment

	Self-regulated Learning			
Group	KAPQOSL1	KAPQOSL4		n
C: Completed 0 SMRs	78.25 (*13.59*)	78.77 (*15.84)*		235
E_5: Completed 1-2 SMRs	76.83 (*14.02*)	80.22 (*16.88*)		52
E_6: Completed 3-4 SMRs	75.68 (*14.21*)	78.07 (*12.98*)		57
E_7: Completed 5-6 SMRs	76.34 (*13.76*)	79.11 (*16.86*)		105
Source	*SS*	*df*	*MS*	*F*
SRL	815.30	1	815.30	8.76**
Group Assignment	148.09	3	49.36	.837
SRL * Group Assignment	308.37	3	102.79	1.10
Error	41429.88	445	93.10	

Note. C=Control Group. E_5= Experimental Group 5. E_6= Experimental Group 6. E_7= Experimental Group 7. KAPQOSL=In-Class questionnaire of self-regulated learning with possible score of 110 points. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online.
* $p < .05$, * $p < .01$.

Correlation between Student Achievement and Self-regulated Learning

Relationships between students' scores on the fourth KAPQOSL and their final course grades scaled as percents were investigated. Scatter plots were constructed using the sample data to check for linear relationships between students' composite scores on the fourth KAPQOSL and their final course grades as well as students' scores on each subscale of the fourth KAPQOSL, Goal Setting, Environment Structuring, Task Strategies, Time Management, Help Seeking, and Self-evaluation, and their final course grades. There was a general trend in the data such that higher composite KAPQOSL scores were associated with higher final course grades. Less evident were any trends between subscale KAPQOSL scores and final course grades.

Pearson product-moment correlation coefficients were calculated to measure the strength of the relationship between a student's composite score on the fourth KAPQOSL and the student's final course grade as well as students' scores on each subscale of the fourth KAPQOSL and their final course grades. The data analysis was conducted using the sample data, again using the control group and the experimental group from the final phase of the experiment, and then using the modified experimental groups from the final phase.

The results (Table 22) showed significant relationships for some groups. There was a positive correlation between students' level of self-regulated learning and their final course grade for the experimental group, $r(227) = .17$, $p = .005$, though it indicated a weak relationship, for the modified experimental group which completed 1 or 2 self-monitoring record forms, $r\ (56) = .32$, $p = .007$, indicating a moderate strength in relationship, and for the modified experimental group which completed 3 or 4 self-monitoring records $r\ (57) = .24$, $p = .033$, indicating a weak strength in relationship.

All groups except the control group were found to have positive correlations between students' subscale scores of Goal Setting, which included 5 questions, and their final course grades: weak relationships were identified for the entire sample $r(484) = .17$, $p = .005$, and the modified experimental group which completed 5 or 6 self-monitoring record forms $r(110) = .19$, $p = .024$; moderate relationships were identified for the experimental group as a whole $r(227) = .31$, $p < .001$, the modified experimental group which completed 1 or 2 self-monitoring record forms $r(56) = .49$, $p = .007$, and the modified experimental group which completed 3 or 4 self-monitoring record forms $r(57) = .33$, $p = .006$. The experimental group as a whole and the experimental group which completed 3 or 4 self-monitoring record forms in particular had small positive relationships between the subscale score Environment Structuring, which consisted of 4 items, and final course grade, $r(227) = .15$, $p = .011$ and $r(57) = .25$, $p = .027$ respectively. Finally, the experimental group which completed one or two of the self-monitoring record forms also had subscale scores of Help Seeking and Self-evaluation which were significantly related to final course grades $r(56) = .23$, $p = .042$ and $r(56) = .22$, $p = .045$.

Table 22

Correlations between Students' Final Course Grade and Self-regulated Learning Composite and Subscale Scores

SRL Scores	Final Course Grade					
	Sample (n=486)	Control (n=257)	Exp (229)	E_5 (n=58)	E_6 (n=59)	E_7 (n=112)
1. Composite	.06	-.05	.17**	.32**	.24*	.07
2. SS Goal Setting (5 items)	.17**	.03	.31**	.49**	.33**	.19*
3. SS Environment Structuring (4 items)	.07	-.01	.15*	.14	.25*	.09
4. SS Task Strategies (3 items)	-.02	-.07	.03	.19	.12	-.07
5. SS Time Management (3 items)	-.00	-.10	.09	.21	.15	.03
6. SS Help seeking (4 items)	.02	-.08	.11	.23*	.04	.10
7. SS Self-evaluation (3 items)	.01	-.02	.04	.22*	.10	-.03

Note. E_5= Experimental Group 5, completed 1-2 SMRs. E_6= Experimental Group 6, completed 3-4 SMRs. E_7= Experimental Group 7, completed 5-6 SMRs. SS= Subscale score. SRL = Self-Regulated Learning Measurement determined by KAPQOSL scores. SMR = Self-monitoring record form administered online. Course grades were scaled to percents.

* $p < .05$, ** $p < .005$

CHAPTER 5

Summary, Conclusions, and Recommendations

Summary

Currently almost 80% of high school graduates continue in postsecondary education (Aud, Hussar, Kena, Bianco, Frohlich, Kemp, & Tahan, 2011), yet, many of these students are unprepared to take college-level courses (Aud et al., 2011; Bahr, 2010; Bettinger & Long, 2009; Boylan, 2009; Martorell & McFarlin, 2011; Parsad, Lewis, & Greene, 2003). Being unprepared for college coursework is a widespread phenomenon among students attending college (Attewell, Lavin, Domina, & Levey, 2006; Aud et al., 2011; Breneman, 1998; Martorell & McFarlin, 2011) as it was reported that over 2 million students annually fall into this group who are not ready (Boylan, 2009). Based on entrance exam scores reported by American College Testing (ACT, 2005, 2012), students have shown deficiencies in mathematics, science, reading, and writing.

For most undergraduate degrees, students are required to fulfill a baseline of mathematics requirements, however some students must begin coursework in a developmental mathematics course (Bettinger & Long, 2009). Developmental mathematics, sometimes referred to as remedial mathematics, mathematics skills courses, or college preparatory mathematics courses, at postsecondary institutions have been described as non-credit prerequisite courses designed to strengthen the computational skills as well as conceptual understanding of students who are unprepared for college-level mathematics (Bahr, 2008, 2010; Bettinger & Long, 2009; Bonham & Boylan, 2011; Brothen & Wambach, 2004; Donovan & Wheland, 2008; Gerlaugh, Thompson, Boylan, & Davis, 2007; Kinney, 2001; Martorell & McFarlin, 2011; Parsad et al., 2003). These courses are intended to help students gain the knowledge and understanding required to be successful in subsequent credit-bearing college-level mathematics courses (Attewell et al., 2006; Hammerman & Goldberg, 2003).

The students enrolled in developmental mathematics courses are a part of a large sector of the student population enrolled in postsecondary institutions (Bettinger & Long, 2009; Bonham & Boylan, 2011; Breneman, 1998; Donovan & Wheland, 2008; Duranczyk & Higbee, 2006; Golfin, Jordan, Hull, & Ruffin, 2005; Martorell & McFarlin, 2011; Parsad et al., 2003). Parsad, Lewis, and Greene (2003) reported that in the fall of 2000, 71% of all US degree-granting postsecondary institutions offered at least one remedial course in mathematics with an average of 2.5 remedial mathematics courses offered by an institution. It was also reported that a larger portion of incoming freshmen enrolled in a developmental mathematics course (22%) than a developmental course in writing (14%) or reading (11%) (Parsad et al., 2003).

Research has indicated that students who attain college-level mathematics skills, regardless of their initial skill deficiency in mathematics, by successfully completing a developmental program, experience long-term academic outcomes that are similar to their college-ready counterparts (Bahr, 2008, 2010; Bettinger & Long, 2009). Success in developmental mathematics courses is a prerequisite for subsequent credit-bearing mathematics courses and therefore the completion of the developmental course becomes a gateway for attaining a postsecondary degree for students enrolled in these courses (Bettinger & Long, 2009; Boylan, 2009; Collins, 2010; Duranczyk & Higbee, 2006; Hall & Ponton, 2005; Levin & Calcagno, 2008; Noel-Levitz, 2006; Smittle, 2003). However, a large number of students are not successful in completing a developmental mathematics course (Bahr, 2008). Research has also indicated that "in the absence of successful remediation, declining math skills foreclose academic opportunities" (Bahr, 2008, p. 440).Therefore, identifying ways to increase the student success rate in developmental mathematics courses is an important issue faced by many postsecondary institutions (Bahr, 2008).

Instruction in developmental courses is being transformed by the use of the Internet in delivering some instruction (Ellis, Ginns, & Piggott, 2009; Parsad et al., 2003; Wadsworth, Husman, Duggan, & Pennington, 2007; Yen & Lee, 2011). Using the Internet for instruction, online learning, or electronic learning (e-learning), is a growing trend in the use of educational technology, in both K-12 and postsecondary institutions (Ellis et al., 2009; Yen & Lee, 2011). Alongside this trend, blended learning, blending face-to-face instruction with online learning activities (Allen & Seaman, 2011; Bluic, Goodyear, & Ellis, 2007; Kim & Bonk, 2006; Lust, Vandewaetere, Ceulemans, Elen, & Clarebout, 2011; Means, Toyama, Murphy, Bakia, & Jones, 2010; Picciano, Seaman, Shea, & Swan, 2012; Vaughan, 2007; Wu, Tennyson & Hsia, 2010; Yen & Lee, 2011), is emerging as a common learning environment in higher education (Chen, Lambert, & Guidry, 2010; Garrison & Kanuka, 2004; Lust et al., 2011; Means et al., 2010). It is estimated that almost 70% of students in higher education were enrolled in at least one blended, or hybrid, course during the 2008 academic year (Chen et al., 2010).

Research suggests that a course completed online is as effective as one taught face-to-face (Dziuban, Hartman, & Moskal, 2004; López-Pérez, Pérez- López, & Rodríguez-Ariza, 2011; Means et al., 2010; Underwood, 2009; Vaughan, 2007) and that a blended course shows higher gains in student performance than either type of instruction alone (López-Pérez et al., 2011; Means et al., 2010; Underwood, 2009; Vaughan, 2007). There are many perceived benefits of integrating online learning with face-to-face instruction including an increase in learning time (Garrison & Kanuka, 2004; Vaughan, 2007), flexibility of time and space (Garrison & Kanuka, 2004; Vaughan, 2007; Yen & Lee, 2011), instructional richness (Wu et al., 2010), enhanced teacher-student interactions (Vaughan, 2007), and increased motivation (Garrison & Kanuka, 2004; López-Pérez et al., 2011).

Although research has identified many educational benefits associated with integrating digital technologies in a course, some challenges have also been identified with the blended learning experience (Garrison & Kanuka, 2004; Lust et al., 2011; Lust, Collazo, Elen, & Clarebout, 2012; Paechter & Maier, 2010; Stacey & Gerbic, 2008; Vaughn, 2007; Yen & Lee, 2011). Researchers have reported that there is a complexity in dealing with two environments for both students and instructors (Stacey & Gerbic, 2008) and oftentimes both groups lacked adequate support (Vaughn, 2007). Students are required to be active learners when working online and some students perceived this accountability as challenging (Vaughn, 2007), had difficulty managing their time spent on online activities (Paechter & Maier, 2010; Vaughn, 2007), maintaining motivation, and learning to use the technology (Vaughn, 2007). Researchers conjectured that some students may not be good judges of their own learning or the functionalities of the various tools (Lust et al., 2011; Lust et al., 2012; Yen & Lee, 2011; Winters, Greene, Costich, 2008). Research also indicates not all students used the technology nor profited from the technology in the same ways (Lust et al., 2011; Lust et al., 2012; Yen & Lee, 2011) and many students failed to take full advantage of available tools (Winters et al., 2008).

Online learning environments offer rich toolsets to support student learning, yet it is up to the individual learner to decide which tools to use and in which manner (Winters et al., 2008); learning that takes place online requires students to be active rather than passive learners (Winters et al., 2008) and as these environments offer more freedom in learning, students must also be self-directed (Wang, 2011) and self-motivated (Yen & Lee, 2011), characteristics of a self-regulated learner (Zimmerman, 2002). It has been suggested that the quality of a student's self-regulated learning behaviors is connected to his/her academic achievement when working in an online learning environment (Kaufman, Zhao & Yang, 2011; Winters et al., 2008). Further, research (Kinney, 2001; Ley & Young, 1998; Wambach, Brothen, & Dikel, 2000) has specifically investigated the differences between developmental students and regular admission students and results suggested that these groups of students may differ "in the way they plan, organize, monitor, evaluate, and even think about the learning process" (Ley & Young, 1998, p.47). These findings imply that developmental students are less self-regulated than their college-ready counterparts.

Self-regulated learning (SRL) is described as an active process of learning comprised of metacognitive, motivational and behavioral constructs (Elliott, Hufton, Illushin, & Willis, 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008). Self-regulated learners, influenced by their beliefs, orient their behaviors and adjust their efforts to accomplish goals that they have set (Elliott et al., 2005; Pintrich, 1999; Pintrich & Zusho, 2002; Schmitz & Perels, 2011; Zimmerman, 1994, 2002, 2008), transforming "their mental abilities into academic skills" (Zimmerman 2002, p. 65). These learners are described as confident and strategic (Zimmerman, 1994), with an ability to self-start and persist in completing tasks (Cervone, Jiwani, & Wood, 1991; Zimmerman, 1994). They are self-evaluative (Zimmerman, 1994, 2002), able to seek help if needed (Newman, 2002; Zimmerman, 1994), and modify their environment to accomplish tasks (Zimmerman, 1994, 2002).

Self-regulated learning is not a skill that an individual possesses but rather the ability to select, use, evaluate and modify strategies flexibly to accomplish specific learning tasks (Zimmerman, 2002). A substantial body of research indicates that students who are self-regulated are more likely to have academic success (Lan, 1996; Perels, Dignath, & Schmitz, 2009; Pintrich, 1999; Pintrich & De Groot, 1990; Pintrich & Zusho, 2002). Correlation studies have identified variables related to self-regulated learning indicating a positive correlation between (a) self-regulation and academic achievement (Lan, 1996; Perels et al., 2009; Pintrich, 1999; Pintrich & De Groot, 1990; Pintrich & Zusho, 2002), (b) self-regulation and self-efficacy (Cervone et al., 1991; Hall & Ponton, 2005; Pintrich, 1999), and (c) self-regulation and motivational beliefs (Pintrich, 1999; Pintrich & De Groot, 1990). In experimental studies (Kaufman et al., 2011; Lan, 1996; Ley & Young, 1998, 2001; Perels et al., 2009; Pintrich, 1999; Schmitz & Perels, 2011; Zimmerman, 2008), investigators have tested specific intervention effects and identified relationships between self-regulated learning and other learning variables. Self-monitoring (Kaufman et al., 2011; Ley & Young, 1998, 2001), organizing (Ley & Young, 2001), self-evaluation (Ley & Young, 2001), and goal setting (Pintrich, 1999; Zimmerman, 2008) are a few strategies that have been found to increase student achievement.

Self-monitoring, which was introduced as a data recording technique, was found to transform an individual's behaviors; the mere act of recording one's own behaviors could change behaviors (Lan, 1996; Ley & Young, 2001; Schmitz & Perels, 2011). Self-monitoring as a self-regulated learning strategy has been described as a conscious awareness of one's behaviors; the individual evaluates the effectiveness of his/her behaviors and makes decisions about subsequent actions based on these judgments (Lan, 1996) which can happen during a specific phase or throughout the complete cycle of self-regulation (Schmitz & Perels, 2011). Various monitoring strategies, such as self-testing and tracking of attention, can inform the learner about his/her level of attention, comprehension of and how to complete the task, and ability to complete the task

(Pintrich, 1999). Any perceived breakdowns and/or obstacles can then be managed using regulation strategies (Pintrich, 1999).

The act of recording behavior, mentally paying attention to the behavior and/or physically recording the behavior, has been shown to affect changes in the behavior, referred to as reactivity effects (Schmitz & Perels, 2011). Schmitz and Perels (2011), through their literature review, were able to identify explanations for reactivity to self-monitoring: attention focusing, reminder/checklist, and self-reflection. Asking and answering questions in regards to specific behaviors focuses attention and often will lead to changes in those behaviors. Similarly, a checklist instrument acts as a reminder providing cues for important topics which can alter behavior. Self-reflection stimulates more focused attention on the behavior and provides opportunities to consider changing behavior if needed to reach goals.

Self-monitoring has been found to be an effective strategy to increase student achievement (Kaufman et al., 2011; Lan, 1996; Schmitz & Perels, 2011). Self-monitoring and its relationship to academic achievement in traditional classrooms has been documented, however, this relationship in blended learning environments, particularly in the online portion of a course, is just beginning to be researched (Schmitz & Perels, 2011).

There is a growing body of research focused on examining students' self-regulated learning in blended learning environments (Azevedo, 2005; Barnard, Lan, To, Paton, & Lai, 2009; Kim & Bonk, 2006; Lust et al., 2011; Lust et al., 2012; Lynch & Dembo, 2004; Means et al., 2010; Wadsworth et al., 2007; Wang, 2011; Winters et al., 2008; Yen & Lee, 2011). Much research focuses on the online component of a blended learning course since working in online environments requires students to be self-directed and self-motivated (Lust et al., 2011; Lust et al., 2012; Lynch & Dembo, 2004; Wang, 2011; Yen & Lee, 2011). This autonomy is a facet of online learning and therefore, self-regulation becomes an important element for success in learning in this type of environment (Lust et al., 2011; Lust et al., 2012).

Researchers have recommended that students should be trained in using self-regulated strategies when working in blended environments to improve learners' success (Kim & Bonk, 2006; Wadsworth et al., 2007; Yen & Lee, 2011). Research has suggested that features of blended learning environments should be utilized to maximize the potential to buttress students' self-regulation such as providing students with quality opportunities for interaction (Barnard et al., 2009; Wang, 2011) and additional support (Azevedo, 2005; Barnard et al., 2009). It has been suggested that "enabling learners to interact with computers and adding more strategies to increase human-machine interaction" could improve self-regulated learning in the online environment (Wang, 2011, p.1810). Azevedo (2005) suggested that aids inside or outside the online learning environment could encourage students' use of self-regulatory processes. Azevedo (2005) also observed that learning supports such as online prompts could act as a scaffold by providing support and guidance to help students regulate their learning. Human tutors, considered external regulating agents, could also assist students in planning, monitoring, and evaluating self-regulatory strategy use (Azevedo, 2005).

Wadsworth et al.'s (2007) study examined the relationship between learning, motivation, and self-regulatory strategies of developmental mathematics students in online courses. Yet no research studies were identified that focused on the relationship between self-regulated learning of developmental mathematics students and the work they do online in a blended course. Research has suggested that success in a developmental mathematics class where some of the instruction is delivered online is dependent to some extent on students' uses of a variety of learning strategies (Wadsworth et al., 2007). To improve transfer of strategies to an online environment, research has suggested that developmental mathematics students are taught strategies important to the online environment and given real examples and ample opportunities to practice those strategies online (Wadsworth et al., 2007).

The purpose of this study was to investigate student use of a self-monitoring instrument when working online in a university developmental mathematics course, Intermediate Algebra, which blended online learning and face-to-face instruction. Comparisons of achievement, course grade, and self-regulated learning levels were made between students using a self-monitoring instrument while working online and those that did not use this instrument for self-monitoring when working online.

This study investigated the following research questions:

1. Was there a statistically significant difference in student achievement, indicated by mean scores on three unit exams, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
2. Was there a statistically significant difference in students' levels of self-regulation, indicated by mean scores gathered from a questionnaire completed four different times throughout the semester, between students who formally completed self-monitoring record forms during the course and students who did not complete this form?
3. Was there a statistically significant relationship between a student's perceived level of self- regulation and final course grade?

To answer the research questions, this study used a nonequivalent-control-group experimental design with repeated measures (Shavelson, 1996).

There were 36 sections of Intermediate Algebra which were included in the study. These sections were taught by 29 different instructors. Sections were selected to be either in the control or experimental group using random assignment where possible, while also maintaining balance among several factors. The number of classes a TA was assigned, the days and time the classes met, and whether the instructor assigned to teach the section was new or returning, were all considered in selecting sections for assignment into the control or experimental groups. There were 18 sections in the control group and 18 sections in the experimental group.

During the semester, all participants had similar classroom and online experiences; they were required to complete the same lessons and assignments in class, out of class, and online, take the same unit exams, and use the same materials. All students had access to the same resources. All participants were asked to complete a questionnaire in class after each unit exam to measure each individual's level of self-regulation of online learning for a total of four times. Comparisons about the groups were made using self-regulation scores, scores on three unit exams, and a final course grade.

All students were given credit for completing each online record form regardless of which group they were in and so two different forms were used and were distributed to the participants through email using a survey engine. The form students in the experimental group were asked to complete included questions regarding self-regulated learning attributes and the form that students in the control group were asked to complete was a shortened generic version which did not include any questions regarding self-regulated learning attributes.

There were three phases in this study. In Phase 1 students in the experimental group received the most intense treatment. All participants were asked to complete their appropriate online record form after every online assignment for a total of four times. During Phase 2, the treatment was moderate as students were asked to complete the online record form after every other online assignment for an additional two occurrences. In Phase 3 the treatment was removed and students were not required to complete any online record forms. It was intended that students completed the self-monitoring form more often at the beginning of the semester and then requirements tapered off, referred to as fading, so that no requirement to complete the self-monitoring form was present at the end of the semester. This allowed the researcher to examine if the strategy use of self-monitoring had any effect on students' levels of self-regulation of online learning in the experimental group after fading.

The means, standard deviations, and medians for four unit exams and four in-class self-regulation questionnaires, the KAPQOSLs, were calculated for the control group, the experimental group, and each modified experimental group. The exam scores were based on 100 points and the scores for the KAPQOSLs were out of 110 possible points.

A series of ANCOVAs were conducted to investigate the impact of the completion of self-monitoring record forms on students' mathematics achievement. Prior to completing the analyses, statistical tests were run to screen for underlying assumptions for scores on all exams. The data were found to meet the assumptions of homogeneity of variance and homogeneity of regression slopes. Yet *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics revealed that the distributions for all exams of all groups were not normal. As the mean scores from all exams were slightly to moderately negatively skewed, as recommended (Tabachnick & Fidell, 2001), the scores were transformed by reflecting and then taking the square root to normalize the distribution. Procedures were used again to assess the normality of the transformed data set and all calculations reflected acceptable measures. Typically achievement scores are viewed as higher scores reflecting better performance but since the transformed data included a reflection, lower transformed scores indicated higher performance on the exam. The series of ANCOVAs were conducted using group assignment based on the completion of self-monitoring record forms as the independent variable, transformed exam scores as the dependent variable, and transformed prior exam scores as the covariate to investigate the impact of the completion of self-monitoring record forms on students' mathematics achievement.

A series of mixed ANOVAs were conducted to identify any significant relationships between completion of self-monitoring record forms and levels of self-regulated learning with a within-subject variable of self-regulated learning, measured by KAPQOSL scores, and a between subjects variable of group assignment which was determined by level of treatment. Statistical measures were used to assess the underlying assumptions. All data sets were found to meet the assumptions of normality using *z*-scores of skewness and kurtosis and Shapiro-Wilks statistics and homogeneity of covariance matrices using Box's M statistics. Further, since the repeated measure variable of self-regulated learning, KAPQOSL scores, had only 2 levels, the assumption of sphericity was met (Field, 2005).

Included in Phase 1 were students in both the control group and the experimental group who completed the Unit 1 and Unit 2 exams, and/or both of the in-class questionnaires KAPQOSL1 and KAPQOSL2, and up to four online self-monitoring record forms. The analyses in this phase examined two situations: Phase 1 Inclusive included those students who withdrew later in the semester but had enough data for comparison and Phase 1 Exclusive included only the students who had enough data for comparison in this phase and completed the course.

For Phase 1 Inclusive, there were 661 (78.6%) students included in this sample with 336 (50.8%) students who were initially in the control group and 325 (49.2%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring record forms they had completed: Group 1 consisted of 48 (14.8%) students who completed one of the four record forms; Group 2 included 48 (14.8%)

students who completed two of the four record forms; Group 3 included 66 (20.3%) students who completed three of the four record forms; and Group 4 contained 112 (34.4%) students who completed all four record forms. The remaining 51 (15.7%) students who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus, for analyses purposes, the control group had 387 (58.5%) participants and the experimental group had 274 (41.5%) participants. Out of this sample of 661 students, scores from 655 (99.1%) students who completed both Exam 1 and Exam 2 and scores from 512 (77.5%) students who completed both KAPQOSL1 and KAPQOSL2 were explored and analyzed.

For Phase 1 Exclusive, after removing the 32 (3.8%) subjects who had withdrawn during the course of the semester, there were 629 (74.8%) students included in this sample with 314 students who were initially in the control group and 315 students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring record forms they had completed: Group 1 consisted of 47 (14.9%) students who completed one of the four record forms; Group 2 included 46 (14.6%) students who completed two of the four record forms; Group 3 included 64 (20.3%) students who completed three of the four record forms; and Group 4 contained 110 (34.9%) students who completed all four record forms. The remaining 48 (15.2%) students who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus, for analyses purposes, the control group had 362 (57.6%) participants and the experimental group had 267 (42.4%) participants. Out of this sample of 629 students, scores from 623 (99.0%)

students who completed both Exam 1 and Exam 2 and scores from 493 (78.4%) students who completed both KAPQOSL1 and KAPQOSL2 were explored and analyzed.

Similar results were obtained from both Phase 1 Inclusive and Phase 1 Exclusive. When considering mathematics achievement, the experimental group as a whole, as well as each modified experimental group, had higher mean scores for Exam 2 than the control group. The transformed and adjusted mean scores and results of the ANCOVA revealed that this difference was not statistically significant at the $\alpha = .05$ level. In regards to self-regulated learning, the mean scores for KAPQOSL1 and KAPQOSL2 showed that the experimental group as a whole had a slight increase in self-regulated learning mean score and the control group had a slight decrease in mean score, and that the modified experimental group which completed all of the online self-monitoring record forms had the largest increase in mean score yet the series of mixed ANOVAs revealed that these differences failed to be statistically significant at the $\alpha = .05$ level whether comparing the control group and the experimental group or when comparing the control group and the modified experimental groups.

During Phase 2, students were asked to complete an online self-monitoring record form after the due date of every other online assignment for a total of two additional occurrences. Included in Phase 2 were students in both the control group and the experimental group who completed the Unit 2 and Unit 3 exams, and/or the in-class questionnaires KAPQOSL1 and KAPQOSL3, and up to six online self-monitoring records.

From the 629 students in the Phase 1 Exclusive sample, an additional 15 (2.4%) students who did not have enough data for comparisons, i.e. no scores for Exam 2 and Exam 3 or KAPQOSL1 and KAPQOSL3, were removed which resulted in a sample of 614 (97.6%) students in Phase 2 with 302 (49%) students who were initially in the control group and 312

(51%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring records they had completed: Group 1 consisted of 77 (24.7%) students who completed one or two of the six forms; Group 2 included 74 (23.7%) students who completed three or four of the six forms; and Group 3 included 132 (42.3%) students who completed five or six of the forms. The remaining 29 (9.3%) students in the experimental group who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus for analysis purposes, the control group had 331 (53.9%) participants. Out of this sample of 614 students, scores from 610 (99.3%) students who completed both Exam 2 and Exam 3 and scores from 464 (75.6%) students who completed both KAPQOSL1 and KAPQOSL3 were explored and analyzed.

When considering mathematics achievement, the experimental group as a whole, had a slightly lower mean score for Exam 3 than the control group. The transformed and adjusted mean scores and results of the ANCOVA revealed that there was a statistically significant difference in academic performance on Exam 3 scores after controlling for the effect of scores on the prior exam at the $\alpha = .05$ level indicating that the control group performed significantly better on Exam 3 than the experimental group. Yet the effect size of 0.7% for this situation was small which indicated that group assignment accounted for less than one percent in the variance in scores. When comparing the control group with the modified experimental groups, the modified experimental group which completed one or two of the six online self-monitoring record forms had the lowest mean score for Exam 3 while the modified experimental group which completed three or four of the six online self-monitoring forms had the highest mean score for this exam. The transformed and adjusted mean scores and results of this ANCOVA revealed that this difference was statistically significant at the $\alpha = .05$ level and the effect size of 1.7% was also small, indicating that group designation accounted for a small amount of variance in scores. Subsequent comparisons indicated that the experimental group which completed one or two self-monitoring record forms performed statistically significantly lower on Exam 3 when compared to both the control group which completed no self-monitoring record forms and the experimental group which completed five or six self-monitoring forms.

In regards to levels of self-regulated learning, the mean scores for KAPQOSL1 and KAPQOSL3 showed that the experimental group as a whole had an slight increase in level of self-regulated learning mean score and the control group had a slight decrease in mean score. The mixed ANOVA revealed that these differences were statistically significant at the $\alpha = .05$ level. Two paired sample *t*-tests were conducted as a follow-up analysis and indicated that the change in scores of the experimental group was statistically significant at the $\alpha = .05$ level. This result suggested that having at least one experience of completing a self-monitoring record form online had a slight but statistically significant increase in students' level of self-regulated learning. When comparing the control group and the three modified experimental groups, the modified experimental group which completed three or four of the six online self-monitoring record forms had the largest increase in mean score. Similarly, the mixed ANOVA used to compare these groups revealed that these differences in scores were statistically significant at the $\alpha = .05$ level indicating that there was a statistically significant effect of completing a self-monitoring record form on an individual's level of self-regulated learning in Phase 2. To follow up the statistical significant interaction indicated by the analysis between self-regulated learning and treatment group, four paired sample *t*-tests were performed. The results indicated that the only difference in levels of self-regulated learning over time found to be statistically significant occurred in the change in scores of the modified experimental group which completed three or four self-monitoring records at the $\alpha = .01$ level.

During Phase 3, students in either the control group or experimental group were not required to complete any self-monitoring record forms. Included in Phase 3 were students in both the control group and the experimental group who completed the Unit 3 and Unit 4 exams, and/or the in-class questionnaires KAPQOSL1 and KAPQOSL4, and up to six online self-monitoring records.

From the 629 students in the Phase 1 Exclusive sample, an additional 31 (4.9%) students who did not have enough data for comparisons, i.e. no scores for Exam 3 and Exam 4 or KAPQOSL1 and KAPQOSL4, were removed which resulted in data from 598 (95.1%) students in Phase 3 with 295 (49.3%) students who were initially in the control group and 303 (50.7%) students who were initially in the experimental group. Students in the experimental group were further categorized by the number of online self-monitoring records they had completed: Group 1 consisted of 75 (24.8%) students who completed one or two of the six forms; Group 2 included 72 (23.8%) students who completed three or four of the six forms; and Group 3 included 131 (43.2%) students who completed five or six of the forms. The remaining 25 (8.2%) students in the experimental group who did not complete any of the record forms and therefore were not exposed to the self-monitoring questions regarding self-regulated learning attributes on the form were re-categorized to be members of the control group. Thus for analyses purposes, the control group had 320 (53.5%) participants. Of the 598 students included in the sample, scores from 597 (99.8%) students who completed both Exam 3 and Exam 4 and scores from 449 (75.1%) students who completed both KAPQOSL1 and KAPQOSL4 were explored and analyzed.

When considering mathematics achievement, the data analyses showed that the experimental group as a whole, as well as each modified experimental group, had higher mean scores for Exam 4 than the control group. Of the modified experimental groups, the group which completed one or two of the six online self-monitoring record forms had the lowest mean score for Exam 4. The transformed and adjusted mean scores and results of the ANCOVA revealed that this difference was statistically significant at the $\alpha = .05$ level when comparing the control group and experimental group as a whole yet there was a small effect size of 1.0%.

In regards to self-regulated learning, the mean scores for KAPQOSL1 and KAPQOSL4 showed that the experimental group as a whole had a larger increase in self-regulated learning mean score than the control group and the experimental group which completed three or four of the six online self-monitoring record forms had the largest increase in mean score. The mixed ANOVA revealed that although the scores from the two KAPQOSLs were statically different, there was a not a statistically significant interaction effect at the $\alpha = .05$ level.

Finally, relationships between students' scores on the fourth KAPQOSL and their final course grades scaled as percents were investigated. Scatter plots were constructed using the sample data to check for linear relationships between students' composite scores on the fourth KAPQOSL and their final course grades as well as students' scores on each subscale of the fourth KAPQOSL, Goal Setting, Environment Structuring, Task Strategies, Time Management, Help Seeking, and Self-evaluation, and their final course grades. There was a general trend in the data such that higher composite KAPQOSL scores were associated with higher final course grades. Less evident were any trends between subscale KAPQOSL scores and final course grades. Pearson product-moment correlation coefficients were calculated to measure the strength of the relationship between a student's composite score on the fourth KAPQOSL and the student's final course grade as well as students' scores on each subscale of the fourth KAPQOSL and their final course grades. The data analysis was conducted using the sample data, again using the control group and the experimental group from the final phase of the experiment, and then finally using the modified experimental groups from the final phase.

Several significant relationships were identified. Positive correlations existed between students' level of self-regulated learning and their final course grade for the experimental group, for the modified experimental group which completed 1 or 2 self-monitoring record forms, and for the modified experimental group which completed 3 or 4 self-monitoring records. All groups except the control group were found to have positive correlations between students' subscale scores of Goal Setting, which included 5 questions, and their final course grades. The experimental group as a whole and the experimental group which completed 3 or 4 self-monitoring record forms in particular had small positive relationships between the subscale score Environment Structuring, which consisted of 4 items, and final course grade. Finally, the experimental group which completed one or two of the self-monitoring record forms also had subscale scores of Help Seeking and Self-evaluation which were significantly related to final course grades.

Conclusions

The following conclusions address the research questions for this study.

1. During both Phase 1 Inclusive and Phase 1 Exclusive, though most groups increased their mean scores on Exam 2, no statistical differences were found to be significant between the control group and the experimental group or the modified experimental groups on Exam 2 scores after accounting for prior Exam 1 scores. The lack of treatment effect in

this phase could be attributed to the lack of adequate time to effect a change in student behaviors to improve academic achievement.

In Phase 2, the modified experimental group which completed five or six self-monitoring forms performed significantly better on Exam 3 than the experimental group which completed one or two self-monitoring record forms. This would suggest that the number of self-monitoring record forms that were completed was a factor which affected student achievement.

Finally, during Phase 3, the experimental group as a whole performed significantly better than the control group on Exam 4. This would suggest that having at least one experience in completing a self-monitoring record form was a factor in student achievement improvement even after the opportunities to complete the form had been removed.

2. No statistically significant differences in levels of self-regulation between the control group and the experimental group or the modified experimental groups over time could be identified in either Phase 1 Inclusive or Phase 1 Exclusive. The lack of treatment effect could be attributed to the lack of adequate time to effect a change in students' levels of self-regulation.

   During Phase 2, the experimental group as a whole increased their level of self-regulation significantly over the control group suggesting that having at least one experience in completing a self-monitoring record form had an effect over time. Further analysis comparing the control group and the three modified experimental groups separately indicated that only the modified experimental group which completed three or four of the six self-monitoring record forms significantly increased their level of self-regulated learning.

During Phase 3, though the mean scores from the first and last KAPQOSLs varied significantly over time, no significant differences in levels of self-regulation could be identified between the groups over time. Since all students completed the in-class questionnaires to measure their levels of self-regulation, the nature of the questions themselves and the act of recording behavior which most likely required students to mentally pay attention to the behavior, may have contributed to the increase in scores for both groups. It may be that having exposure to these questions from the in-class questionnaire was enough to have an effect on raising levels of self-regulated learning.

3. There were statistically significant relationships identified between a student's perceived level of self-regulation and final course grade. Positive correlations were identified between students' composite score on the fourth KAPQOSL and their final course grade.

   Some relationships between subscale scores and final course grades were also identified. Subscale scores for Goal Setting, Environment Structuring, Help Seeking, and Self-evaluation and final course grade showed a positive correlation. Further, the subscale of Goal Setting and final course grade showed a positive correlation across all experimental groups. Items on the self-monitoring record form are specifically related to these subscales of self-regulated learning and may have contributed to this significant relationship. This may also suggest that increasing scores on these subscales of self-regulation could increase student academic achievement.

Recommendations for Educators

1. Students working online should be exposed to and taught to use the self-regulatory skill of self-monitoring when they are working online. For the students in this study there were small yet statistically significant effects of completing a self-monitoring record form on their exam scores and levels of self-regulated learning. Similar to recommendations made by Schmitz and Perels (2011), teachers should explain to students how to self-monitor and why it should be done so that students will understand the possible benefits of the procedure. Raising student awareness and understanding of self-monitoring, particularly when working in an online environment, may result in more substantial increases in academic achievement and levels of self-regulated learning.
2. The results of this study indicated that a positive correlation existed between students' level of self-regulation when working online and their final course grade. Administering a form similar to the KAPQOSL would allow instructors to identify their students' level of self-regulated learning. Though not done in this study, students could score their own KAPQOSL so that they could identify subscale scores which could suggest areas where improved focus could increase their overall score. Instructors could conference with students to discuss individual results as well as offer suggestions on ways to develop different self-regulatory strategies to improve levels of overall self-regulated learning.
3. The results of this study identified a positive correlation between a subscale of self-regulated learning, Goal Setting, and final course grade. Therefore it is recommended that students be given opportunities in class to set short-term goals as well as long-term goals in regards to the work they do online. They should also be given opportunities to evaluate their progress toward those goals. Setting and evaluating progress towards goals could

also help cultivate learner independence, an attribute of self-regulated learners (Smittle, 2003; Zimmerman ,2002).

Suggestions for Future Research

1. The current study was only interested in whether a student completed the self-monitoring record forms and did not analyze the actual student responses on the form. Further research should analyze student responses on these forms to identify any emerging patterns to provide insight into student behavior when working in an online environment.
2. For this study, the strategy of self-monitoring was not formally discussed with the students. Further, students were able to view the contents of the self-monitoring record form individually outside of class but the form was not shared formally in class with the students. Still, there was a significant though small effect of completing a self-monitoring record form in increasing achievement as well as levels of self-regulated learning. Future research should replicate this study and include instruction on what self-monitoring is and ways for students to self-monitor as well as share the self-monitoring record form to see if this added information has a greater effect on results when compared to results found in this study.
3. Future research should replicate this study allowing more frequent occasions to complete self-monitoring records for a longer duration of time before fading the prompts. Increasing the frequency of this routine could help to develop and reinforce the habit of self-monitoring.
4. This study delivered a link to students' school email accounts for each self-monitoring record form after the due date of the corresponding online assignments. For some students it may not have been their primary email account and so they may not have seen

the link in time to complete the form. Therefore, future research should design a way in which the self-monitoring record forms could be delivered to students immediately upon completing the online assignments. This immediacy could improve the completion rate of these forms which could result in different outcomes than those from this study.

5. Although it is suggested that students who score lower than 16 on the math portion of the ACT or 440 on the math portion of the SAT should take a beginning Algebra course, there is no minimum requirement to enroll in Intermediate Algebra at the university where the study took place. Future research could analyze the data of those students who fall into the suggested interval of 16-22 on the math portion of the ACT to identify effects of completing a self-monitoring record form on academic achievement and levels of self-regulated learning.
6. This study targeted students enrolled in Intermediate Algebra at a Midwestern university. The results suggested that the self-monitoring intervention enhanced self-regulated learning for this group of students. Future research is needed to investigate ways to strengthen students' self-regulation when working online in other levels of mathematics as well as in other fields of study.

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Appendices

Appendix A: Student Questionnaire

1. Name_________________________________:
2. What is your gender? Male Female
3. What is your age? _______
4. What is your ethnicity?

   White | Black or African-American
   American Indian or Alaskan Native | Asian
   Hispanic | Native Hawaiian or other Pacific Islander
   From multiple races | Other (Please specify) _________________

5. What year did you graduate from high school? ______
6. Are you considered In-state or out-of-state residency? In-state Out-of-state
7. What is your academic year in school?

   Freshman Sophomore Junior Senior
8. Have you declared a major? Yes No

   If yes, please list your declared major? _____________________________
9. What was the last math course you completed? _________________________

   When did you complete this course (semester and year)? ___________________

   Where did you complete this course?

   High school 2-year College 4-year College/University Other: _______________
10. Is this your first time taking this course or are you repeating the course? First Repeat
11. Do you have Internet access outside of KAP? Yes No
12. Number of online/blended courses previously taken or currently taking? __________

    Of these courses, how many have been math courses? __________
13. How many online homework assignments have you completed in all other courses?

    None Some Numerous
14. How many online homework assignments have you completed in math courses?

    None Some Numerous

Appendix B: Instructor Questionnaire

1. Name
2. Gender?

   Male Female
3. Age?
4. Ethnicity?
5. Teaching Assistant Category
   a. Undergraduate student:
      i. Numbers of semesters completed at a postsecondary institution?
      ii. Declared major?
      iii. Number of semesters teaching Math 002 or equivalent?
      iv. Other teaching experience(s) (include duration of each) :

      ____
   b. Graduate student:
      i. Bachelor's Degree: _____________________
      ii. Master's Degree: ______________________
      iii. Number of semesters teaching Math 002 or equivalent?
      iv. Other teaching experience(s) (include duration of each):

      ____
   c. Lecturer
      i. Bachelor's Degree: _____________________
      ii. Master's Degree: ______________________
      iii. Doctoral Degree: ______________________
      iv. Number of semesters teaching Math 002 or equivalent?
      v. Other teaching experience(s) (include duration of each):

      ____

Appendix C: OSLQ – Online Self-regulated Learning Questionnaire

Item							Subscale
1.	I set standards for my assignments in online courses.	1	2	3	4	5	Goal Setting
2.	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	1	2	3	4	5	
3.	I keep a high standard for my learning in my online courses.	1	2	3	4	5	
4.	I set goals to help manage studying time for my online courses.	1	2	3	4	5	
5.	I don't compromise the quality of my work because it is online.	1	2	3	4	5	
6.	I choose the location where I study to avoid too much distraction.	1	2	3	4	5	Environment Structuring
7.	I find a comfortable place to study.	1	2	3	4	5	
8.	I know where I can study most efficiently for online courses.	1	2	3	4	5	
9.	I choose a time with few distractions for studying for my online courses.	1	2	3	4	5	
10.	I try to take more thorough notes for my online courses because notes are even more important for learning online than in a regular classroom.	1	2	3	4	5	Task Strategies
11.	I read aloud instructional materials posted online to fight against distractions.	1	2	3	4	5	
12.	I prepare my questions before joining in the chat room and discussion.	1	2	3	4	5	
13.	I work extra problems in my online courses in addition to the assigned ones to master the course content.	1	2	3	4	5	
14.	I allocate extra studying time for my online courses because I know it is time-demanding.	1	2	3	4	5	Time Management
15.	I try to schedule the same time everyday or every week to study for my online courses, and I observe the schedule.	1	2	3	4	5	
16.	Although we don't have to attend daily classes, I try to distribute my studying time evenly across days.	1	2	3	4	5	
17.	I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	1	2	3	4	5	Help Seeking
18.	I share my problems with my classmates online so we know what we are struggling with and how to solve our problems.	1	2	3	4	5	
19.	If needed, I try to meet my classmates face-to-face.	1	2	3	4	5	
20.	I am persistent in getting help from the instructor through email.	1	2	3	4	5	
21.	I summarize my learning in online courses to examine my understanding of what I have learned.	1	2	3	4	5	Self Evaluation
22.	I ask myself a lot of questions about the course material when studying for an online course.	1	2	3	4	5	
23.	I can communicate with my classmates to find out how I am doing in my online classes.	1	2	3	4	5	
24.	I communicate with my classmates to find out what I am learning that is different than what they are learning.	1	2	3	4	5	

Barnard, Lan, To, Paton, & Lai (2008)

Appendix D: KAPQOSL – Kansas Algebra Program Questionnaire of Online Self-regulated Learning - Complete

Item							Subscale
1.	I set standards for my online assignments.	1	2	3	4	5	Goal Setting
2.	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	1	2	3	4	5	
3.	I keep a high standard for my learning when I work online.	1	2	3	4	5	
4.	I set goals to help manage studying time for my online assignments.	1	2	3	4	5	
5.	I don't compromise the quality of my work because it is online.	1	2	3	4	5	
6.	I choose the location where I study to avoid too much distraction.	1	2	3	4	5	Environment Structuring
7.	I find a comfortable place to study.	1	2	3	4	5	
8.	I know where I can study most efficiently when I work online.	1	2	3	4	5	
9.	I choose a time with few distractions for studying online.	1	2	3	4	5	
10.	I try to take more thorough notes when I work online because notes are even more important for learning online than in a regular classroom.	1	2	3	4	5	Task Strategies
11.	I read aloud instructional materials posted online to fight against distractions.	1	2	3	4	5	
12.	I work extra problems when working online in addition to the assigned ones to master the course content.	1	2	3	4	5	
13.	I allocate extra studying time for my online assignments because I know they are time-demanding.	1	2	3	4	5	Time Management
14.	I try to schedule the same time everyday or every week to work on my online assignments, and I observe the schedule.	1	2	3	4	5	
15.	Although we don't have to attend classes daily, I try to distribute my studying time evenly across days.	1	2	3	4	5	
16.	I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	1	2	3	4	5	Help Seeking
17.	I share my problems with my classmates so we know what we are struggling with and how to solve our problems.	1	2	3	4	5	
18.	If needed, I try to meet my classmates face-to-face.	1	2	3	4	5	
19.	I am persistent in getting help from the instructor through email.	1	2	3	4	5	
20.	I summarize my learning when working online to examine my understanding of what I have learned.	1	2	3	4	5	Self Evaluation
21.	I ask myself a lot of questions about the course material when working online.	1	2	3	4	5	
22.	I communicate with my classmates to find out what I am learning that is different than what they are learning.	1	2	3	4	5	

Adapted from Barnard, Lan, To, Paton, & Lai (2008)

Appendix E: KAPQOSL – Kansas Algebra Program Questionnaire of Online Self-regulated Learning -Student

Instructions: Please choose a number for each item that best represents where on the scale you mostly agree with the statement.

Item		Strongly Disagree				Strongly Agree
1.	I set standards for my online assignments.	1	2	3	4	5
2.	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	1	2	3	4	5
3.	I keep a high standard for my learning when I work online.	1	2	3	4	5
4.	I set goals to help manage studying time for my online assignments.	1	2	3	4	5
5.	I don't compromise the quality of my work because it is online.	1	2	3	4	5
6.	I choose the location where I study to avoid too much distraction.	1	2	3	4	5
7.	I find a comfortable place to study.	1	2	3	4	5
8.	I know where I can study most efficiently when I work online.	1	2	3	4	5
9.	I choose a time with few distractions for studying online.	1	2	3	4	5
10.	I try to take more thorough notes when I work online because notes are even more important for learning online than in a regular classroom.	1	2	3	4	5
11.	I read aloud instructional materials posted online to fight against distractions.	1	2	3	4	5
12.	I work extra problems when working online in addition to the assigned ones to master the course content.	1	2	3	4	5
13.	I allocate extra studying time for my online assignments because I know they are time-demanding.	1	2	3	4	5
14.	I try to schedule the same time everyday or every week to work on my online assignments, and I observe the schedule.	1	2	3	4	5
15.	Although we don't have to attend classes daily, I try to distribute my studying time evenly across days.	1	2	3	4	5

Adapted from Barnard, Lan, To, Paton, & Lai (2008)

16.	I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	1	2	3	4	5
17.	I share my problems with my classmates so we know what we are struggling with and how to solve our problems.	1	2	3	4	5
18.	If needed, I try to meet my classmates face-to-face.	1	2	3	4	5
19.	I am persistent in getting help from the instructor through email.	1	2	3	4	5
20.	I summarize my learning when working online to examine my understanding of what I have learned.	1	2	3	4	5
21.	I ask myself a lot of questions about the course material when working online.	1	2	3	4	5
22.	I communicate with my classmates to find out what I am learning that is different than what they are learning.	1	2	3	4	5

Adapted from Barnard, Lan, To, Paton, & Lai (2008)

Appendix F: Revised OSLQ Items

The following are the original items from the OSLQ and the revised items in the KAPQOSL. Italicized phrases indicate the changes.

OSLQ Item #		OSLQ Item	Revised Item	KAPQOSL Item #
1.	*	I set standards for my *assignments in online courses*.	I set standards for my *online assignments*.	1.
2.		I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	2.
3.	*	I keep a high standard for my learning *in my online courses*.	I keep a high standard for my learning *when I work online*.	3.
4.	*	I set goals to help manage studying time for my online *courses*.	I set goals to help manage studying time for my online *assignments*.	4.
5.		I don't compromise the quality of my work because it is online.	I don't compromise the quality of my work because it is online.	5.
6.		I choose the location where I study to avoid too much distraction.	I choose the location where I study to avoid too much distraction.	6.
7.		I find a comfortable place to study.	I find a comfortable place to study.	7.
8.	*	I know where I can study most efficiently *for online courses*.	I know where I can study most efficiently *when I work online*.	8.
9.	*	I choose a time with few distractions for studying for *my online courses.*	I choose a time with few distractions for studying *online*.	9.
10.	*	I try to take more thorough notes *for my online courses* because notes are even more important for learning online than in a regular classroom.	I try to take more thorough notes *when I work online* because notes are even more important for learning online than in a regular classroom.	10.
11.		I read aloud instructional materials posted online to fight against distractions.	I read aloud instructional materials posted online to fight against distractions.	11.
12.	**	I prepare my questions before joining in the chat room and discussion.		
13.	*	I work extra problems *in my online courses* in addition to the assigned ones to master the course content.	I work extra problems *when working online* in addition to the assigned ones to master the course content.	12.
14.	*	I allocate extra studying time for my online *courses* because I know it is time-demanding.	I allocate extra studying time for my online *assignments* because I know they are time-demanding.	13.
15.	*	I try to schedule the same time everyday or every week to *study for my online courses*, and I observe the schedule.	I try to schedule the same time everyday or every week to *work on my online assignments*, and I observe the schedule.	14.
16.	*	Although we don't have to attend *daily classes*, I try to distribute my studying time evenly across days.	Although we don't have to attend *classes daily*, I try to distribute my studying time evenly across days.	15.
17.		I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	I find someone who is knowledgeable in course content so that I can consult with him or her when I need help.	16.

18.	*	I share my problems with my classmates *online* so we know what we are struggling with and how to solve our problems.	I share my problems with my classmates so we know what we are struggling with and how to solve our problems.	17.
19.		If needed, I try to meet my classmates face-to-face.	If needed, I try to meet my classmates face-to-face.	18.
20.		I am persistent in getting help from the instructor through email.	I am persistent in getting help from the instructor through email.	19.
21.	*	I summarize my learning *in online courses* to examine my understanding of what I have learned.	I summarize my learning *when working online* to examine my understanding of what I have learned.	20.
22.	*	I ask myself a lot of questions about the course material when *studying for an online course*.	I ask myself a lot of questions about the course material when *working online*.	21.
23.	**	I can communicate with my classmates to find out how I am doing in my online classes.		
24.		I communicate with my classmates to find out what I am learning that is different than what they are learning.	I communicate with my classmates to find out what I am learning that is different than what they are learning.	22.

* Denotes a revised item.

** Denotes a deleted item.

Appendix G: Math 002 Calendar FALL 2013

	Monday	*Tuesday*	Wednesday	*Thursday*	Friday	Experimental Procedures
	26-Aug	*27-Aug*	28- Aug	*29-Aug*	30-Aug	
Week 1	Intro-MML	*Intro-Review*	Review	*L1.1*	L1.1	**Student Questionnaire** **Instructor Questionnaire**
	2-Sept	*3-Sept*	4-Sept	*5-Sept*	6-Sept	
Week 2	***Labor Day***	**MML Orient & #1** *L 1.2*	L1.2 A	**MML #2 (L 1.2 A)** *L1.3*	MML Q1 L 1.2 B	
	9-Sept	*10-Sept*	11-Sept	*12-Sept*	13-Sept	
Week 3	L 1.3	**MML #3** (L1.2B, L1.3) *L1.4*	L1.4 A	*More Applic*	MML Q2 L 1.4 B	
	16-Sept	*17-Sept*	18-Sept	*19-Sept*	20-Sept	
Week 4	More Applic	**MML #4** (L 1.4) *Review*	Review	***Exam 1*** *L 2.1*	***Exam 1*** L 2.1A	**KAPQOSL #1 (In Class T/W)**
	23-Sept	*24-Sept*	25-Sept	*26-Sept*	27-Sept	
Week 5	L 2.1B	**MML #5(L2.1)** *L 2.2*	L 2.2A	**MML #6 (L 2.2)** *L 2.3A*	MML Q3 L 2.2B	**Collect Exam 1 scores this week.** **Self-monitor Record #1, #2** **After MML #5, #6**
	30-Sept	*1-Oct*	2-Oct	*3-Oct*	4-Oct	
Week 6	L 2.3A	*L 2.3B*	L 2.3A	**MML #7** (L 2.3) *L 2.4*	MML Q4 L 2.3B	**Self-monitor Record #3** **After MML #7**
	4-Mar	*7-Oct*	8-Oct	*9-Oct*	9-Oct	
Week 7	L 2.4	**MML#8** (L 2.4) *Review*	Review	***Exam 2*** *L 3.1*	***Exam 2*** L 3.1A	**Self-monitor Record #4** **After MML #8** **KAPQOSL #2 (In Class T/W)**
	14-Oct	*15-Oct*	16-Oct	*17-Oct*	18-Oct	
Week 8	***FALL BREAK***	***FALL BREAK***	L 3.1B	**MML #9** (L 3.1) *L 3.2*	MML Q5 L 3.2	**Collect Exam 2 scores this week.**
	21-Oct	*22-Oct*	23-Oct	*24-Oct*	25-Oct	
Week 9	L 3.3A	**MML #10** (L 3.2) *L 3.3*	**RETAKE for Exam 1 or Exam 2** L 3.3B	**MML #11** (L 3.3) **RETAKE for Exam 1 or Exam 2** *L 3.4*	MML Q6 **RETAKE for Exam 1 or Exam 2** L 3.4A	**Self-monitor Record #5** **After MML #10**

	28-Oct	*29-Oct*	30-Oct	*31-Oct*	1-Nov	
Week 10	L 3.4B	**MML #12** (L 3.4) *Review*	Review	***Exam 3*** *L 4.1*	***Exam 3*** L 4.1A	**Collect retake scores this week. Self-monitor Record #6; MML #12 KAPQOSL #3 (In Class T/W)**
	4-Nov	*5-Nov*	6-Nov	*7-Nov*	8-Nov	
Week 11	L 4.1B, 4.2A	**MML #13** (L 4.1) *L 4.2*	L 4.2B	**MML #14** (L 4.2) *L 4.3*	MML Q7 L 4.3A	**Collect Exam 3 scores this week.**
	11-Nov	*12-Nov*	13-Nov	*14-Nov*	15-Nov	
Week 12	L 4.3B	**MML #15** (L 4.3) *L 4.4*	L 4.4A	**MML #16** (L 4.4A) *L 4.5*	MML Q8 L 4.4B	
	18-Nov	*19-Nov*	20-Nov	*21-Nov*	22-Nov	
Week 13	L 4.5	**MML #17** (L 4.4B, 4.5) *Review*	Review	***Exam 4*** L 5.1	***Exam 4*** L 5.1	**KAPQOSL #4 (In Class T/W)**
	25-Nov	*26-Nov*	27-Nov	*28-Nov*	29-Nov	
Week 14	L 5.2A	*L 5.2*	***Thanksgiving Break***			
	2 -Dec	*3-Dec*	4-Dec	*5-Dec*	6-Dec	
Week 15	L 5.2B	**MML #18** (L 5.1, 2) *L 5.3*	L 5.3	**MML #19** (L 5.3) *L 5.4*	MML Q9 L 5.4	**Collect Exam 4 scores this week.**
	9-Dec	*10-Dec*	11-Dec	*12-Dec*	13-Dec	
Week 16	**Final Review**	**MML #20** (L 5.4) ***Final Review***	**RETAKE for Exam 3 or Exam 4** **Final Review**	***Final Review***	**STOP DAY**	**Collect retake scores this week.**
	16-Dec	*17-Dec*	18-Dec	*19-Dec*	20-Dec	
Week 17	**Finals Week**					**Collect Final Score & Final Grade**

Appendix H: Self-Monitoring Record

Please respond to the following questions:

1. Assignment #: _______
2. I completed the assignment. ☐ YES ☐ NO
3. How many sessions (different times logged in) I used to complete the assignment: _____
4. The recorded time I used to complete my assignment was: ____________
5. The recorded time is accurate. ☐ YES ☐ NO
6. Most of my online work for this assignment took place at:
   - ☐ Dormitory/Sorority/Fraternity
   - ☐ Apartment/Condominium/House
   - ☐ Library
   - ☐ KAP lab
   - ☐ Other: _________
7. Distractions while working online on this assignment (check all that apply):
   - ☐ Humans
   - ☐ Electronics: TV, Music, Phone
   - ☐ Pets
   - ☐ Other: _____________________
8. **Online** resources I used while working on this assignment (Check all that apply):
   - ☐ Help Me Solve This
   - ☐ View an Example
   - ☐ Video
   - ☐ Textbook
   - ☐ Calculator
   - ☐ Other: _______________
9. I will seek help (Check all that apply):
   - ☐ KAP Helproom
   - ☐ Email instructor
   - ☐ Ask in class
   - ☐ Ask a peer
   - ☐ Other: ___________
   - ☐ No help needed.
10. My work on this assignment was:

    ☐ Good ☐ Adequate ☐ Needs improvement

Appendix I: Math 002 – Unit 1 Student Notes
Solving 1-Variable Equations

The online MML assignment due dates are uniform for all classes and are not subject to change. All online assignments will be due on Tuesdays and Thursdays and online quizzes will be due on Fridays. Any adjustments will be announced in class.

MWF MEETING SCHEDULE					
		Discussion Topic	**Due in Class**		**MML Deadlines**
M	26-Aug	Introduction; Review			
W	28-Aug	Review			
F	30-Aug	L1.1 Linear Equations	CP1.1		
M	2-Sep	LABOR DAY - NO CLASSES			
T	3-Sep				A1
W	4-Sep	L1.2A Linear Inequalities	CP1.2a	HW1.1	
R	5-Sep				A2
F	6-Sep	L1.2B Compound Inequalities	CP1.2b		Quiz 1
M	9-Sep	L1.3A Absolute Value Equations	CP1.3a	HW1.2	
T	10-Sep				A3
W	11-Sep	L1.3B Absolute Value Inequalities	CP1.3b		
F	13-Sep	L1.4A Problem Solving	CP1.4a	HW1.3	Quiz 2
M	16-Sep	L1.4B Problem Solving	CP1.4b		
W	18-Sep	Review		HW1.4	

EXAM 1:	**Group A:** TH- Sept 19 **Group B**: FR – Sept 20

TR MEETING SCHEDULE					
		Discussion Topic	**Due in Class**		**MML Deadlines**
T	27-Aug	Introduction; Review			
R	29-Aug	L1.1 Linear Equations	CP1.1		
M	2-Sep	LABOR DAY - NO CLASSES			
T	3-Sep	L1.2AB Linear Inequalities	CP1.2ab	HW1.1	A1
R	5-Sep	L1.3AB Absolute Value	CP1.3ab	HW1.2	A2
F	6-Sep				Quiz 1
T	10-Sep	L1.4 Problem Solving	CP1.4ab	HW1.3	A3
R	12-Sep	L1.4 Continued			
F	13-Sep				Quiz 2
T	17-Sep	Review		HW1.4	

Each lesson has three parts:

1) **Class Preparation (CP):** These are tasks that you need to complete before coming to class which includes readings from the textbook, filling in some definitions, and trying a few examples.
2) **In Class:** This is what will be covered in class.
3) **Homework (HW):** This is your homework assignment for the lesson and should be turned in the next class meeting.

Additional Resources to prepare for this course are available on the **KAP Website**.

L 1.1 Solving Linear Equations Algebraically & Formulas (1.5, 1.8)

Objectives

- Solve linear equations
- Check solutions to linear equations.
- Identify conditional equations, identities, and contradictions.
- Solve a formula for a specified variable

Vocabulary: *expression, equation, equivalent equations, solution, conditional equation, identity, contradiction, formula*

Class Preparation:

Complete this section prior to the next class meeting.

1. Read pages **43-49, 77**.
2. Complete the following definitions and provide an example.

Definition	Example
An **equation** is a statement that ______________________________ are ____________________.	
A **solution** of an equation is a _____________________________ that makes the equation a _________________________________.	
Equivalent equations have the same _________________________.	
A _______________________, is a linear equation that has **exactly one** solution.	
A __________________ is an equation that has **no** solution. This is also called an ***impossible equation***.	
An ___________________ is an equation that has **all real numbers** as solutions.	
A **formula** is an equation that describes a ___________________ _________________________ among quantities.	

TRY IT

3. ***Solve*** the following equations and ***check*** the solution.

a) $12n - 3 = 4n + 21$

b) $4(x - 2) = 6x - 10$

4. Solve the formula $y = mx + b$ for x.

In Class L 1.1

Concept Check: I

By inspection, decide which equations have ***no solution*** and which equations have ***all real numbers as solutions***. Then identify the equation as a **contradiction** or **identity**.

a) $2x + 3 = 2x + 3$

b) $-3x + 1 = -3x - 4$

c) $5x - 2 = 5x - 7$

d) $4x - 1 = 4x - 1$

5. Solve each linear equation.

a) $0.2b + 0.1 = 0.12b - 0.06$

b) $3(y - 3) + y = 2(6 + 2y)$

c) $\frac{x}{6} - \frac{x}{8} = \frac{1}{8}$

d) $7n - 6 + n = 2(4n - 3)$

6. Summarize steps to solve algebraically:
   - Clear fractions, decimals, and groupings (parentheses).
   - Combine like terms on each side of the equation.
   - Use the addition/ subtraction properties of equality to isolate the variable term.
   - Use the multiplication/division properties of equality to solve for the variable .

7. A **formula** is an equation that describes a ____________________ ____________________________ among quantities.

Formula	Meaning
	Area of a rectangle = length · width

8. Solve the formula for the specified variable. *Similar to solving a linear equation in one variable.*

a) $A = 5H(b + B)$; for b

b) $L = a + (n - 1)d$; for d

L 1.2a Solving Linear Inequalities in One Variable (3.2)

Objectives:
- Use interval notation.
- Solve linear inequalities using the addition and the multiplication properties of inequalities.

Vocabulary: *inequality symbols, linear inequality, solution, solution set, interval notation, , empty set*

Class Preparation:

Complete this section prior to the next class meeting.

1. Read pages **217-222**.
2. Identify the following symbols:

$<$ $>$ ∞

$\leq$ $\geq$

TRY IT

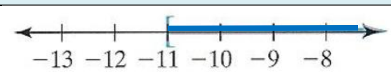
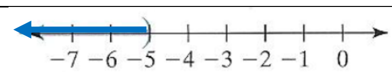
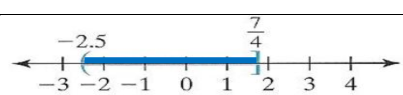
3. A ***solution*** of an inequality is a value that makes the inequality __________________.

Determine whether each number is a solution of $3x + 6 \leq 6$.

a. 0 b. $^{2}/_{3}$ c. -10 d. 1.5

4. The ***solution set*** of an inequality is the set of ________________________________.

Each row shows three equivalent ways of describing a solution set. Complete this table by filling in the equivalent descriptions. The first row has been completed for you.

	Set Notation	*Graph*	*Interval Notation*
a)	$\{x \mid x \geq -11\}$		$[-11, \infty)$
b)			
c)	$\{x \mid x \leq 0\}$		
d)			$(2, \infty)$
e)			

A bracket means that the value is *included* in the solution

A parenthesis means that the value is *not included* in the solution set.

5. Solving linear inequalities is similar to solving linear equations.

- <u>Addition/Subtraction property of Inequality</u>: can add/subtract the same number to both sides of the inequality and the direction of the inequality symbol ______________________.
- <u>Multiplication property of inequality</u>: multiply/divide both sides
  i. by a ***positive*** number the direction of the inequality symbol _______________________.
  ii. by a ***negative*** number the direction of the inequality symbol _______________________.

Each inequality below is solved by dividing both sides by the coefficient of *x*. In which inequality will the inequality symbol be reversed during the solution process?

e. $3x > -14$ f. $-4x \leq -4$ g. $2x > -5$ h. $-x \geq 23$

In Class L 1.2a

1. Rewrite each inequality so that the variable appears on the left.

   a. $5 < x$ b. $-3 \leq n$ c. $-7 > y$

Solving Linear Inequalities in 1-Variable

2. Solve the linear inequalities, graph their solution sets, and write solution sets in interval notation.

   a) $8x - 7 < 7x - 5$

   b) $-(2x - 6) \leq 4(2x - 4) + 2$

   c) $\frac{x-4}{2} - \frac{x-2}{3} > \frac{5}{6}$

   d) $5(x - 3) < 5x + 2$

L 1.2b Solving Compound Linear Inequalities (3.3)

Objectives:
- Find the intersection and union of two sets.
- Solve compound inequalities containing **and** or **or**.

Vocabulary: *intersection, union, compound inequality*

Class Preparation

Complete this section prior to the next class meeting.

1. Read pages **231-236**.

TRY IT

2. Use the choices below to fill in each blank. Some choices may be used more than once.

or	$\cup$	⍰
and	$\cap$	compound

   a. Two inequalities joined by the words “and” or “or” are called ______________________________.

   b. The word _____________ means intersection.

   c. The word _____________ means union.

   d. The symbol ___________represents intersection.

   e. The symbol ___________ represents union.

   f. The symbol ___________ is the empty set.

   g. The inequality $-2 \leq x < 1$ means $-2 \leq x$ ________ $x < 1$.

   h. The solution for $\{x|x < 0 \text{ and } x > 0\}$ is ___________.

- The solution set of a compound inequality formed by the word ***and*** is the ____________________ of the solution sets of the two inequalities which includes all numbers that make ________ inequalities true.
- The solution set of a compound inequality formed by the word ***or*** is the ______________________ of the solution sets of the two inequalities which include all numbers that make _________ inequality true.

3. **In each case, determine whether -3 is a solution of the compound inequality**.

   i) $\frac{x}{3} + 1 \geq 0$ and $2x - 3 < -10$

   j) $2x \leq 0$ or $-3x < -5$

In Class L 1.2b

Compound Inequalities

Reflect on these situations:

A. You get a discount if you are at least 18 years old ***and*** no more than 60 years old.

B. You get a discount if you are less that 18 years old ***or*** at least 60 years old.

C. You get a discount if you are less than 18 years old ***and*** at least 60 years old.

Solve the compound inequalities, graph their solution sets, and write solution sets in interval notation.

1. Solve compound inequalities containing "***and***".

> The solution set of a compound inequality formed by the word ***and*** is the ____________________ of the solution sets of the two inequalities which includes all numbers that make ________ inequalities true.

a) $\frac{x}{2} + 1 > 0$ and $2x - 3 < 5$

b) $2x \geq 0$ and $4x - 1 \geq -9$

2. Solve compound inequalities in ***compact form***.

> You can solve a compound inequality written in compact form by _________________________________ _________________ by applying transformations to each member of the inequality.

c) $11 \leq 3z + 2 < 15$

3. Solve compound inequalities containing "***or***".

> The solution set of a compound inequality formed by the word ***or*** is the ______________________ of the solution sets of the two inequalities which include all numbers that make _________ inequality true.

e) $x - 7 > 1$ or $2x - 6 > 2$

f) $3x \geq 12$ or $x - 6 < -4$

L 1.3a Solving Absolute Value Equations & Inequalities (3.4, 3.5)

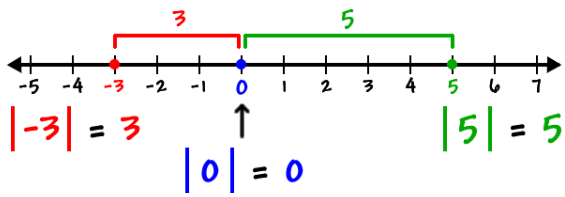
Objectives

- Understand the geometric representation of the absolute value.
- Solve absolute value equations $|x| = a$.

Class Preparation:

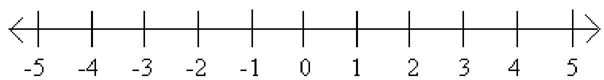
Complete this section prior to the next class meeting.

1. Read pages **239-241** (Example 1-4). We will not use the graphical solution this time.
2. The absolute value of a number is its ____________________from 0 on the real number line.



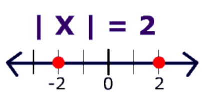
Try It

3. Answer the following and then show the meaning on the number line.
   a) $|4| =$ _______ b) $|-2.5| =$ ________



4. SOLVING EQUATIONS OF THE FORM $|X| = a$

If a is a positive number, then $|X| = a$, where $a > 0$, is equivalent to __________________



Solution: x is either 2 or -2; $x = -2$, $x = 2$; $\{-2, 2\}$

c) $|x| = \frac{3}{2}$

d) $|4x| = 5$

e) $|5t| + 9 = 19$

In Class L 1.3a

Absolute Value Equations

SOLVING EQUATIONS OF THE FORM $|X| = a$

If a is a positive number, then $|X| = a$, where $a \geq 0$, is equivalent to ____________________

Verbal Phrase	The distance from x to 0 is 4.	
Absolute Value Eqn		$\|x\| = 1.5$
Graph		
Solution		

Solve the following absolute value equations.

a) $|4x| = 2$

b) $|2w - 3| = 4$

c) $|3x - 2| - 5 = 3$

d) $|2y| + 7 = 6$

e) $\left|\frac{7x - 5}{4}\right| = -3$

L 1.3b Solving Absolute Value Inequalities (3.5)

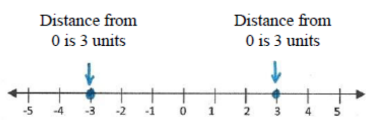
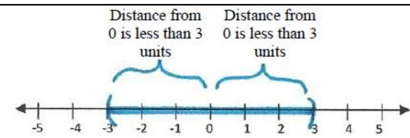
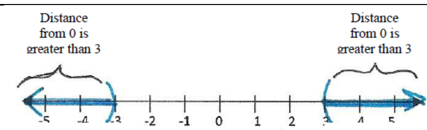
Objectives

- Solve absolute value inequalities of the form $|x| < a$.
- Solve absolute value inequalities of the form $|x| > a$.

Class Preparation:

Complete this section prior to the next class meeting.

1. Read pages **245-250**. Look at algebraic solutions-we will not use the graphical solution this time.
2.

$\lvert x \rvert = 3$	$\lvert x \rvert < 3$	$\lvert x \rvert > 3$
		
The distance from x to zero is 3. x can be either 3 or -3.	Anything in between -3 and 3: $-3 < x < 3$	Anything to the left of -3 or to the right of 3: $x < -3$ or $x > 3$

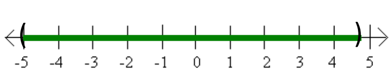
Try It

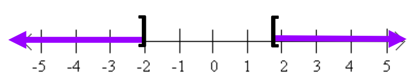
3. Solve the absolute value inequality. Graph the solution set on a number line and write it in interval notation.

   a) $|x| < 4.5$

   b) $|x| + 3 \geq 10$

4. Find an equivalent inequality with absolute value.

   a) 

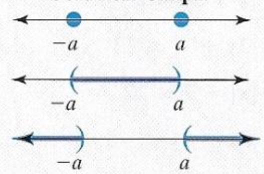
   b) 

In Class L 1.3b

Absolute Value Inequalities

Solving Absolute Value Equations and Inequalities With $a > 0$

Algebraic Solution	Solution Graph
$\lvert X \rvert = a$ is equivalent to $X = a$ or $X = -a$.	
$\lvert X \rvert < a$ is equivalent to $-a < X < a$.	
$\lvert X \rvert > a$ is equivalent to $X < -a$ or $X > a$.	



1. Explain in your own words why -7 is not a solution of $|x| < 5$.

2. Determine whether -3 is a solution of the given equation or inequality.

   a) $|x - 1| \leq 4$

   b) $|x - 1| = 4$

   c) $|x - 1| > 4$

   d) $|5 - x| = |x + 12|$

3. Solve the absolute value inequality. Graph the solution set on a number line and write it in interval notation.

   e) $|x - 2| \leq 1$

   f) $|2x - 3| > 5$

4. Match each absolute value statement with an equivalent statement.

1. $\lvert 2x + 1 \rvert = 3$	A. $2x + 1 > 3$ or $2x + 1 < -3$
2. $\lvert 2x + 1 \rvert \leq 3$	B. $2x + 1 \geq 3$ or $2x + 1 \leq -3$
3. $\lvert 2x + 1 \rvert < 3$	C. $-3 < 2x + 1 < 3$
4. $\lvert 2x + 1 \rvert \geq 3$	D. $2x + 1 = 3$ or $2x + 1 = -3$
5. $\lvert 2x + 1 \rvert > 3$	E. $-3 \leq 2x + 1 \leq 3$

L 1.4a An Introduction to Problem Solving and Formulas (1.6, 1.8)

Objectives

- Write algebraic expressions that can be simplified.
- Apply the steps for problem solving.
- Use formulas to solve problems.
- Solve problems that can be modeled by linear inequalities.

Class Preparation:

Complete this section prior to the next class meeting.

1. Read pages **14, 52-57, 79-80**.
2. Identify key words/phrases for the following operations. (more/less than, increase/decrease, times, etc)

Addition	Subtraction	Multiplication	Division

TRY IT

3. Fill in the blank with < , > , or =. (Assume that the unknown number is a positive number.)

a) 130% of a number is _____ the number.

b) 70% of a number is ______ the number.

c) 100% of a number is _____ the number.

d) 200% of a number is _____ the number.

4. Complete the table. The first row has been completed for you.

	First Integer	All Described Integers
Three consecutive integers	18	18, 19, 20
Four consecutive integers	31	
Three consecutive even integers	-24	
Three consecutive odd integers	53	
Three consecutive integers	y	
Three consecutive even integers	z (z is even)	
Three consecutive odd integers	p (p is odd)	

5. The unit used to measure the intensity of sound is called the *decibel.* In the table, translate the comments in the right column into mathematical symbols to complete the decibels column.

Activity	Decibels	Compared to conversation
Conversation	d	---
Vacuum cleaner		15 decibels more
Jet takeoff		20 decibels more than
Whispering		10 decibels less than half
Rock band		Triple the decibel level

6. Compound Interest: $\boldsymbol{A = P\left(1 + \frac{r}{n}\right)^{nt}}$

What do the variables stand for?

$A =$ $P =$ $n =$

$r =$ $t =$

In Class L 1.4a

Translating

1. Write the following as algebraic expressions. Then simplify.
   a) The sum of two consecutive even integers, if *x* is the first even integer.

   b) The perimeter of the rectangle with sides of length *x* and 2*x* -1.

Problem Solving

General Strategy for Problem Solving: This is in your book.

   d. **Understand** the problem. Become comfortable with the problem:
      i. Read and reread the problem.
      ii. Construct a drawing.
      iii. **Choose and define a variable to represent the unknown**.
   e. **Translate** the problem into an equation
   f. **Solve** the equation
   g. **Interpret** the results: Check the proposed solution in the stated problem and state your conclusion.

2. Mark-up (increase) /mark-down (decrease): Luisa is a computer programmer. Her new salary of $30,000 reflects a 20% raise. What was her salary before the raise?

3. Perimeter: In a blueprint of a rectangular room, the length is to be 2 centimeters greater than twice its width. Find the dimensions if the perimeter is to be 40 centimeters.

Using Formulas

4. A principal of $25,000 is invested in an account paying an annual percentage rate of 5%. Find the amount in the account after 2 years if the account is compounded

	a) semiannually	b) quarterly	c) monthly
n			
A			

L 1.4b Cont, An Introduction to Problem Solving and Formulas (1.6, 1.8)

Objectives

- Write algebraic expressions that can be simplified.
- Apply the steps for problem solving.
- Use formulas to solve problems.
- Solve problems that can be modeled by linear inequalities.

Class Preparation:

Complete this section prior to the next class meeting.

1. Read pages **224 & 225**.
2. Identify key words/phrases for the following

$<$	$\leq$	$>$	$\geq$

TRY IT

3. Write the following statement as an inequality.
   a) The minimum value of y is 12.

   b) The maximum value of n is 8.

4. Insert the correct symbol $\geq$ or $\leq$.

   a) As many as 16 people were seriously injured:

   The number or people seriously injured _____ 16.

   b) There were no fewer than 8 references to carpools in the speech.

   The number of carpool references _____ 8.

In Class L 1.4b

Translating

1. Translate the following sentences into inequalities.

Sentence	Translation
a) b exceeds -3.	
b) z is at most 7.	
c) d is more than 15.	
d) Max is at least 18 years old.	
e) Bing weighs no more than 90 pounds.	
f) Heather's income is between \$23,000 and \$35,000.	

Problem Solving

2. Four times the difference between a number and six is less than or equal to six times the sum of a number and four. Find the smallest number that will satisfy the inequality.

3. The relationship between Celsius temperature and Fahrenheit temperature is given by the formula $\mathrm{F} = \frac{9}{5}\mathrm{C} + 32$. If the temperature is between 77°F and 86°F, what is the temperature range in degrees Celsius?

4. Chris can be paid in one of two ways. Plan A is a salary of \$420 per month, plus a commission of 7% of sales. Plan B is a salary of \$526 per month plus a commission of 5% of sales. For what amount of sales is Chris better off selecting Plan A?

Appendix J: Math 002 Teaching Schedule Fall 2013

	Class Time	Section	Level	Status	TA	Group
1	TR 8:00-9:15	13423	undergrad	returning	J.W. (2)	E
2		19246	undergrad	returning	C.S.	C
3		13412	undergrad	new	R.A.	E
4	MWF 9:00 - 9:50	13425	undergrad	returning	L. Sw. (2)	C
5		13424	undergrad	returning	S.N.	E
6		16433	undergrad	new	B.D.	E
7		13413	undergrad	new	M.H.	C
8		22311	undergrad	new	G.S.	C
9		25813	undergrad	returning	J.K.	E
10	TR 9:30-10:45	13426	undergrad	returning	J.W. (2)	C
11		23581	undergrad	returning	A.P.	C
12		13414	undergrad	new	N.C.	E
13		13415	undergrad	returning	J.G. (2)	E
14		23582	undergrad	new	K.S.	C
15	TR 11:00-12:15	13428	researcher	returning	L.M.	C
16		13427	grad	new	S.M. (2)	E
17		13416	undergrad	returning	C.E. (2)	C
18		13417	undergrad	returning	S.L. (2)	E
19		17669	undergrad	returning	M.A.	C
20	TR 1:00-2:15	13430	undergrad	new	L.D.	E
21		13429	undergrad	new	G.G.	C
22		13418	undergrad	returning	C.C.	E
23		13419	undergrad	returning	S.L. (2)	C
24		19247	undergrad	returning	B.P.	C
25	MWF 2:00-2:50	13432	undergrad	new	I.N.	E
26		13431	undergrad	returning	L.Sw.(2)	E
27		13420	undergrad	new	S.E.	C
28		13421	undergrad	new	M.K.	E
29		25821	undergrad	new	R.L.	C
30	TR 2:30-3:45	13433	undergrad	new	L.Si.	E
31		19248	undergrad	returning	C.E. (2)	E
32		23583	undergrad	returning	J. G. (2)	C
33	TR 4:00 - 5:15	13436	undergrad	returning	M.P.	E
34		13435	grad	new	S.M. (2)	C
35		13422	grad	new	A.K. (2)	C
36	TR 6:30 - 7:45	19249	grad	new	A.K. (2)	E

Appendix K: Mixed ANOVA of Self-regulated Learning Graphs

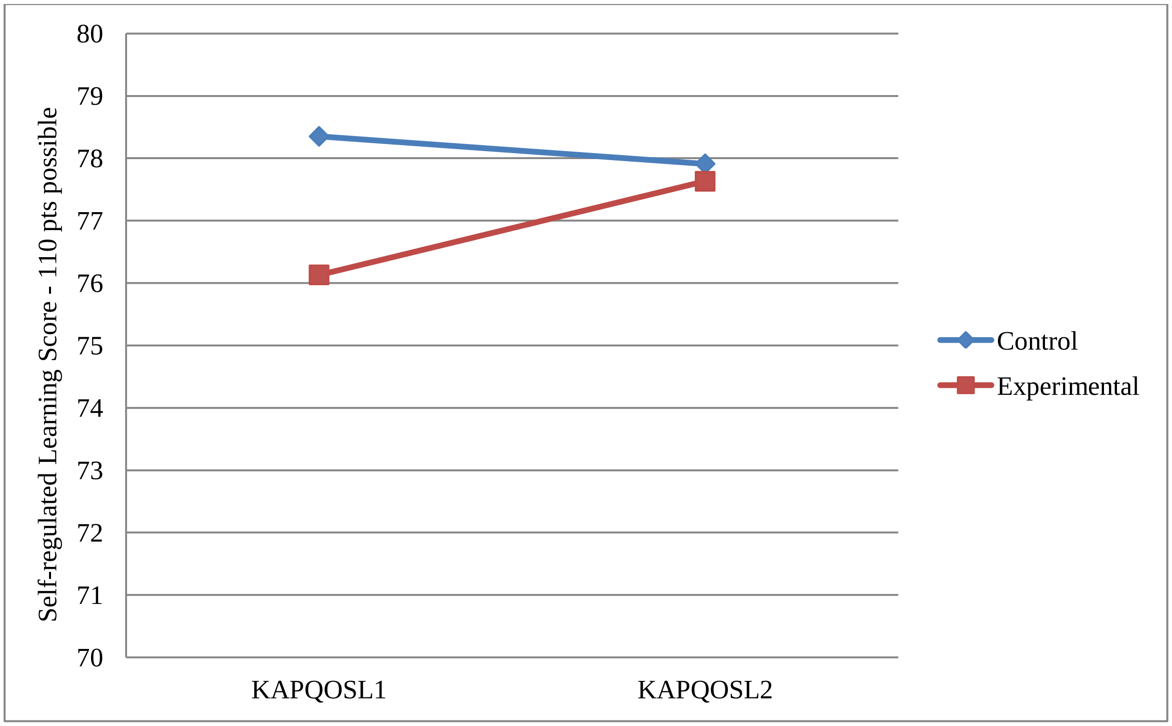


Figure K1: Phase 1 Inclusive - Mean Self-regulated Learning Scores by Groups

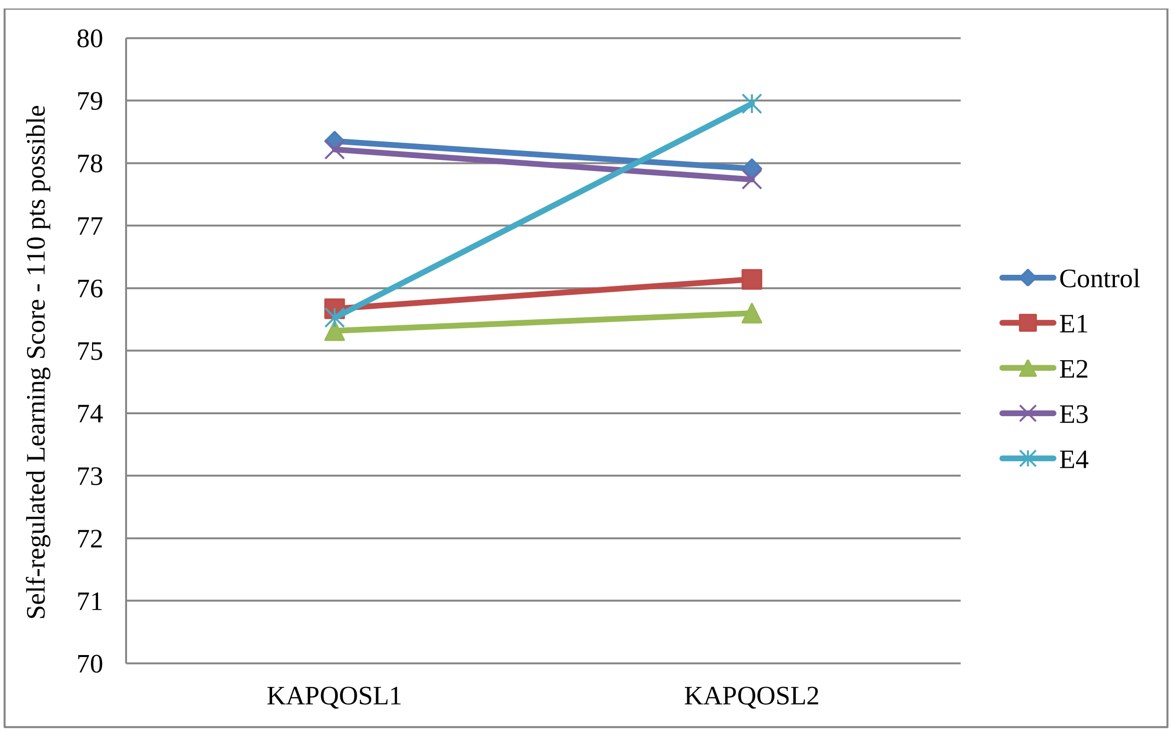


Figure K2: Phase 1 Inclusive - Mean Self-regulated Learning Scores by Modified Groups

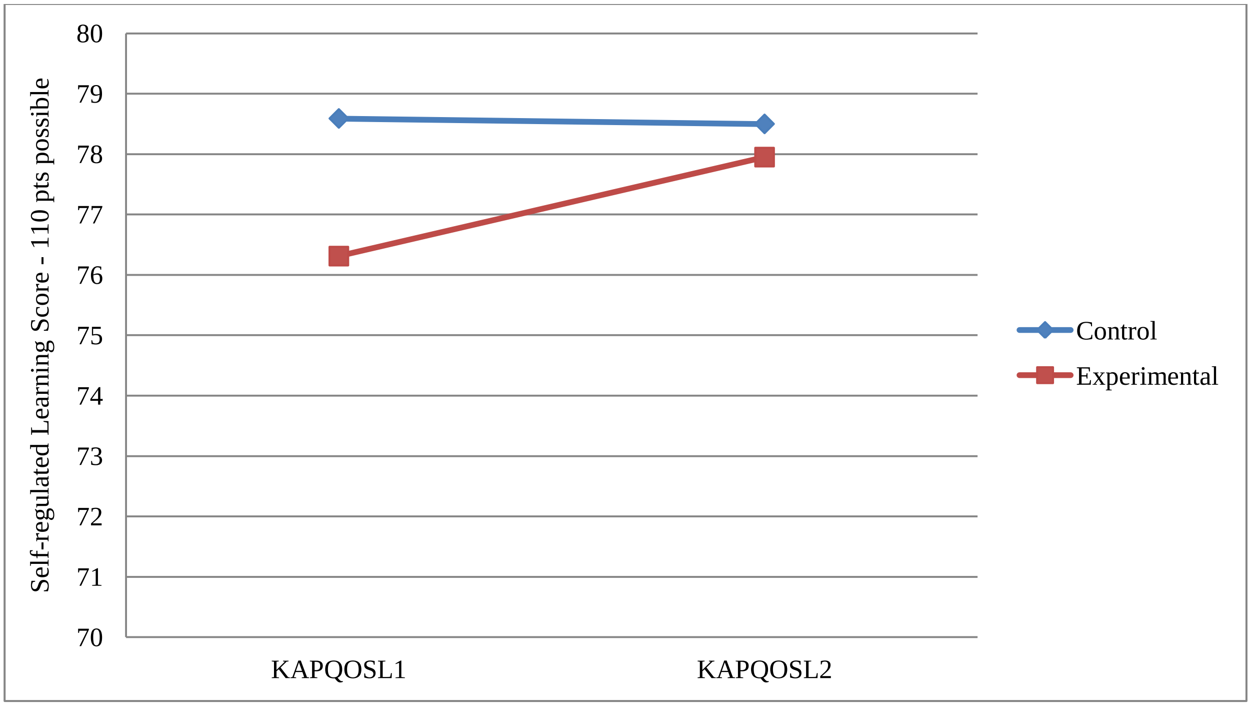


Figure K3: Phase 1 Exclusive - Mean Self-regulated Learning Scores by Groups

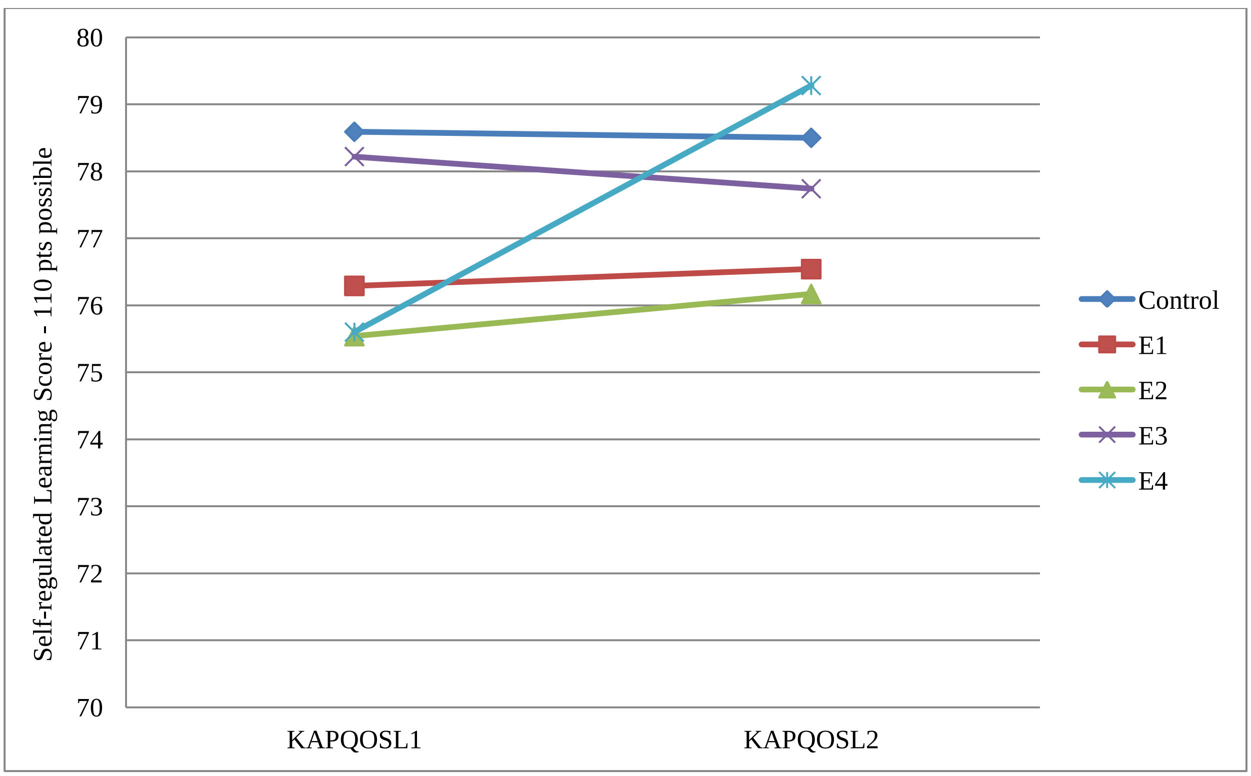


Figure K4: Phase 1 Exclusive - Mean Self-regulated Learning Scores by Modified Groups

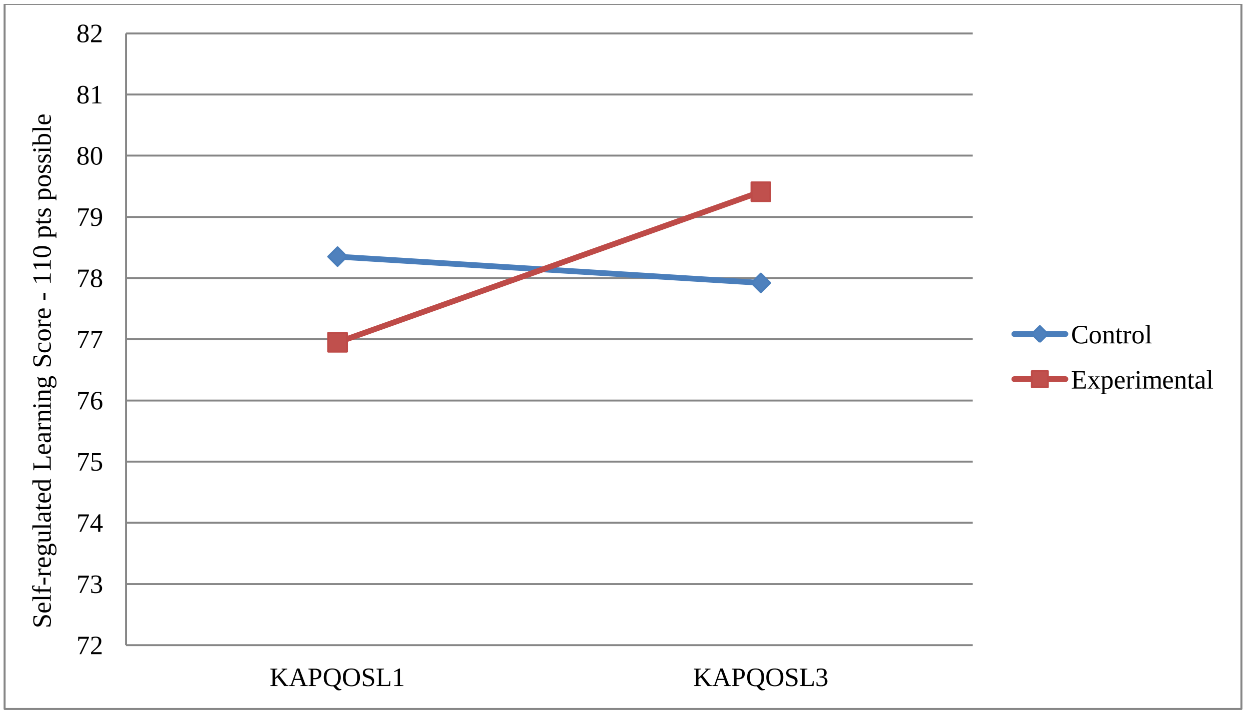


Figure K5: Phase 2 - Mean Self-regulated Learning Scores by Groups

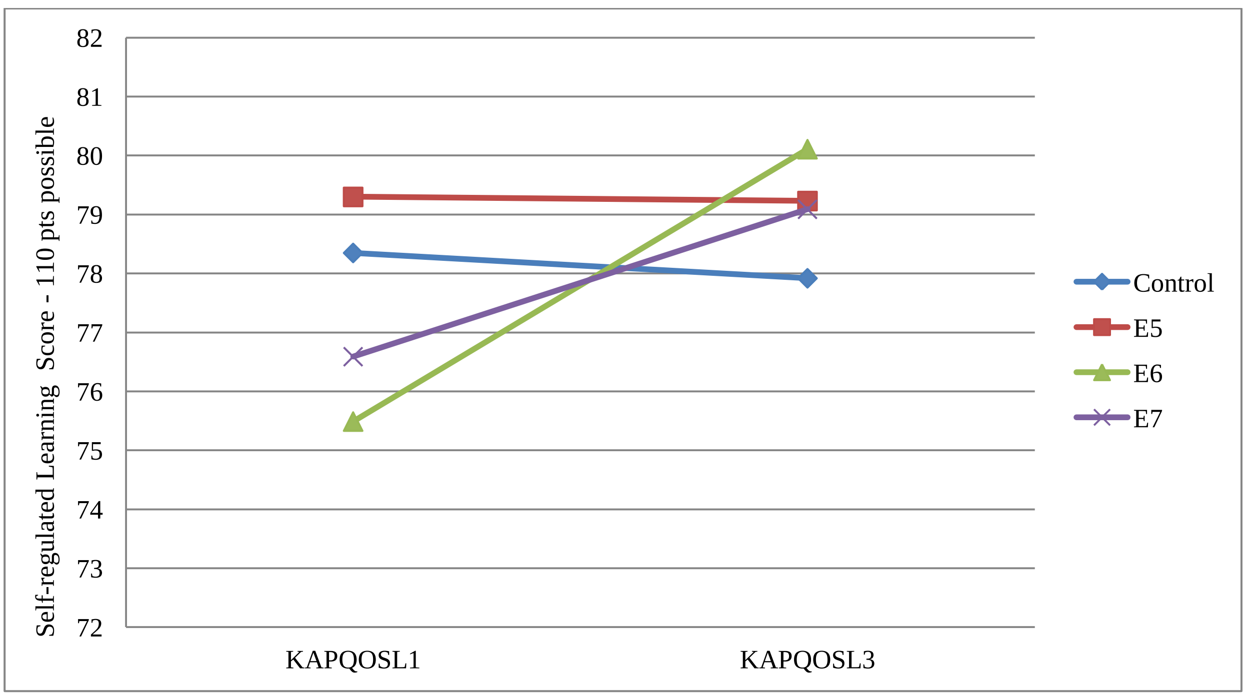


Figure K6: Phase 2 - Mean Self-regulated Learning Scores by Modified Groups

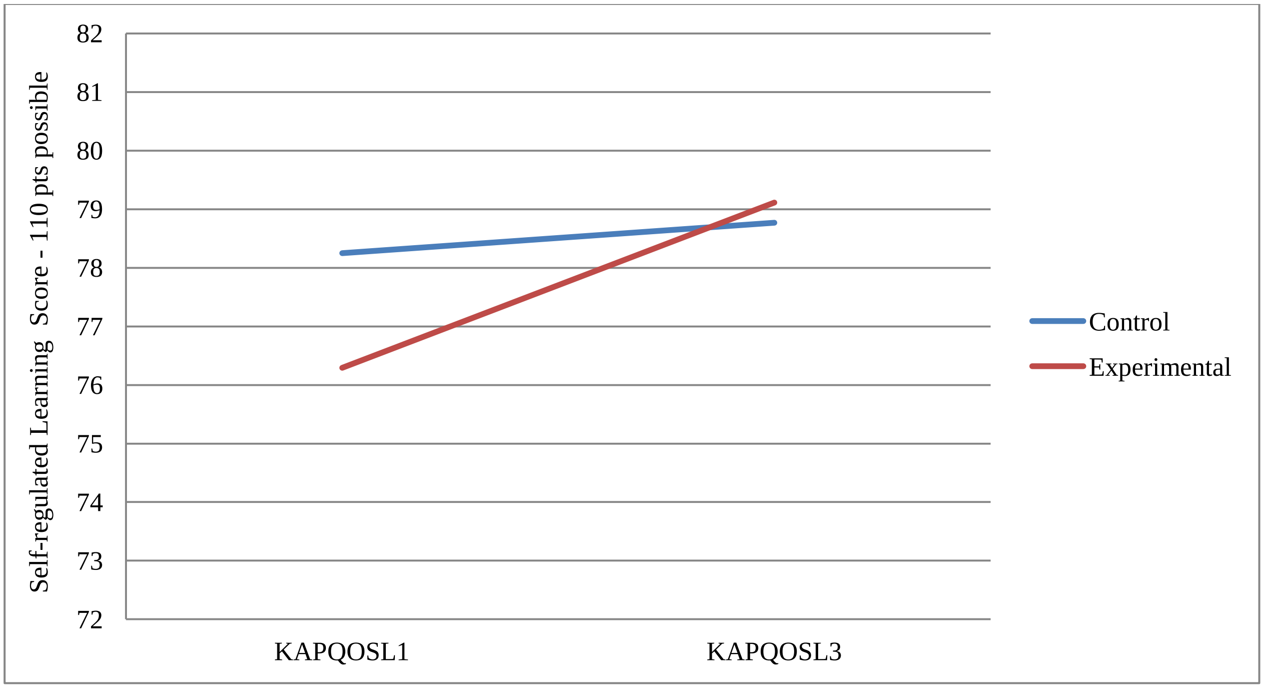


Figure K7: Phase 3 - Mean Self-regulated Learning Scores by Groups

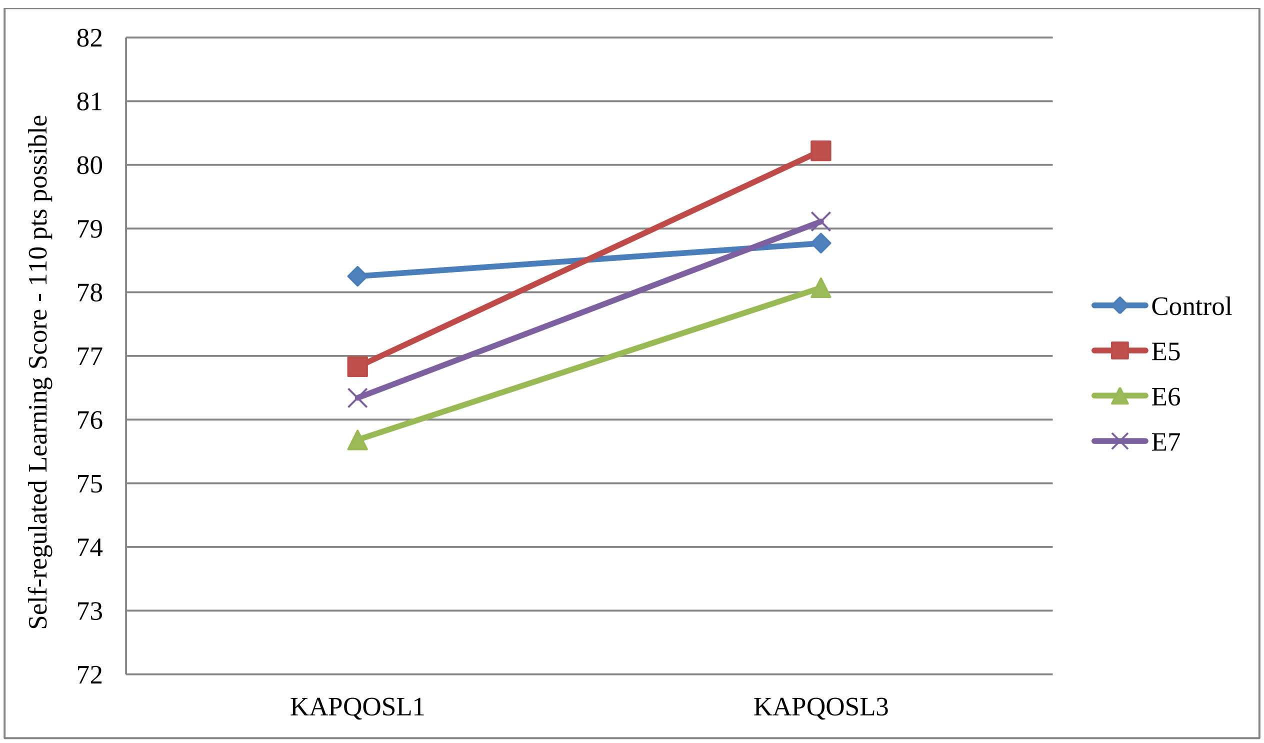


Figure K8: Phase 3 - Mean Self-regulated Learning Scores by Modified Groups