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LEARNING EFFECTS OF EXAMPLES APPLIED TO COLLEGE ALGEBRA STUDENT INTERESTS

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by

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This mixed-methods investigation studied the learning effects of example problems based on college algebra student interests. The study spanned two semesters and included three groups of students. The first group was presented with algebraic procedural examples and assessments without context. The second group was presented with algebraic class examples in contexts related to student majors and hobbies, but assessments without context. The third group was presented with class examples in contexts related to student majors and hobbies and also assessments with context.

Learning growth as measured by performance scores on examinations was analyzed quantitatively. Student comments regarding learning progress were analyzed qualitatively, using grounded theory. Performance improvement was higher for Group 3 than for Group 2 than for Group 1 as context increased, but these most differences were not statistically significant and could have occurred by chance. A large effect size (>0.80) between Group 3 students presented with class examples and homework problems based on student interests and Group 1 (control) students for 50% of quizzes given.

Student engagement was also studied. Results from scaled student survey including questions from the National Survey of Student Engagement were analyzed quantitatively. Participation in completing learning logs provided a measure of student

engagement. Students in higher context groups had higher participation rates, Group 3 having 65% participation, Group 2 at 58% average participation, and Group 1 only averaging 36% of students returning learning logs.

To Dad

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Introduction

Introduction to Chapter One

Chapter One introduces the reader to the research study. A purpose statement describes the investigation goal and research hypothesis to be tested. Context or background information related to the study is summarized, followed by guiding research questions, a summary of methodology, and significance of the study.

Purpose Statement

The purpose of this study is to determine if there is a significant difference in growth of learning for college algebra students taking an interest-based, applications-focused class and college algebra students taking a traditional concept- and equation-based class, as measured by outcome assessments.

Null Hypothesis: There is no significant difference in learning outcome for college algebra students presented with class examples applied to student interests and students presented with algebraic class examples without application, as measured by change in posttest-pretest scores.

Alternative Hypothesis: There is a significant difference in learning outcome for college algebra students presented with class examples applied to student interests and students presented with algebraic class examples without application, as measured by change in posttest-pretest scores.

Context/Background

College algebra textbooks need to present material well and provide practice problems conducive to student learning; they also need to consider current trends in mathematics education – facts that have been evident at least for the past century. For an early statement of this belief see (Merrill & Smith, 1917). Although algebra has long been a standard course in the college curriculum, there is still considerable discussion among educators and mathematicians regarding the role and value of college algebra today (CBMS, 2001). Bressoud (2005) has observed that college algebra failure rates are disappointing to students as well as college officials. Since college algebra is often the only math course college students take (CUPM, 2005), active debates exits regarding the appropriate purpose of college algebra and the value of learning college algebra for today's students. Mathematical historian Roger Cooke (2008) has remarked on the abstraction of algebra problems that places the emphasis on algebra as a "source of innumerable pointless riddles" such as: a father is three times as old as his son today, and in ten years he will be twice his son's age; determine the ages of father and son. Cooke noted that examples of this type appeared in early textbooks on algebra and continue to appear today.

With limited class time available, departments find it necessary to limit the content of college algebra. Accordingly, a number of questions are raised in regard to the offering of algebra courses at the college level. (1) Which mathematical concepts are most beneficial to students and for what reasons? (Ellington; Fox and West, 2001) (2) Should college algebra be a course consisting solely of functions and models? (3) What assumptions should we make about what students know about algebra when entering college? (Fox and West, 2001) (4) Would college algebra be better received, learned, and remembered if it is applied to life/career situations? (5) Should an entire course focus on applications with algebra as a means to a mathematical solution? (6) Should students be able to recognize and solve applied problems in their personal and professional lives beyond the using methods learned in college algebra? (7) Should college algebra be taught as a pure mathematics class, learning to solve systems of equations and inequalities and other algebraic problems with the use of symbolic tools and the operations or relationships that bind them? (8) Should students learn how to think logically and carefully, how to solve number puzzles, and to appreciate working with algebraic symbols and rules, manipulating the equations while maintaining balance. Can college algebra students share the joys of mathematics-related activities and mathematical thought—exercise for the brain?

"There is something perverse in the way many mathematics departments structure their courses" (CUPM, 2005, p.2). The task for colleges and universities is to decide which mathematical concepts in the vast collection of mathematics are most important for undergraduates to learn (Goodman, 2002). These mathematical concepts should define the college algebra course. College algebra needs to adapt to the changing needs of students. Academic research is deemed necessary to make wise, effective decisions regarding curricular changes (CUPM, 2007). Research is needed to determine the changes that would result in significant improvements in student learning.

Textbook authors including Anthony Goodman, Edward Burger and Michael Starbird, Peter Tannenbaum, and Robert Arnold are addressing new issues, questions, and demands from students, teachers, and administrators as they attempt to improve the student learning of college algebra. They realize that traditional college algebra is not working. A consensus at a conference to improve college algebra held at the U. S. Military Academy (2002) identified the need to concentrate on the improvement of traditional college algebra.

Major changes in curriculum and degree requirements at colleges and universities should be based on solid research (CUPM, 2007). Mathematics departments must seriously consider the student needs, mathematical societal needs, and the attitudes many hold toward the study of mathematics. Also, mathematics should be current and age-appropriate so that it applies to student groups in environments familiar to students of today and tomorrow (Mathematical Association of America [MAA], 2005). "Developmental mathematics does not adequately prepare students to continue in the algebra sequence", as reported by the 2003 paper from in *Assessing the General Education Mathematics courses at a Liberal Arts College for Women* (2003). One proposal for college algebra is to focus on the topic of functions (Ellington, A.J., 2005)—not only algebraic definitions and relationships in mathematics, but also applications of functions as small-scale model versions of phenomenon. (Fox & West, 2001).

Research into the educational outcome effects of applications, especially interest-based applications on student learning, is desperately needed to determine the value added and the learning acquisition outcomes of such an endeavor (Pearson, 2000). While some research has been conducted in high school algebra classrooms comparing performance scores on algebraic problem solving and reasoning skills for students taught using a traditional method with students taught using an applications-based method, little has been found regarding college algebra students. No research articles have specifically focused on the use of interest-based (student-centered) applications in algebra classes at the college level.

The purpose of this study is to assist in fulfilling the void of research needed for making important decisions regarding the future of college algebra, and mathematics in general, for many college students. The research focus for this study is on the effects of class examples embedded in contexts related to student interests on student learning performance.

Research Questions

Q1: To what extent do class examples applicable to student interests effect student learning performance? Is there a noticeable difference in learning outcomes such as homework, quiz, and examination performance scores, for college algebra students presented with class examples based on hobbies and major areas of study, and for college algebra students presented with class examples without application?

Q2: To what extent do class examples applicable to student interests effect student engagement or perceptions? What themes or patterns of learning growth, learning differences, or educational planning regarding learning are apparent between the control group and the two experimental groups, as evidenced by Learning Logs? Is there a difference in student engagement such as class participation, attitudes, and perceptions?

Methodology

This study will use a mixed-methods approach, a combination of qualitative and quantitative methods to analyze the data. Differences in the academic scores from pretest to posttest examination scores will be the dependent variable for this study. Quantitative data will be used to make comparisons between groups based on examination scores. Qualitative methods will be used to analyze patterns in written statements provided by students via Learning Log responses throughout the semester and survey responses at the end of the semester. The Learning Log comments will be gathered and viewed as group summations for similarities and differences between the control group and the experimental group and will be viewed for information regarding student learning.

Significance

Research to determine effectiveness and attitudinal improvements are key elements to improvement of teaching skills, teaching techniques, and best (better) practices and is interesting to most effective math educators. However, research on improved teaching technique or methodology for mathematics educators is limited.

No research articles have been published in the *Journal for Research in Mathematics Education [JRME]* since 2000 that involve college algebra exclusively, and only one research article in the *JRME* has included college students at all as part of a study since the year 2000. There has been research, however, into algebra at the junior high and high school levels that may be similar to algebra at the college level.

Summary of Chapter One

The purpose of this study is to determine the effects on college algebra students when presented with examples based on student interests. A literature review in chapter two provides context for this study in light of related research. Research methodology using mixed methods is detailed in chapter three. Results from the study are presented and analyzed in Chapter Four, with conclusions and implications discussed in Chapter Five.

Chapter Two

Literature Review

Introduction to Chapter Two

Chapter Two introduces the reader to the research literature related to the study. This literature review is organized into the following six related categories: (1) national interest, (2) expectations, (3) attitude, anxiety, and confidence, (4) knowledge gap, (5) content, and (6) similar studies. A summary of the literature closes the chapter.

National Interest in Mathematics Success

Mathematics is a measure of position and prestige among nations. Mathematics is used in economics, technology, science, cryptography, weapons research, and other areas of national security. So a strong mathematical and scientific background is valuable for a sound economy and to develop advanced technology and research. With so much of the nation's homes depending on math and science, these subjects attract attention and assessments, measuring and comparing our students' knowledge with those from other countries. Lower scores are considered a sign of weakness. The fears of being weak in these critical areas are cause for concentration of improved efforts and outcomes leading to incentives and research to improve teaching and especially learning in science, and its building block – mathematics.

To excel in science research and exploration, a strong background and understanding in mathematics is necessary and should be learner centered (Johnson, Berg & Heddens, 2006). Educating as many students as possible provides a higher probability that some of these students will further science research and find solutions to the Nation's challenging problems. The No Child Left Behind Act of 2001 [NCLB] and the 2002 article entitled “The Facts About Math Achievement” are based on assessments of mathematics achievement determined by standardized exams, and compared to scores from other nations. When looking at the data from these tests, American students did not achieve as high a standard math score as students in other nations. While math scores for American students are slowly rising, only 25% of students tested at fourth and eighth grades, have reached the “proficient” mark (NCTM, 2000). Research suggests using multiple teaching approaches to improve student learning in mathematics and for better preparing pre-service mathematics teachers. Professionals, organizations, opinions, and disseminated information will aid in the modification of curriculum and instruction and the development of teaching techniques to improve mathematics achievement among our nation’s children (NAEP, 2009). Mathematics proficiency is expected for students of all ages. As young students in grade school increase mathematical knowledge, they must be encouraged and supported to continue learning and advancing through the realm of mathematics. National and state assessment scores are used as indicators of a measurement of success for both the student and the schools based upon that particular standard. The impact of more instructional time on mathematics learning is not clear-cut.

Although mathematics has always been considered important enough to have been a required math course for graduation, twenty-five years ago A Nation at Risk Report encouraged higher math requirements for high school graduation; thus, pushing more students into algebra and higher mathematics during the high school years. Theoretically, algebra and higher mathematics better prepared students for advanced mathematics in college. Math became one of the added requirements for the students to successfully graduate from an accredited and perceived “quality high school.” The intent was deemed admirable and defendable for pursuing the goal of improved academic standards and performance levels to better enable the students, and ultimately the nation, to be more competitive in the world standings. Unfortunately, the resultant effect is determined to have somewhat missed the target and desired outcomes. Some issues that plague us today are that the standards and success rate of improving the educational level of graduating high school students has not improved as expected. The attitude of the students toward the value of math has not improved regarding the value of math and a student's desire to take more math courses without having the "required" label or stigma forcing them to undertake such courses. High school students that are required to take more predetermined or prescription courses feel resentment toward some of the required courses and feel they are missing some elective course options that would have benefited them more directly if they were allowed the freedom to choose more of their preferred courses over the required curricular offerings. Math teachers have not found a fool proof and prescribed method of instructing students in a manner that causes the students to meet with academic standards success and to, ultimately, cause them to affectively appreciate mathematics as a valuable and desirable attribute worthy of their study.

The No Child Left Behind Act (2001) has mandated that all children be provided a learning environment in which students are taught by licensed professional teachers utilizing research-based best practices in schools that make annual yearly progress toward the success of every student in academic endeavors. It is well documented that for some segments of our national student population, this lofty ideal is not being reached. This is the case for some Hispanic students (and students of other nationalities with native languages different from English) in general and for English Language Learners (ELL) in particular. ELL are, from the time they enter a U. S. public school, challenged to (1) learn a new language, (2) learn a new language in a relatively short time span, (3) learn and master the content of at least the core disciplines, (4) pass state-wide high stakes testing at periodic points along their educational career, and (5) pass state-wide high stakes testing at the end of their educational career in order to receive a high school diploma. A curricular content area that noticeably suffers is math because of the need to learn the language specific and its precise placement and usage when using formulas and equations in association with the signs, symbols and the precise process that is required for the accurate solving of problems associated with the higher levels of mathematics. The challenge for teachers and administrators is to provide a positive learning environment that successfully maximizes the learning experiences of students and provides them access to the opportunities for other educational experiences and meaningful participation in the democratic experience.

Mathematics is a very valuable discipline of knowledge as a key ingredient in the advancement of individuals, which collectively has the ultimate impact on a nation in improving their educational standards. The educational preparations are a vitally important element in preparing a nation to be equal to or better qualified than the others in knowledge, skills, and resources when in competition and to also feel comfortable and capable of cooperation with others when that serves the situation. The ultimate strength of a nation often comes down to the ingenuity and power of knowledge and abilities of one country as compared to another, and the two major disciplines for such rating comparisons are the math and sciences. This concern for math and science is evidenced when there is a national safety and security scare, as pointed out by wars, the space race, and Sputnik. The politicians discussed educational issues, and the United States placed tremendous weight on the students learning mathematics in the public schools and further pressed for higher education, placing more emphasis on mathematics at that level.

The No Child Left Behind Act of 2001 further raises the academic standards bar for all students, including “at-risk” students to meet higher expectations in all academic areas especially in mathematics. A higher percentage of high school graduates are now attending colleges and universities than ever before. These added student numbers and higher standards pose a problem for lesser prepared students now faced with a math requirement, generally college algebra or higher (MAA, 2001).

Math is recognized as an important academic subject by most people; however, some students view math as having somewhat of a questionable value and as being difficult to learn. This combination makes taking the math course a less desirable venture, and they are not motivated to learn and succeed. This raises some to question the value added by taking an algebra course and its importance to their personal and professional needs. When visiting with algebra students, it appears most students are apprehensive about taking college algebra for one of the following reasons:

- They do not understand or do well in math areas.
- They did not understand the math courses they took in their high school.
- There is no perceived relevance made between the math and their chosen professional career.
- The time required to learn math is too great of an investment of time for the value or benefit to them.

Clements (1999), through the National Council of Teachers of Mathematics, reported that the teachers expressed the following beliefs regarding mathematics in the early years:

- Although algebra can empower students to handle variables, to explore functional relationships, and to model reality, only a small proportion of lower secondary students in Brunei Darussalam reached the stage of being able to do any or all of those things well.
- Notwithstanding, algebra is an important vehicle for generating many deductive "proofs" in mathematics (and without proof, mathematics is not really mathematics).
- Algebra has a rich and fascinating history, and is an important part of the stories of how mathematics developed through the ages, and how the present technological age evolved.
- Furthermore, technological advances have made it easier for people to apply algebraic-ideas—provided they have acquired a "feel" for what is needed (and at least a modest understanding of algebraic "basics").
- Algebra is often employed in "mathematical models" which enable predictions of real-life events to be made.
- Algebraic structures are fundamentally important in mathematics. They can guide one's thinking in many different mathematical contests, and indeed, in "non-mathematical" contexts too.
- Graphs, which are an important aspect of algebra, are used in many real-life contexts. Certainly, most people need to be able to "read" them, if not create them.

Many standards-based high school curricula attempt to develop understanding in algebra by focusing on multiple representations numerical, symbolic/algebraic, graphical/visual, verbal (Merrill & Smith, 1917). Studies of some of these curricula have found that students using such material perform as well as or better than students studying from more traditional texts on assessments of problem solving and applications. For instance, Huntley, Rasmussen, Villarubi, Sangtong, & Fey (2000) reported that students studying from the Core-Plus curriculum were better able to solve problems that required movement across symbolic, tabular, and graphical forms than students studying from a traditional curriculum (Senk & Thompson, 2003; Thompson & Senk, 2001).

Expectations for Students' Algebraic Knowledge

High school transcripts or math entrance examinations comprise the data used by most universities and colleges to determine which mathematics course a student should be best suited to enroll in as their first college mathematics course. Sometimes students are assigned to one specific course, and sometimes students are provided with a list of appropriate courses and may select a course from this list with the help of their advisor. Decisions may be influenced by mathematics requirements in the student's major department of study, a student's career goals, and probability of success. Course options are also dependent on course offerings at the university (Bennet et. al, 2009). Some universities don't offer remedial/noncredit mathematics courses which forces the student to either take the regular college algebra course without the proper preparation skills or to go to another school or college to take a remedial math course to adequately be prepared for entry into the College algebra course.

Schreibner (2002) also criticizes the practice of academic ability grouping or "tracking." A possible explanation for the differences in performance among U. S. students is tracking in math, while a possible explanation for the difference in performance among U. S. students in science is the practice of having students take specialized courses from middle school onward, the report says. The single factor that accounted most for disparities in achievement among U. S. students was what class they were assigned especially when the difference was between an algebra class and a non-algebra "regular" math class. The American system appeared to focus on an exaggeration of the differences among groups of students instead of helping all students get to some common students or a given set of knowledge.

Research continues in an effort to seek answers to the questions of how we best can improve the curricular and methodological delivery of mathematics to enable individuals to better understand the need for math, value added, and appreciation of mathematics in the quality of life (MAA, 2006).

Math Attitude, Anxiety, and Confidence

The term "attitudes" has included various indicated meanings to define the characteristics for the different categories such as self-concept, confidence in mathematics, anxiety of mathematics, and enjoyment working with mathematics (Leder, 1987; Khoo & Veloo, 1990). All these various differentiating categories of attitudes are relatively important when evaluating where students are impacted when measuring students' attitudes.

The general relationship between attitude and achievement is based on the concept that the better the attitude a student has toward a subject or task, the higher the achievement and performance level tends to be (Schreibner, 2002). Influences on students' attitudes vary a great deal and are different from student to student; however, the categories listed by Schreibner (2002) as impactors of these influences are based upon or related to: their perceived value for return on the time invested in study and the effort of the study they have put forth. Studies (Jamilah, 1993; Khoo & Veloo, 1996) have been conducted on students' attitudes toward mathematics. Studies have shown that promoting positive attitudes toward mathematics become an important objective in teaching mathematics (Alrwais, 2000; McLeod, 1992).

Alrwais (2000) examined the relationship among the factors associated with a student's attitude toward learning mathematics, student's mathematical creativity, and student's school grades, and their effect on achievement in mathematics. He found out that the best predictor of a student's success ratio was the student's attitude toward learning mathematics. McLeod (1992) found similar results when he studied students' attitudes compared to success and concluded that students' attitudes play a significant central role in mathematics achievement.

A primary goal of college mathematics departments is to increase performance in college algebra (Warkentin & Whistler, 2001). Students often have low confidence and a poor attitude about mathematics. Alrwais (2000) and McLeod (1992) both noted in their studies that indicators are students identified as fitting this category will undoubtedly struggle with mathematics. Cognitive restructuring is suggested as a possible strategy for assisting students to combat negative thinking. Some researchers such as Arem (2003) suggest an examination of the student's attitude to determine baseline status of the student and to construct and administer positive traits of the self-affirmations. Student's self-affirmations are encouraged by creating personal, positive metaphors (words or phrases that carry the meaning of success with math), as well as to identify their own “math support group.” Arem (2003) suggests that successful math students often visualize themselves succeeding and rehearse forthcoming math situations. They are told to create a “memory bank” of positive images and practice anchoring to these images, thereby, increasing their confidence.

Students who develop positive attitudes toward subjects, and who feel good about their learning, will develop more positive feelings about themselves which in turn will contribute significantly to their personal growth (Duncan & Thurlow, 1989). This fact is a valuable tool that can be utilized by instructors to assist the students in understanding the value of their studies and to effectively use teaching aids and scenarios to assist the student in the understand and formatting the relevance by transition to their practical application in career or interest areas. In addition to the actual knowledge acquisition, the instructor can assist the student in realizing their growth improvement by using a benchmarking system that will afford the student the opportunity to realize the present level as compared to the prior assessment level of functioning.

Students feel a lot of pressure from their change in surroundings and the loss of the items they felt provided a form of security for them in their previous school settings. For most of the students, there is an added concern that the instructors have distanced themselves from the need to make certain the students are performing the necessary tasks of the learning process and gathering the necessary information for understanding. This change is more emphasized when the students are taking a subject in which they do not normally have a high degree of comfort and success. College Algebra, therefore, has the immediate effect upon the students as they realize they now have to assume more, if not most, of the responsibility for learning the subject matter adequately to pass the course. This uncertainty and magnitude (of the weight of the pressure and concern) factors into creating a situation that increases in the student and grows into what is recognized as "math anxiety". Math anxiety rarely goes away by itself. It must be addressed as a primary concern by the sufferer to see improvement. It exists in many forms, degrees, and at many levels. Learners must be actively engaged as participants in mathematical problem solving. Most importantly, instructors must believe that each student can learn math (Preis & Biggs, 2001) and must help students come to believe that they can do math (Dodd, 1999).

College advisors have stated that their advisees exhibit math anxiety and even some degree of fear of math (Warkentin & Whisler, 2001). Even secondary and elementary teacher candidates have difficulty embracing mathematics. Several students majoring in elementary education believe that they only need to know the elementary math that they will teach their elementary students. Mathematics beyond their future instructional levels are considered above and beyond what realistically should be expected for them to be proficient. Many of these future elementary teachers do not like mathematics (Patton, et al., 2008). Students notice teacher attitudes and preferences whether or not the instructor intends to share these views (Healy & Hoyles, 2000).

Fiore (1999) emphasized the anxiety of some students being as a helplessness and mental disorganization. They found that this feeling arises among some people when they are required to solve a mathematical problem. It is both an emotional and cognitive dread of mathematics. Pries and Biggs (2001) describe a cycle of math avoidance as: 1) the person experiences negative reactions to math situations; 2) a person avoids math situations; 3) poor mathematics preparation; 4) poor math performance. This generates more negative experiences with and brings us back to number one. This cycle can repeat so often that the math anxious person becomes convinced they cannot do math, and the cycle is rarely broken. Arem (2003) equates a lot of math anxiety with math test anxiety, which she says is threefold: poor test preparation, poor test-taking strategies, and psychological pressures. The degree of math anxiety varies greatly from individual to individual, but all anxiety is influenced and related in part to gender, ethnic background, age, attitude towards math, and previous math experience.

A perceived indicator of math anxiety, fear, or dislike for math is that math is consistently a course that has been postponed in a college student's pursuit of their educational requirements. Algebra is a freshman level course but quite often is taken by the students when they have a junior or senior standing. The reasons given by the students as to why they waited so long to take the course vary, but it is evident that they procrastinate and hold off on taking this course requirement.

Math anxiety disrupts on-going activities of working memory, making mathematical performance less accurate and more time consuming (Ashcraft & Kirk, 2001). The effects are intrusive thoughts of inadequacy and failure that lead to a cycle of math avoidance. Instructors can have a large hand in reducing math anxiety in their classrooms. Some of the recommendations by Jackson et al (1999) are for the instructor to disclose his or her own math anxiety and how it was overcome, to project interest and enjoyment in math, to offer positive reinforcement and help to the math anxious, and to make respect dwell in the classroom. In addition, it is desirable to see to it that one-on-

one tutoring is available, either by yourself or others, to provide written and verbal reviews before exams, to seek support from other colleagues when teaching becomes overwhelming, and to provide special testing situations, such as before or after class. Instructors can also inform students that the ability to do math is not automatic, but rather takes years to develop. Instructors must believe that every one of their students can succeed at math (Preis & Biggs, 2001; Dodd, 1999).

For decades, mathematics has been stereotyped as a predominantly male area of study. According to Zaslavsky (1994), people of all races and economic backgrounds fear math, but women and minorities are most hindered by the fear of math. Zalavsky (1994) reported research which suggests that around seventh grade, girls begin to doubt their ability to do math. Since self-confidence and math performance are so closely related, it plays a major role in girls' choices to continue math into high school. Preis & Biggs (2001) cite research that finds that women, in particular older women, often experience more math anxiety than men. Some students have reported similar or related feelings. Some students also report a perception that one of their former math instructors seemed to be concentrating their attention on a few members of the class–those appearing to have a better understanding of the mathematical process–rather than the rest of the class which was struggling. Other sources of math anxiety are referred to as a myth or math myth by Pries & Biggs (2001). Some perceived myths are: "women can't do math"; only "some people can do math," students from certain backgrounds and geographic locations are not very good at understanding math related issues, and "some races are good at math" and others are not very good at mathematics. Colleges and universities should modify their curricular offerings based upon real world situations by creating and interpreting mathematical models (McCallum, Small & Haver, 2007).

Another serious problem associated with math and the feelings related to it can be greatly influenced by media, advertising and sports personnel, celebrities and even the products a person purchases such as a recorded Barbie doll saying “Math class is tough,” giving a negative message to little girls. This type of message from idols, whether Barbie or a highly respected source, influences and reinforces children, including young girls. While the Barbie doll saying was removed upon protest by concerned individuals, the myth of “Girls cannot do math” was reinforced in some of the young girls, and was prevalent enough to be initially created (Preis & Biggs, 2001). .

At the lower grades, gender differences between interpretations of the equal sign were marginal (McNeil & Alibali, 2005). They stated that the students’ ratings differed across the three definition types.” They discovered the distracter definitions were rated lower than both operational and relational definitions. They further felt both analyses support the hypothesis that seventh-grade students’ interpretations of the equal sign are highly dependent on context. Seventh-grade students interpreted the equal sign operationally in the alone and addition contexts but relationally in the equivalence context. Across all three contexts, elementary students maintained an operational interpretation and undergraduates and graduate students maintained a relational interpretation (McNeil & Alibali, 2005).

There has been a concentrated effort put forth to break down gender issues and make careers and disciplines gender neutral by laws, publications and grants. Over the last several decades, mathematics researchers in education have looked into gender equity issues to encourage interest of female students into mathematics through such programs as Summer Math (Morrow, 1995) or EQUALS (Karp & Niemi, 2000). Research has validated the concerns expressed by many that female students' attitudes and self concepts continue to be more negative than their male counterparts when dealing with mathematics.

These types of comments and feelings regarding mathematics causes some dilemma in getting quality students to pursue mathematics as a professional career and for others to focus on and apply themselves to the task of learning mathematics; therefore, furthering themselves and maximizing their educational, professional, and personal abilities. Instructors must be careful to avoid overt and covert behaviors toward students such as nonexistent feedback, insufficient explanations, avoiding proximity to students, avoiding eye contact, or signing in a demeaning manner when teaching their classes. These overt and covert behaviors can affect a student's learning and their feelings and attitudes regarding the course of study they have been taking. Instructors should be aware of their impact on students, being aware if they are happy or unhappy with teaching, and being aware that math anxiety can last 20 years or more.

All educators should also be aware of instructional and motivational techniques for promoting cognition and positive outlook. A noted technique is to make certain that the students understand the lesson and also the value of the lesson that they have learned, by understanding its true meaning, how it applies to something notably of their interest, or where they will be able to utilize the information in a time saving or practical manner to find out answers to an unknown. Continual attention should be directed towards creating, developing, maintaining, and reinforcing positive attitudes as this motivates the student to learn more of the math and increases success.

A combination of the students' math preparation, anxieties, fears, and concerns can be a formidable challenge for the student-learner to overcome in order to be adequately prepared and openly receptive to the instruction provided and to qualify or question areas or concepts of uncertainty. This lack of confidence to make certain they fully understand the necessary information and sequence standards adds to the difficulties of adequately learning math.

Algebra Knowledge Gap

Included in the difficulties facing the students in their efforts to learn algebra are misunderstandings in the use of formulas. Sleeman (1984) found, through the use of a computer learning system, that students had trouble understanding algebraic notation, classifying errors as: manipulative, parsing, clerical, or random. Kirschner & Awtry (2004) also used computer technology to study types of misunderstandings in algebraic rules. These misunderstandings were attributed to errors in visual pattern analysis when looking at rules in algebraic notation (Kirschner & Awtry, 2004). As teachers, we should be aware that "mal-rules" exist and encourage students to explore rules for themselves and to see them in various contexts and representations.

College professors note that many of the students that choose to continue their mathematics education still lack adequate prerequisite mathematics skills. There seems to be a gap between knowledge supposedly learned in high school and prerequisite skills expected when entering college (Cooper, 2008). Students that were not required to develop basic prerequisite skills often need to take transition courses, without college credit, to catch up (DeHart, 2007) before they can enroll in college algebra or other for-credit mathematics courses. Math background knowledge influences performance scores, self-monitoring accuracy, and confidence (Nietfeld, 1999). This further compounds the feelings about math being a limiter and added expense for the students, and it is felt that it further takes time away from their major courses of study. The students, generally, have not met with success in the mathematics arena, and therefore, have some concerns and anxiety regarding being required to prepare for the math standard to then have to take the algebra course. Sometimes it becomes a challenge for the instructor to deal with some of the negative attitudes, the math anxiety, and lack of confidence of some of the students to prepare them to develop a confidence level to assist them in being successful in their math endeavor.

The failure rates for developmental mathematics (Cooper, 2008) and college algebra courses at many colleges and universities are abominable. This causes the students that are not prepared for the college algebra courses or those that attempt the course and are unsuccessful in their attempt to feel the need to take coursework designed to prepare the student for entry to the college algebra or an extra remedial course. This added coursework costs students and universities money and time and adds to the frustration level of the student (Cooper, 2008). For students with learning disabilities, the time commitments are even higher (Xu, 2002). Over one-third of students' tutorial time in Carpenters' 1985 inquiry was used to study mathematics. Students needing extra math courses also were less likely to complete a bachelor's degree (Livingston, 2007).

Researchers in math education found problems associated with students' interpretation of terms, symbols, and rules (McNeil & Alibali, 2005; Knuth, et al., 2006;

Sleeman 1984; Kirschner & Awtry, 2004; Bye, 1975). McNeil & Alibali (2005) found that elementary school students interpreted the equal sign operationally whether they were shown an equal sign by itself, or in the context of addition or equivalence. Seventh-grade students shown an equal sign by itself, or in the context of addition, described its meaning operationally. However, seventh-grade students shown an equal sign in an equivalence context described its meaning relationally. Undergraduate and graduate students interpreted the equal sign relationally whether they were shown an equal sign alone, or in the context of addition or equivalence (McNeil & Alibali, 2005).

Knuth, Stephens, McNeil & Alibali (2006) found that many middle school students, grades 5-8, understand the meaning of the equal sign operationally, while many students lack a relational understanding of the equal sign. Knuth, et al. (2006) also found a correlation between students' understanding of the equal sign and their performance scores. Students who had a relational understanding of the equal sign tended to earn higher scores when solving equations than students who had only an operational understanding of the equal sign. Students with similar mathematics ability, as evidenced by standardized exam scores, followed the same trend. Students within each ability group with a relational understanding of the equal sign earned higher scores when solving equations, on average, than students who did not express a relational understanding of the equal sign.

Mal-rules (or incorrect algebraic rules) used by 14-year-old students to solve algebraic equations via computer and paper exams in Sleeman's (1984) study varied greatly. Sleeman classified these errors into four categories—manipulative, parsing, clerical, and random errors. A manipulative error is one in which a sub step is modified or omitted such as neglecting to write a negative sign in front of a positive number after moving it to the other side of an equation during subtraction. A parsing error implies a misunderstanding of algebraic notation, such as adding when symbols dictate multiplication. A clerical error is like a typo. Clerical errors include visual errors such as substituting 9 for 6 or 8 for 0 in a problem and arithmetic errors such as dividing 30 by 2 to get 18 rather than 15. Other errors went unexplained and were classified as "random" errors.

Kirschner and Awtry's study (2004) focused on eight algebraic rules learned by two groups of 12-year-old students. The treatment group learned rules in traditional algebraic notation —four with high visual salience and four with low visual salience. The control group learned the rules in tree notation. The tree notation was used as a control group because this notation was void of visual salience. Awtry was the instructor for both classes. Students from the treatment group correctly answered a significantly higher percentage of questions involving visually salient rules than students from the control group on both the posttest and the retention test. However, questions involving rules with low visual salience were answered correctly much more often by students from the control group than by students from the treatment group. Students from the control group scored much more consistently than students from the treatment group, but averaged just over 50% correct. While students from the treatment group averaged below 50% correct on questions involving rules with low visual salience, students from the treatment group averaged just over 70% correct. Female students appeared to have larger disparities than male students in the treatment group when comparing percentages correct on questions involving rules with high visual salience and questions involving rules with low visual salience. While scores were lower for students from the treatment group overall for a surprise retention test given a week after the posttest, scores on the retention test were approximately the same for students from the control group when compared with scores from the posttest.

The reading ability of students enrolled in mathematics classes is also a concern to consider (Guterman, 2002). Most college students learn the necessary conceptual informational meanings from reading materials (Hancock, 1975). In general, teachers expect students to know how to read, but not necessarily to know effective metacognitive strategies for comprehending what they read, especially for low-ability students (Arabsolghar and Elkins, 2001). Although students with learning disabilities tend to spend more time reading, studying, and processing, they have learned to compensate by asking questions and applying metacognitive strategies (Trainin and Swanson, 2005).

The language of mathematics poses problems for students at the reading translation level—the meaningful chunks of math language or texts that need to be interpreted both sentence by sentence and in terms of their role in a specific context. The beauty of algebra and most mathematics in general lies within its concise, particular symbolism. By solving one equation, a mathematics student accounts for infinitely many, all, possible solutions simultaneously. As Bye (1975) and Hubbard (1987) state, algebraic equations and related texts, as part of the field of mathematics, are conceptually packed and denser than typical readings. This conciseness adds some complexity to the reading and requires an adjustment to reading-rate, and the importance of understanding may require multiple readings. Text includes several symbols and technical language with precise meanings and requires eye movements to flow vertically and horizontally from left to right.

Some students have indicated that if they could have understood the process and sequenced procedural steps, their frustration level of the study of mathematics would have been greatly reduced and the resultant effect would be that their focusing ability would have been altered in a very positive manner. The world of mathematics has certain processes and sequenced procedures that need to be clearly explained to the students to make certain that students that are concrete learners and sequential learners have the proper key ingredients available for them to process and proceed with the learning progression. Generally, the students that expressed a liking for the organized process or the discovery part of math also related to being an abstract-randomness type of learner and appeared to have a greater comfort zone of the present mathematical process of the traditional math than the remaining portion of the students in the classroom setting.

Some students experience satisfaction of expressing their understanding and concept attainment in many varied approaches. The study of Izsak (2003) reported students demonstrated an example of modeling knowledge by coordinating and associating knowledge for generating and using algebraic representations. Eisenberg and Dreyfus (1994) also discovered that many students could not transfer their newly learned function transformation knowledge to new, but similar, situations. The authors concluded that students taught in this traditional manner developed a static, but not dynamic, concept of functions. The students had acquired an action concept. Dewey (1916, 1944) effectively reformulates the ways in which we consider and examine the process of learning by strategically characterizing the learner as an active participant;

therefore, reestablishing habits of learning, as a means to empower, rather than the having of habits such that intellectual growth is arrested as was the traditional belief.

College Algebra Content

We must ask ourselves what we hope students will learn in algebra. (1) What's truly important to determine a student's mastery of the baseline skills and knowledge necessary for mastery and successfully advancing to the next level? (2) Is it more important to be able to manipulate the letters and numbers in an equation correctly to solve a puzzle-like problem and to understand the mathematics for its own sake, as many math majors do, or is it more important to learn how to use mathematics to solve life situations and practical situations that a person will face in their career, profession, or a hobby of their personal interest that arise outside the classroom? (3) Is there a method that would afford the student-learner an opportunity to maximize both aspects of understanding the math by being able to complete and understand the math as it related to their area of interest and also relay this base information into the random, abstract arena of math problems where the student could correctly solve the problem by manipulating data based upon the processes and procedures for solving for the unknown? (4) Should students be allowed the use of calculators when solving problems or if such opportunities would alter the assessment of the student's acquisition of algebra knowledge and skills? Questions regarding algebra, its value, and its content have been asked for decades. Research indicates that students involved with application-based math programs are less influenced on their understanding of mathematics when using calculators than students utilizing traditional techniques. It is even indicated that application-based programs utilizing calculators appear to perform to standards superior to those that were not associated with calculator usage (Thompson & Senk, 2001; Huntley et. al, 2000; Hirschhorn, 1993). Most students indicate they do not plan to take another math class, and many do not yet value math in its own right or as a tool outside the classroom. In an effort to foster positive and worthwhile views of college algebra, we must all continue our efforts to improve not only the math education and individuals' acceptance and appreciation but also determine the standards and criteria for content selection.

There is extensive literature (CBMS, 2001; Halmos, 1980; Resnick, 1987; Schoenfeld, 1992), though not of the same magnitude as the existing literature identifying general habits of learning, which seeks to answer the question, "What mathematical habits of learning do we want our students to display?" This question has been addressed by two main groups (professional mathematicians and mathematics educators).

Mathematics has several benefits. It exercises the mind and prepares the student to learn and better understand difficult concepts. Mathematics increases the reasoning and understanding skills of people. G.H. Hardy (1940) identified six traits that mathematicians display when doing mathematics. The list of the traits of a mathematician include: (a) intellectual curiosity; (b) a creator of patterns; (c) seeks connections between mathematical ideas; (d) seeks mathematical accuracy; (e) generates mathematical generalizations; and (f) seeks mathematical efficiency and economy. Hardy's traits were intended to describe the practicing mathematician. Polya (1954a, 1954b, 1962) and Wiles (as cited in Singh, 1997) also made contributions to the discussion about the kinds of habits displayed by a mathematician while doing mathematics.

Mathematics is also beneficial to other goals and objectives of many of the math curriculum and professional career development paths, such as using mathematical modeling to make predictions and to solve problems. Learning how to interpret results of algebraic calculations is not highly dependent on the ability to perform the calculations themselves. The procedural understanding is influenced by the careful attention to the sequential aspect of the process. Outcomes indicated that even a curriculum in which emphasis was found on mathematical modeling in real-world contexts for using the algebraic calculations does not necessarily produce students who have mastered that ability (Huntley et. al, 2000).

It is important that students remain positive and open to learning the math content and that a vital component of the learning process is that a precise procedural system must be maintained in a sequenced order to ensure an accurate outcome. This strict and absolute procedural process intrigues some learners that like the structure and can cause unrest and frustration to other learners that perceive math to be hemmed in by rules and procedures that inhibit growth and freedoms. It is the latter group that must be taught the value of math by drawing relationships to other areas thereby enhancing them or providing a foundation allowing the profession or discipline to reach new heights and discoveries.

Dewey (1897) stated, “if we eliminate the social factor from the child, we are left only with an abstraction; if we eliminate the individual factor from society, we are left only with an inert and lifeless mass. Education, therefore, must begin with a psychological insight into the child’s capacities, interests, and habits. It must be controlled at every point by reference to these same considerations” (Dewey & Small, 1897). Similarly, algebraic equations and functions should not be kept completely separated and "abstracted" from the social and practical situations they model; neither should the mathematical operations and relationships between them be neglected.

Many students struggle with understanding mathematical usage concepts, procedural sequenced steps, and the usage of the formulas in a useful format. However, they do see some positive correlation for successes when associated with relevant, practical application settings. The seemingly non-relevant association of math to students' thinking further aggravates the situation the students find themselves in that now forces them to learn college algebra in an unfamiliar and uncomfortable setting. They are generally out of the comfort zone of their home school environment, in a classroom setting that is generally composed of a higher functioning level of students than their previous local school setting, and are more on their own as individuals without their peers to assist them.

"The importance of modeling as a mathematical activity, curricular trends, and the results of past research suggest that mathematics education needs a deeper understanding of how students learn to model" (Izsak, 2003). Izsak reported this article details the steps that need to be taken to make certain efforts have been taken to achieve such an understanding and operational level. Izsak's research analysis of how these instructional understandings emerged led to his concluding two results. He felt students have and can use criteria for evaluating algebraic representations. The analysis also explained how students can model mathematical understanding by coordinating their knowledge by generating and using algebraic representations (Izsak, 2003).

Studies suggest some important patterns of consequences from curricular, instructional, and assessment practices in high school mathematics. Those noted patterns suggest areas in which both reform and traditional curricula need to be improved if they are to reach widely agreed-upon goals, but they also leave open the fundamental questions about what understanding and skill in algebra is most important for students to acquire from their school mathematics experience. Furthermore, they suggest some aspects of both reform and traditional curricula that need to be studied in more depth with methods other than those used (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993).

It is noted that we, as educators, have always been studying and searching for more effective methods of delivering content in a palatable and understandable manner. Some research has supported certain concepts and procedures to maintain while some research also indicates some techniques a teacher can employ to accomplish the advancement of math education and ultimately progressing to the higher standards of math performance and the improvement of the attitudes related to math.

Instructors quite often are looking for ease of their understanding, a smooth process and simplicity in the usage of the instructional devices, easy recordkeeping, time constraints that afford flexibility for varied minutes of class offering settings and defendable outcomes. The administration concentrates on the initial costs, maintenance costs, and successful outcomes. The student is most concerned with the ease of operation for their efforts and how comfortable they are using the material and process.

For instructors and students from the United States and other nations, it seems there is a consensus among them that a major focus of mathematics should be on successful student achievement outcomes. The individuals from the United States generally felt that most educators are using similar curriculums and methodologies of teaching the concepts and usage from the textbooks. The textbooks are generally concentrating on the new skills and processes to be used and not on the student learner styles that might make the learning process more understandable for the concrete-sequential learner that possibly could benefit from the application to a known or interested concept as being beneficial. Some of the international students and teachers felt that they were using the applications in a form of across the curriculum method of coordinating the math educational process into the field preparations of the professional students skilled area of learning. This type of process has been used more as a system in their countries by feeling that math as a stand alone curriculum is somewhat short sighted and that it must have real meaning and a practical outcome for the student to focus on achieving. Therefore, it is considered based upon results of the educational process and resultant successes as the basis for deeming the acceptance of the curricular material projects and delivery process.

Some researchers attribute algebraic errors to student lack of conceptual focus from the aesthetic form of algebraic rules rather than the rules themselves (Kirschner & Awtry, 2004; Sleeman, 1984). Some researchers believe that algebra needs to be taught within "rich contextual settings" (Kaput, 1995; NCTM Algebra Working Group, 1998). Ideas intended to increase students' math skills include using visual explanations of math and playing games in elementary classrooms (Cavanagh, 2008, Clements, 1999). When students are encouraged to relate new information to prior knowledge and personal learning experiences, they are more engaged in learning activities and increase performance on exams (Guterman, 2002; Zan, 2000).

The National Council of Teachers of Mathematics recommended in 1991 a shift from the traditional model of the perceived mathematical structure or body of unconnected and isolated concepts and procedures and the relating mathematics, to ideas, and practical applications (NCTM, 1991; Brahier, 2005). Appealing to learners' interests and sparking their curiosity would help students to connect new knowledge with prior experiences and motivate students to want to learn more.

It might be that the reform curricula that commonly embed algebraic ideas in applied problem-solving explorations need to do a better job of helping students to abstract and articulate the underlying mathematical ideas. Students tended to do better on algebraic tasks embedded in applied-problem contexts when graphing calculators were available; whereas, control-group students did better on traditional symbol-manipulation tasks (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993).

Jones (2001) discussed the learning process as one laden with redundancy, humor, and over-learning. He used a real life hands-on approach, which was not scripted. He offered mnemonic strategies, for example in learning the order of operations, and purposely made incorrect calculations, asking the class for help in finding the mistake. He helped the students navigate through the problem from where they were to where they wished to be, avoiding the feeling of learned helplessness. Jones (2001) presented a positive problem analysis, where he modeled the self-talk involved in finding a solution, used encouraging instead of despairing language, self-humiliation or resentment. He showed multiple solution options. The class chose one to find the solution, and the other to check the solution. He modeled basic short-cuts and only allowed calculators after the problem was setup using units of measure and the necessary algebra. He used calculators to check answers instead of the back of the book, and students grew in confidence when they found errors in the back of the book. Jones (2001) gave half credit if the problem was correctly set up, even if incorrect calculations led to an incorrect answer.

Applied Algebra Studies with younger students

Students who studied with application-based curricula were able to solve problems from life-situations much better than students who studied traditional algebraic curricula that were based upon the sequenced order of the facts and figure system and then utilized in a problem setting by creating a hypothetical situation and providing the critical information to solve for the unknown or missing values (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993). Although students from traditional classes performed better than students from application-based programs when solving algebraic equations without calculators, students from application-based programs solve algebraic equations as well or better than students from traditional programs when allowed to use a calculator (Huntley, 2001).

Students each possess their own preferred learning style. So, all classes are comprised of this accumulation of individual students each with a different and unique learning style of preference. The challenge for the teacher is to choose their approach to teaching the class. Teachers have at least three paths they can choose; they can choose to create and follow one lesson for a group of students, construct individual lesson plans utilizing the preferred learning style of each of the students, use a method that includes individual students within one group lesson, or some other choice. A method that has enough relevant information or interest level to help a student to relate new material to information they already know would help a student to remember and work with new information. It would enable transference of knowledge. If information is related to student interests or goals, the student may be motivated to seek out more related information. Students may want to make certain they learn the necessary knowledge or skills to meet the threshold of the outcome standards intended skills/ knowledge to meet the standards of the subject matter. Regardless of the choice the teacher attempts to engage the student, the teacher must be able to motivate the student to pursue the knowledge acquisition whether it is simply the quest for the necessary knowledge, the individualization, or the enabling of association and transference in order for the outcome standards to be met. The more we as educators address teaching techniques, seeking a solution to meet the variations of learning/teaching styles, the greater the likelihood that we will reach the students with a strong enough portion of the instruction lesson to impart the vital parts of necessary information to the students in a format that they can understand to be deemed successful. The resultant effect of such a match is that students will have better attitudes, learn more material, and the outcome of the class as a whole will meet a higher achievement level.

In recent studies, high school students from application-based programs performed significantly better than students from traditional programs on problems involving applications (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993). Many students from applications-based programs also earn similar scores on traditional algebra exams involving pure algebraic manipulation and presented without context. (Thompson & Senk, 2001). In some cases, however, students from conventional mathematics programs scored higher on algebraic problems void of context (Huntley, 2000). Teachers need resources and mentors or support groups to help them focus on applications, reasoning, and interpretations effectively in classrooms. (Haimes, 1996).

Huntley et al. (2000), Thompson (2001), Hirschhorn (1993), and Haimes (1996) look at effects of application-based curricula. The first three focused on high school students' algebraic performance, using classrooms with traditional curricula as control groups. These three studies compare performance of students in an application-based course with performance of students in a traditional course using a traditional achievement test, an applications test, and interviews. The studies attempt to match students in each group along pretest achievement scores within an age cohort and a mathematics course level cohort. These three studies also have similar research goals and expectations: to determine whether students in the specific application-based program score better on application problems than students in traditional programs, and whether students in traditional programs score better on traditional achievement tests. Instructors can emphasize that learning mathematics is partially like learning a foreign language with its own vocabulary and symbols. In writing, they can encourage self-monitoring, or they can ask students to explain in writing how they solved a given math problem (Preis & Biggs, 2001).

There are various splinter groups or cliques of mathematic professionals that have promoted their belief system and experiences that ultimately influence the systematic process of mathematics education. Mathematics professionals and curriculum specialists have been arguing in favor of a formal discipline and reemphasizing that the major focus and purpose of algebra and higher mathematics levels should again be the reason for mind preparations and logistical reasoning advancements. Furthermore, some math professionals desire changing math back to the traditional system of back to the basics mathematics while another group is looking toward the future and envisions the ability to advance mathematics in concept, level of thinking, and greater acceptance by viewing better methodologies of reaching students now struggling with present day math techniques.

Mann (2000) also explored the influence of a teaching technique on student performance in mathematics. He investigated the ADAGE (activity, data, analysis, generalizations, extensions) approach to teaching mathematics as used in an Interdisciplinary Math and Science class and its effect on students' conceptual understanding of functions, performance on function tasks, personal mathematics attitude, and individual mathematics aptitude when compared with students from a traditional pre-calculus class. The determination made by Mann in his study was that the students that took the math course along with the science course outperformed the other group that did not have the math course also. That shows a positive attribute and value for taking the two courses together. The focus was on the value added by taking the math with the science. Another associated determination regarding the synergy effect of the combination of the improved scores in the science also would be a valuable study if found to be mutually beneficial to both curricular areas in combination. Students who studied with application-based curricula are able to solve problems from life-situations much better than students who study traditional algebraic curricula. Although students from traditional classes perform better than students from application-based programs when solving algebraic equations without calculators, students from application-based programs solve algebraic equations as well or better than students from traditional programs when allowed to use a calculator (Huntley, 2001). We must ask ourselves what we desire to obtain and focus on those issues.

Instructors need to remember that people cannot work to achieve mathematics mastery until personal (psychological, physiological) needs are met, in keeping with the theories of Maslow. Therefore, instructors need to be cognizant of these basic needs of all students (MAA, 2006). These basic needs must be met before students can devote their undivided attention to the task of learning any subject matter. In addition, Dodd (1999) suggests that instructors keep in mind the fact that many students cannot sit for more than 50 minutes before becoming restless and that the students be afforded a variety of educational methodology approaches to meet their learning styles. These format variations could float between board work, reciting, working problems at their desks, mental computations, lectures, demonstrations, and question and answer opportunities.

Computer assisted curriculum is a form of an alternative approach to the traditional method of teaching algebra and has results that appear more effective than the conventional/traditional curricular offerings regarding student development and ability to solve algebraic problems when those problems are presented in practical contexts. When students are allowed to use technologies such as graphing calculators to assist them with the formal computation of a problem but not allowing them to be able to by-pass any formula aspect, the student outcome of successfully completing the mathematical problem increases. It has also been determined that the students learned the essential part of the total of the conceptual portion deemed necessary to know for successfully meeting the lesson standard of any math lesson. Conventional curricula instructional methodologies of presentation are more commonly associated in algebra when the expressions, theories, and processes are presented without any application context and when students are not allowed to use technological devices to assist in computations (Huntley, 2001).

It is understandable the most consistent finding of algebra assessments is perhaps that students learn more about topics that are emphasized in their mathematics classes and less about topics that are not emphasized (Fox & West, 2001). The content of curriculum text materials and classroom coverage of those materials makes a significant difference (Huntley, 2001). Thompson & Senk (2001) found that students performed much better on problems with multiple steps in work assignments and on examinations when the students had experienced application based instruction in the algebraic skills in their classroom setting than students that merely learned the equations and process procedures to find the correct answers (MAA, 2003).

The instructional assistance the textbook authors suggest accompanies the work assignments, creates a situation for students in scenarios that are hypothetical in nature, and deals with a perception the students are capable of being involved in the practical application situation level. The textbook authors further encourage the utilization of demonstrations with viewable devices such as winches, so the students could work the problems and understand both their value and practical useful work applications as noted by Meirn (1998) and Izsak (2003) in their studies. It is, therefore, a correlation of possibility that the students could use a transference of knowledge from their field of interest or of knowledge basis such as a career choice or experience with a sport utilizing a similar association to a known task or skill to the usage of the algebraic skill as seeing it performed by utilizing a device or machine application as the other researchers have done. The major change being to replace the physical object to utilizing the previous knowledge and experiences the student has and replacing the physical object with the association of the known function/operation or object by association and transference of previously learned skills and knowledge. The students have expressed a concern that the situations provided in such context does not really meet their personal experience or interest needs and felt that it would be better if the situations were real to each student and could fit their personal understanding or career choice areas. Textbook practical example results have been considered an improvement over the "traditional method" and will assist in enabling the instructors to greatly expand the skill development portion of a practical lesson without physically having to have the lab equipment at hand. Presently, there is a serious mismatch between the rationale for college algebra requirement and actual needs of students taking the course (CBMS, 2000). This enables the instructor to modify the lesson quickly to meet the unique needs of students in a multitude of practical applications, therefore, enhancing the learning opportunities for most if not all the students and not just the ones that one particular apparatus served in the educational sense (Pearson, 2000).

Haimes' research shows that there is a direct correlation of positive attribute relating to the effects of a teacher's practical use of an instructional technique in delivering the lesson if the student understands the relationship of practical application to the lesson point being taught if it can be tied to something the student has previously experienced or has a desire to learn. Haimes (1996) uses a qualitative case study approach to examine a 9th grade (high school) introductory algebra classroom in Western

Australia and what he calls a "function" curriculum, which also focuses on applications and reasoning/interpreting skills. Haimes examined the effect of the curriculum on organization of content, content foci, and teaching practice. In particular, he studied whether by using this curriculum (a) the instructor followed the spirit of the curriculum, and continued the notion of mathematics being a process of thinking and not a remote series of discrete content areas (Western Australian Ministry of Education, 1990 as cited in Haimes, 1996); (b) how much the focus of lessons and activities related to the curriculum's focus; and (c) whether the teaching practices would fall into the exemplar, or recommended category.

Haimes' study of a teacher who had begun teaching from an applications-based curriculum illuminates the difficulties of a seasoned teacher in completely changing her practices (1996). Although applications, reasoning, and interpretations should be strongly encouraged in classrooms, teachers need resources and mentors or support groups to help them focus (CUPM, 2007). Other researchers have indicated they believed in the value of using applications in the teaching of mathematics, but did not focus on them; some included them in the course as an enriched story problem in rare instances as time allowed, and continued to use experienced ways of teaching that attempted to further the envelope of understanding and thinking. Newer teachers will struggle to find well written materials to assist them with the applied mathematic examples for the students and therefore may find it easier to avoid the attempt to meet this aspect of their educational efforts and remain with the more traditional system utilized by most present day publishers.

A conventional curriculum is determined to be effective for the development of student skills in the utilization of symbolic expressions in algebra when the format of presentation is application context based (Huntley, 2001). A further enhancement of understanding of the value added by the usage of math skills and knowledge in other of the students' career interest areas begins with a broader understanding of concepts and fitting to support other application areas. Improved performance in new content areas can be achieved through curricular implementation of materials teaching that practical approach to content. Students address problems presented as real world problems based upon real world situations possessed outside academia and using the mathematical modeling process (CUPM, 2007). If goals other than better performance, such as improved attitudes toward mathematics, are desired, then it is unlikely that solely adopting new materials will suffice and other methods or techniques must be considered (Hirschhorn, 1993)

Students who studied with application-based curricula are able to solve problems from life-situations much better than students who study traditional algebraic curricula (CUPM, 2001). Students from traditional classes perform better with the use of calculators than the students that had the practical based instruction but had not been used to the calculator usage. Huntley noted a difference in the two class settings of the traditionally taught class and the practical-based class, but the variable of notice was the usage of the calculator on the success of the two groups of students. He went on to note that students from application-based programs when solving algebraic equations without calculators, solved algebraic equations as well or better than students from traditional programs when allowed to use a calculator. This poses the question of the strength of the application-based instructional techniques as compared to the traditional technique upon the student's acquisition of algebraic knowledge and the satisfaction of the students regarding their learning experience (Knowles, 1997).

An important aspect of any research is to clearly define the object of viewing and detail the intent. This intent quite often is to view what is the present status and outcomes while looking at possible methods or ways of improvement. This is accomplished by beginning to analyze the effects of a particular teaching technique on student learning and ability to utilize relevant mathematics. While "applications-based" problem textbook usage are included in studies of application-based programs, these applications are not necessarily of a tailored design to be able to utilize or benefit from the students' interests and experiences. The other area of association that could benefit the teacher/student in the endeavor of learning Algebra would be to key in on the students' intended professional careers and assist them in understanding the relevance and importance to the relationship of math and the career.

There appears to be some evidence that researchers have found indicators of variances in student outcomes based upon the types of instructional delivery methods the teachers employ, but no one has concentrated solely upon the effects of a practical application based curricular and teaching methodology experimental study that focuses on student interests and careers. This type of focused research, like similar studies of traditional versus application-based problem focus, would help to form the foundational basis for determining the validity of this type of curricular development as it would relate to the outcomes based educational opportunities for students with the learning styles or practical-based mindset of concrete thinking. This activity research would have merit by continuing to advance mathematics by enriching the conceptual, curricular, and methodology of instruction with the major focus being the methodology of practical, appropriate, and relevant referencing of mathematics, specifically, algebra to their present knowledge base reference or to their desired interests or career choices.

Learning Journals

According to current research, students answering reflection questions and receiving instructor feedback are more likely to increase metacognition and the mathematical processes of communication, connections, reasoning and proof, and problem-solving achievement. Students are also more likely to read the textbook outside of class.

Assigning reflective questions over current or recent topics and pending reading assignments may help students think reflectively on their own and requires more time thinking about their learning (Cisero, 2006). Thinking about the subject matter through reflective questions “allows students to connect with information on a more personal level, and has the potential to change the student as a thinker and learner” (Cisero, 2006, p.234). Guterman also found in his investigation of students learning with computerized coaching that “the instruction to stop and observe or reflect on what they did, why they did it and how to use what they did, breaks down their spontaneous tendency to ‘start working’” (2002, p.285). Kapa identifies this break for reflection as a “metacognitive strategy” (2001, p.318). The more strategies students use to recognize similar problems, apply relevant techniques, and determine their own proficiency while solving problems, the more students are likely to solve problems correctly and efficiently (Kapa, 2001; Fortunato, Hecht, Tittle and Alvarez, 1991; Swanson, 1990; Zan, 2000).

According to Kapa, in 1985, Elaware and Corno found that individualized feedback to students with low ability helps students to be aware of their mistakes so that they can avoid making them in the future (2001). Through his own study, Kapa also discovered that students with little previous knowledge improved their problem-solving ability after receiving metacognitive feedback in an intervention program. Student reflections along with instructor feedback are a way of providing individualized instruction, which increases achievement, retention, and transfer (Hancock, 1975).

Reflection goes well with the mathematical processes of communication, reasoning and proof, connections, and problem solving. As a form of communication, students "receive a dual benefit of communicating to learn mathematics and learning to communicate mathematically" (NCTM, 2000 as cited in Pugalee, 2004, p.27). Written communication should be encouraged (NCTM, 2000). As students develop their mathematical communication skills, they will increase the ability to think mathematically (NCTM, 2000).

Communicating through writing about reflections can help students to be more aware of their learning and thought processes (Cisero, 2006), and can assist understanding new information (Cisero, 2006; Lesley, 2004) It is also an alternative assessment method for "determining what pupils know, how they know it and how they are able to use their knowledge to answer questions, solve problems and engage in additional learning" (Guterman, 2002, p.284; Lesley, 2004, p.323). Based on his research, Guterman (2002) concludes that assessment of student knowledge should be based on research about how students express and acquire this knowledge. Students can then begin to form connections between new and past information (Kapa, 2001; Zan, 2000). When reflections encourage students to relate new information to prior knowledge and personal learning experiences, their interest and time-on-task rises, mastery learning increases, and academic achievement improves" (Guterman, 2002, p.297; Zan, 2000, p.146).

Since common assessment practices often measure students' ability to solve mathematical problems, improving academic achievement often is equated with the ability to solve problems. After metacognitive assistance through prompts or reflective questions, the problem solving ability of students with some prior knowledge increased significantly, while students with low prior knowledge increased enough to go "beyond trial-and-error strategies" (Kapa, 2001, p.332), and students with high prior knowledge continued to have high problem-solving ability (Cisero, 2006, p.233; Kapa, 2001, p.332).

Cisero's overarching goal in assigning reflective journals was to encourage students "to be more actively engaged while reading in order to enhance their learning, thereby improving their performance" (2006, p.234). Students in Cisero's educational psychology classes and Conner-Greene's personality theory classes verified that the journals did indeed promote reading the book and reflecting about learning and teaching (Cisero, 2006; Conner-Greene, 2000). Strategies that increase students' grasp of knowledge found between the covers of a textbook include relevance to academic success and/or student interests (Lesley, 2004). Assessments should be FOR learning, rather than OF learning—a part of instructional feedback and the learning process (Guterman, 2002; Stiggins, 2005).

Helping students to be aware of their learning development and mastery, and focusing their reading assignments increases learners' comprehension, performance, and long-term memory (Guterman, 2002). Hancock's (1975) research indicates that students taught in a way conducive to their learning styles remember material longer. He concludes that although certain teaching methods may help students to learn information short-term, these individual methods may not be sufficient for students to retain new knowledge for longer periods.

Research studies found several benefits to guiding and assessing student learning through reflective questions. However, potential problems arose as well. Concerns for implementing reflections include high student resistance (Lesley, 2004) and reading abilities of students. Reflections create an additional workload for students that some deem a needless waste of time (Cisero, 2006). Cisero reflects that this learning and instructional technique will only be effective if students are willing to accept this assignment and actively engage in their learning process "and construct meaning for themselves" (2006, p.234). Conner-Greene (2000) discovered that five journal entries were just as effective as 15 journal entries in one semester, and required less time.

The reading ability of students enrolled in mathematics classes is also a concern to consider (Guterman, 2002). Most college students learn well from reading materials (Hancock, 1975). In general, teachers expect students to know how to read, but not necessarily to know effective metacognitive strategies for comprehending what they read, especially for low-ability students (Arabsolghar and Elkins, 2001). Although students with learning disabilities tend to spend more time reading, studying, and processing, they have learned to compensate by asking questions and applying metacognitive strategies (Trainin and Swanson, 2005).

In summary, research shows that promoting student reflection increases students' metacognitive abilities, textbook reading, communication, reasoning and proof, connections, problem-solving, and therefore academic achievement and overall learning. Disadvantages include time required for students and teachers and possible reading deficiencies of students. These disadvantages can be reduced through adjusting other time requirements and allowing alternative media formats such as audio textbooks and voice recorded student assignments. Thus, the advantages far outweigh the disadvantages. Further research is needed to determine the effects of journal reflections on student learning in university mathematics classes.

The most interesting articles were those most closely related to my courses—mathematics research such as Hancock's (1975) study and university undergraduate courses such as Connor-Greene's (2000) and Cisero's (2006) psychology investigations related to student journal reflections. The most credible articles were very thorough and well-defined. Hancock even got a panel of colleagues to verify that his two instructional strategies included the same content and that the strategies were properly identified.

Student concerns were considered in the research, but mostly in terms of the instructor's ability to effectively implement the journal reflections into assessment practice. Arabsolghar and Elkins (2001), Guterman, E. (2002), Hancock, R. (1975), and Trainin and Swanson (2005) recognize that reflective journals would involve adequate reading and writing abilities, and considered students that may have difficulties with reading and writing. As Hostetler (2005) suggests, they raise the concern about a possible threat. However, the investigators do not consider the possible threat to students' well-being enough to suggest alternative solutions to achieve the same goal, such as voice-recorded media.

Student concerns regarding time and busy work were addressed only after students disclosed these concerns in written survey comments (Cisero, 2006; Conner-Greene, 2000). Brown's (2002) students would have spent significantly more time developing an experiential learning portfolio, and although time is mentioned, no student appears to say anything negative about the program. As the director of the program, I don't think she considered students' comfort in honest communication when deciding to conduct her own interviews. Cisero (2006) and Conner-Greene (2000) both use anonymous surveys to collect student evaluations.

Summary of Chapter Two

Chapter Two provided a review of related literature including similar studies. The limited study and research regarding teaching techniques at the college level of mathematics, the concerns and issues of relevance of algebra both in curricular and methodology delivery, the value of algebra noted as necessary for success in other disciplines, the attitudinal issues of both the instructors and students, the issue of the textbooks providing direction and options rather than the process of the traditional method of delivery.

Chapter Three

Methodology

Introduction to Chapter Three

Chapter Three describes the research methodology in this investigation. The following pages include methods, research hypotheses, definition of terms, delimitations, strengths and limitations.

This study involved three courses over a two semester time frame. Semester one had a control group and an experimental group. Semester two had an experimental group. The experimental groups are viewed by comparison and analysis to the control group for noticeable and significant differences, and for similarities. The first semester included Groups 1 and 2 while Group 3 followed in the second semester. Group 1 was the control group; Groups 2 and 3 were the experimental groups. Students from the control group (Group 1) were compared with students from the experimental groups (Groups 2 & 3). Participant selection in Groups 1, 2, and 3 were “randomly” enrolled through the regular scheduling process, utilizing a computer scheduling package to enroll students based upon seats available, prerequisite needs, and schedule conflicts. This enrollment process was free from instructor and researcher influence and biases. Characteristics between the three classes are considered to be very similar and were viewed regarding similarities or notable differences. Areas viewed included gender, year in school, pretest and posttest scores. The base mathematical knowledge level of all the students was determined by results from a pretest given to all participants during their first week of class.

Table 1

Descriptive Statistics Pretest, ACT Comp, and ACT Math Scores, Beginning the Semester

		Pretest	ACT Comp	ACT Math
Group 1 (Control)	Mean	14.23	22.9	21.7
n = 20	SD	6.53	2.1	2.3
Group 2 (Experimental)	Mean	13.79	23.0	22.1
n = 21	SD	4.95	3.7	3.6
Group 3 (Experimental)	Mean	14.45	23.4	22.7
n = 11	SD	5.92	2.5	2.6
Groups 2 & 3 combined	Mean	14.02	23.2	22.5
n = 32	SD	5.22	3.0	3.0

Discussion and referencing of practical applications to students' interest areas differed between the control group and the experimental groups.

Table 2

Features of Groups 1, 2, and 3

	Control Group	Experimental Groups	
	G1	G2	G3
Examples	Algebraic	Applied to student interests	Applied to student interests
Homework	Algebraic	Algebraic	Included problems applied to student interests
Quizzes	Algebraic	Algebraic	Included problems applied to student interests
Exams	Algebraic	Algebraic	Included problems applied to student interests
Pre/Post Tests	Algebraic	Algebraic	Algebraic

The control group, Group 1, focused on mathematical concepts by teacher discussion regarding the how-to processes and mathematical reasons, while the experimental classes, Group 2 and Group 3, focused on applications in students' areas of interest and career choices, providing contexts in which the equations could be used to solve a practical problem in various fields and scenarios in which students had shown interest. While Group 1 (control) was given traditional class examples, the experimental Groups 2 and 3 were given class examples in context of student interest and practical applications pointed out. Examinations, homework, and quizzes consisted of traditional problems for both Group 1 (control) and Group 2 students. Group 3 students were given exams, homework, and quizzes that included context-based problems. (Experimental) Group 2 was the second class taught by the instructor each class day during the first semester, following the control group, Group 1, so it was easier for the instructor to keep detailed application discussions (the research variable) to the second class. There was a ten minute transition period between the control Group 1 and the experimental Group 2. Group 3, the second semester experimental group, also received problems with focus on application discussions and performance problems given in context.

Teaching approaches included a traditional approach with Group 1 (control) that consisted of traditional examples and problems given on performance assessments and two experimental approach groups (Groups 2 and 3), both using class examples based on student interests. Group 2 consisted of class examples applied to student interests, but traditional problems given for performance assessments. Group 3's class examples were also applied to student interests, and problems given for performance assessments included problems applied to student interests. Groups 1 and 3 had performance assessments that matched examples given in class. Group 2 was given examples with context and assessed with traditional examples without context. Student scores from pretest and posttest examinations were analyzed to determine differences or similarities between the teaching approaches. Relationships between examination scores, gender, year in school, major study area, and group within the study were examined.

Learning Logs (reflections) that asked students to reflect on the lesson and their understanding of the material, questions they had, and their plans for resolving these questions were requested of all students, collected, and qualitatively analyzed to determine common themes. Theme classifications were determined by the survey completeness of answers, the depth of the survey answers, the types of the language the students used, students' comments, and the students' plans regarding answering their questions to learn the material being taught. Individual pretests, group averages, and Learning Log reviewed patterns were used as a basis for measuring individual and class learning progress over the semester.

Methods

This study used a mixed-methods approach, a combination of qualitative and quantitative methods to analyze the data. Using both quantitative and qualitative aspects of analysis allows more varying insight into a research problem (Creswell, 2008; Coleman, 1996; Mays, 1995). Quantitative methods were used to analyze the scores from homework, quizzes, and examinations, including mean and effect sizes among groups. The human factors portion of the Learning Log, when used as a monitoring tool to assess the students' perception of learning mastery of the concepts taught and further viewed for the attitudinal and commitment purposes of various groups in the study that might be reflective of the teaching techniques the students were exposed to and the ramifications of such, required being viewed in the qualitative analysis category (Creswell, 2008). The students' perceptions from the Learning Logs were then categorized into groups for further analysis to see any noticeable effects the students were reporting.

Differences in the academic scores from pretest to posttest examination scores will be the dependent variable for this study. Quantitative data was used to make comparisons between individuals and groups based on individual and mean examination scores. Qualitative methods were used to analyze patterns in written statements provided by students via Learning Log responses (Willig, 2008). The Learning Log comments were gathered and viewed as group summations for similarities and differences between the control group and the experimental group and were viewed for information regarding student learning.

Quantitative Methods

One popular type of research study that uses mostly quantitative methods is comparative experimental research. Comparative experimental research in education studies: effects of curriculum, instructional methods, the color of a wall, or any change or difference in students' or teachers' environments that might affect learning or teaching. This type of research is often conducted in schools and other learning environments. Observations are made in classrooms, lunch rooms, or other places where the student or teacher or school community frequents. Investigators have control over the independent variable and should design the experiment so that this variable is the only significant difference between their randomly assigned subjects in the experimental group and the control group. The experiment should be free from confounding variables, include random assignment, apply experimental conditions, and monitor dependent variables. The more representative the sample, the more accurately results will reflect the population. Comparative experiments try to determine effects of an intervention. Some subjects are assigned to participate in the intervention group while others are assigned to a control group. Results of both groups are measured and compared to determine whether the intervention group's results were significantly different from those of the control group.

The most common type of statistical test used in analysis of data in a quantitative approach are "ANOVAs," or analyses of variance. An ANOVA is a statistical technique used to compare two or more treatment means. It is used to measure variability and explain where it comes from. Most research studies will use a one-factor, two-factor, three-factor, repeated measures, or mixed model design.

Studies with one, two, and three independent variables would use a one-, two-, and three-factor ANOVA, respectively. Within each factor, there are also levels. For example, consider a study conducted to determine the effects room temperatures of 50, 70, and 90 degrees Fahrenheit have on student quiz scores. The factor, or independent variable, would be temperature and there would be three levels, or three conditions, within that factor. Two- and three- factor ANOVAs include the interaction of two or three independent variables, such as temperature, time of day, and noise level. A 3x2 ANOVA would be a two factor ANOVA with three conditions in one independent variable and two conditions in the other independent variable. Participants are randomly assigned to one of the six subgroups. A 4x4x3 ANOVA would be a three factor ANOVA with four, four, and three conditions for the independent variables. Participants in the 4x4x3 ANOVA would be in one of the 48 subgroups.

Repeated measures ANOVAs are used when comparing pretests and posttests, where the same individual students are participating each time. Checking blood pressure for the same set of patients would also warrant a repeated measures ANOVA. A mixed model ANOVA combines repeated measures and one or more factors into one statistical analysis technique. A mixed model ANOVA would be used for a study investigating the effect of example type on exam scores. Example type would be an independent variable, or factor. If there are two types of examples, then there would be two levels to this one factor. The other variable is student exams. If a pretest and a posttest were the two exams considered, repeated measures would occur for each student. The mixed model ANOVA incorporates the other models.

Alpha is the probability of a type I error- that a false null hypothesis is not rejected. The lower this probability, the higher the probability that a false hypothesis was accurately rejected. When comparing the difference in means between two classes, alpha is the probability that the population our sample represents would find a significant difference in means when comparing an experimental and a control group, but our sample fails to indicate a significant difference in means. The data is not strong enough to reject the hypothesis. A higher sample size would result in a higher probability of rejecting the null hypothesis. The lower this probability of error is, the more accurate the final decision will be. One minus alpha is the level of confidence we have in our decision. For example, if we fail to reject the null hypothesis (i.e., we find no significant difference in means), with an alpha of 0.05, we would be 95% confident that we are correct.

Differences in mean for random samples from this population would fall within two standard deviations of the mean difference in this study.

Beta is the probability of a type II error – that a null hypothesis is rejected based on sample data when true for the population. This is the probability that the sample used in the experiment indicates a significant difference in means when including context in classroom examples versus without, but with more random samples, the data should indicate no significant difference for the overall population. The complement of beta is called the "power". Power is the probability that a false null hypothesis was correctly rejected. With a beta of 0.10, power would be 0.90. This means that if the proposed null hypothesis is rejected, there is a 90% probability that mean differences in algebraic learning would be significant when providing class examples in contexts related to student interests for the population as a whole.

Sample size affects all of these. The larger the sample size, the more representative the sample will be of the population studied, and the more accurate the findings of one large random sample reflects the potential findings of the population. The sufficiency in size of a sample depends on the amount of error a researcher and the community of scholars in this field is willing to allow. In education, research is often non-life-threatening and some error is allowed. The typical standard of error is a 5% probability of failing to reject a false null hypothesis. Higher values for alpha are more conservative, more resistant to change.

Standard values for alpha and beta would be .05 and .10, respectively. This study therefore uses these values for alpha and beta. The relationship between Cohen's d, as a measure of effect size, and sample size was used to determine appropriate sample size to detect at least a one standard deviation difference in means, i.e., d=1.00. With a one-tailed t-test, and assuming the standard deviations within the control group and the experimental group are equivalent, 19 participants would be the approximate number required. Enrollment for the first two groups was 20 and 21 students. This means that a large effect would be required to reject the hypothesis that students presented with class examples within contexts directly related to students' interests, hobbies, and career goals would score the same on a test of algebra skills as students presented with class examples without context, on average. There was a 10% chance that results from this study would not be significant enough to reject the null hypothesis, but 90% of all other samples from the same population would yield significant effects, rejecting the null hypothesis. There was also a 5% chance of a type I error—that the null hypothesis would be rejected based on results of this study, when there was no significant difference for the population as a whole. The difference needed to be detected as a mean exam score improvements for the experimental group over the control group measuring just under one standard deviation or more.

The quantitative portion of this investigation was a comparative experimental research study. It focused on quantitative analysis, measuring differences in mean exam scores. An additional role that was related, but separate from the hypothesis, was played in collecting the survey results based on a Likert-type scale from this survey on student perceptions of classroom examples. Comments related to learning as collected from students in optional, anonymous "Learning Logs", or learning progress reports, were analyzed qualitatively, using codes and themes. These student comments, analyzed using qualitative grounded theory methodology would help to paint a picture of the effects or feelings the students have as a group, in addition to group mean scores from exams.

Qualitative Methods

Qualitative research via learning logs and student comments on survey questions attempted to understand college algebra students and their behaviors in their "natural" learning environment, from the students point of view. How does a certain person or group of people, think, behave, react? What, when, why, and how do they do what they do or believe and think what they do? A extended amount of time was spent with student participants throughout two semesters. The teacher-researcher was continually observing, conversing, and asking questions, of those she studied (Hatch, 2002; Jaeger, 1997; Bogdan & Biklen, 1992; Erickson, 1986; Hammersley & Atkinson, 1983; Jacob, 1998; Lincoln & Guba, 1985, 2002). According to Albert Schutz, conversation is the most important aspect of a qualitative study. He claims "that only through communication can we understand a social scene. … If we recognize that the reality of classrooms is that which is experienced by teachers, students, and administrators living and talking together, we can begin to engage in meaningful research" (Schutz, 1967, p.53). Qualitative researchers rely on the experiences shared with those they study, the conversations, interviews, observations, and reflections when they reflect and take notes and write up their findings, inviting readers to share the knowledge and insight gained about a particular culture through research experience.

In contrast with quantitative research methods, qualitative research methods often involve less unknown factors, less people or locations, a more particular representation, more reliance on those studied, a deeper quest for understanding, more general purposes, less literature review, less number data, more written or verbal data, more biased evaluations and interpretations, less comparison among those studied and others (900K powerpoint). Qualitative studies are more likely to occur "under natural conditions," less likely to be replicable, more likely to actively interact with those studied, more likely to determine common themes, and less likely to be generalizable (Miller, 2000).

Common characteristics of qualitative research found in this investigation include a natural (classroom) setting, researcher as key instrument, multiple data sources including learning logs and survey responses, inductive data analysis from codes to themes, and focus on participant perspectives. This study was conducted in a natural classroom setting. The instructor-researcher, is a key instrument in data collection and examining documents that were prepared prior to the experiment. Data sources such as the Learning Logs that document student trials and celebrations as learning progresses may provide insight into student learning as a group, and any differences between students in the control group and students in the experimental group. Any comments provided on the survey regarding student perceptions of class examples may also prove interesting in forming a better understanding of student learning in each class. These comments and written progress reports were recorded as individual units and coded by patterns, categories, and themes that emerged from the comments, adjusting final themes as needed. Conclusions were based on student data and comments, student scores and perceptions. While adjustments in direction design are not anticipated, these can still emerge and be reworded, as long as both classes remain the same and the change will not jeopardize the research. The appropriate theoretical lens is through the eyes of the student, and student perceptions should be viewed through that lens. Interpreting results and comments from student data collected, the researcher were detached from the role as instructor as much as possible and summarized findings, unbiased by known contexts. To form a more complex, holistic picture of student perceptions, all documented perceptions were analyzed and summarized in the research report, and exceptions considered from group consensus.

Categorical data was summarized verbally with written explanation and visually in a table or graph. A Likert scale was used to convert categorical data to be analyzed as as quantitative data. Such as responses to the student survey regarding student perceptions.

Care was taken to note exceptions to these themes to ensure that research findings accurately reflected student perceptions. Multiple data sources including: group comments regarding material students learned and challenges students faced throughout the semester, comments and Likert scale values regarding student perceptions of class examples, and mean exam scores converged to form a more complete and accurate view of effects of class examples. Quality of all instrument questions, especially the survey, were viewed carefully to not direct or influence the results. Directions and questions were intended to be clear, and written in such a way to illicit the appropriate responses, i.e., instruments measure what they were designed to measure. These steps were taken to ensure rigor in evaluating student comments using qualitative analysis.

Grounded theory was used to analyze comments from student Learning Logs and survey questions. The purpose of a grounded theory study (Creswell, 2007; Glaser & Strauss, 1967) was to construct theories from collected student data (Creswell, 2007; Strauss & Corbin, 1998). Student responses to learning log and survey questions were "topic" coded with phrases similar to direct student response, then grouped into themes, which were used to characterize general student responses. This sort of coding can be fairly "descriptive (the respondent is talking about the headmaster) or more obviously interpretive (hostility, authority figure, role model, and so on)" (Morse and Richards, 2002, p.117). As "topic coding is a very analytic activity" (Morse and Richards, 2002, p.117), topic codes were recoded or more generalized, as needed. Topic coding lead to even more "analytic" coding, which can generalize and abstract main ideas, which then lead to a few general themes that interlace the data.

Research Hypotheses

- Null Hypothesis: There is no significant difference in performance scores for college algebra students (in Group 1) presented with traditional class examples and college algebra students (in Groups 2 and 3) presented with class examples within context of student interests.
- Alternative Hypothesis: There is a significant difference in performance scores for college algebra students (in Group 1) presented with traditional class examples and college algebra students (in Groups 2 and 3) presented with class examples within context of student interests.
- Q1: To what extent do class examples applicable to student interests effect student learning performance?
- Q2: To what extent do class examples applicable to student interests effect student engagement or perceptions?

Student interests and career goals were supplied by students on the first day of class with a notecard used to help introduce students to their classmates and instructor.

Student interests and goals were summarized for all learners and differentiated by groups. Based on these interests and goals, class examples were developed for groups 2 and 3. Students in Group 3 were assigned to homework groups, based on similar career goals such as natural sciences, business, and education.

Pretest and ACT scores served as a student's base mathematical knowledge level. Posttest and comprehensive final exam scores were used to measure growth over the semester. Other data points were collected and available for further detail on student progress throughout the semester. These included four unit exams, eight quizzes, and 20 homework sets.

Learning Logs (see Appendix A for Learning Log) were analyzed for a qualitative aspect of learning based on students' perceptions of learning. Learning Logs, or journals, were collected throughout the course. Student engagement was defined as student behaviors and attitudes toward class, including participation in class activities. A student survey of behavior such as time spent studying, attitudes toward math such as perceived value, were collected as student perceptions. Survey questions (see Appendix B for survey given) were taken from the National Survey of Student Engagement and from class evaluations (see Appendix C for questions selected).

The purpose of a Learning Log is to provide unsolicited, self-reported information from the students' perception of what they learned in the lesson, and questions they still have that need to be clarified for them to feel they understand the lesson and the plans they have to make certain they learn the necessary information. The goal of mastery learning techniques is supported by the Learning Log as it aides in determining of sequentially connected information/understanding. The Learning Logs also assist in this endeavor by providing a communication tool noting as the students' confidence regarding learned information, the unknown and uncertain areas of learning and the part three of the log, the plan is the acceptance that learning is their responsibility to seek the information to master the learning.

The value for the use of the Learning Log in this research found, in addition to the educator's value, that the buy-in of the student to learning the information can be viewed by the students use of the Learning Log, the completeness of their answers, and the wordage or tone of their answers, another view point is the students' comments about their plans for learning the information. The Learning Logs also assist as a communication tool for the student to visit (discuss) thoughts and feelings anonymously without being face-to-face. Also, it provides a vehicle to start the openness conversation and follow up with a face-to-face classroom or office visit.

As a class, students using the Learning Logs showed combined/common trends regarding the percent of students in each class filling out the sheets, the language and completion they use in each section, their accepting ownership of their responsibilities, the range or similarities of comments.

The data compared to observations in the classroom, office visits, class grades, apparent comfort zones of classes, homework similarities and differences will support or contrast other findings.

In summary, Table 3 displays the key variables created for this study:

Table 3

Description of Variables

Code	Variable	Type of Variable
Major	Major area of study	Qualitative
Interest	Student interest(s)	Qualitative
ACT comp	ACT composite score	Quantitative
ACT math	ACT Math score	Quantitative
Pretest	Pretest	Quantitative
LrngLog	Learning Logs	Qualitative
HW 1-20	20 homework sets	Quantitative
Qz 1 – 8	8 quizzes	Quantitative
Exam 1 – 4	4 unit exams	Quantitative
Final	comprehensive exam	Quantitative
Posttest	Posttest	Quantitative
SQ1-4	Survey ~Class Examples	Quantitative
SQ 5-19	Survey ~ Engagement	Quantitative
SQ 20-21	Survey ~ Practices	Qualitative

Definition of Terms

Student Majors and Interests

On the first day of class, major area of study, along with favorite hobbies and interests were solicited from students. These written statements served as a basis for selecting class examples in Group 2 and Group 3.

Major: ____________

Career preference: _______________

Hobbies/Interests: _______________

ACT scores

Two scores from the American College Test (ACT) were recorded for individuals in each group and used as a standardized measure for group comparisons. The ACT composite score includes five categories: English, Mathematics, Reading, Science, and Writing. The first four are answered with multiple choice while the fifth is an essay given a writing prompt. Students that score higher on the ACT tend earn higher GPAs in college and vice versa. The ACT mathematics score was taken from the mathematics category as a more specific measure.

Pretest and Posttest

A ten-item pretest was given to students at the beginning of the semester. The pretest consisted of ten questions, two to three from each of the four units, typically found in a college algebra curriculum (see Appendix E). A ten-item posttest, which consisted of parallel questions in the same format as the pretest, was given to students at the end of the semester. The solution to each problem was graded based on a five-point rubric (see Appendix C) to provide a measure of how correct or incorrect an answer was given. Means, standard deviation, and effect size were then compared across groups for each 50-point pretest and 50-point posttest.

Learning Logs

Learning Logs (see Appendix A) are reflections students have regarding their learning progress (Denton & Seifert, 2004). Students were asked to respond to three writing prompts, adapted from Denton and Seifert's example, which comprise these "Learning Logs":

- I have learned:
- I still have questions about:
- Plans I have to obtain the needed answer(s) to my question(s):

Learning Logs were collected nine times throughout the semester in all three groups – Group 1, Group 2, and Group 3.

Groups

All three groups of students met three times per week, on Mondays, Wednesdays, and Fridays, at either 12:00 or 1:00 in the Fall 2008 or Spring 2009 semesters. As students entered the classroom, an agenda was on the left hand side of the front board.

For Group 1, this front board was a white markerboard. A black chalkboard lined the right side of the classroom, as students faced front. The control group (Group 1) and the experimental groups (Group 2 and Group 3) all followed the same teaching format, with lecture examples and group work examples at the board. A typical class structure would begin with approximately one minute returning homework and verbalizing the agenda for the day, approximately five minutes requesting and reviewing or answering any student questions or questions from previous learning log comments. New material then began, discussing and brainstorming the meaning of a concept would lead into showing an algebraic example, going through an example together, asking students to form small groups of 2-4 to complete an example, and then going over the examples together.
The next type of example would then be shown by the instructor, then another assisted by students, and then student groups were asked to write at the board, as the instructor visited each group and viewed progress around the classroom. This continued until approximately the last 10 minutes of class, when questions and similar examples were discussed, and announcements & homework were given for next class. Grading systems were consistent across all three groups. The only difference between Group 1 and Group 2 was that Group 2's class examples were tied to contexts similar to student interests. The difference between Group 2 and Group 3 was that some of Group 3's homework problems and exam questions were tied to contexts similar to student interests, as well.

Group 1 (control group). Group 1 was treated as the control group. Lecture broken by group board work and student questions was the teaching format. This college algebra course consisted of algebraic problems to solve. Students were shown how to solve various types of equations, inequalities, and other types of problems, and then given examples and homework to try. The course focused on the process of solving a problem without embedding it in context. Class examples, homework, quizzes, exams, pretest, and posttest in group 1 consisted of pure algebraic problems, solving equations and inequalities without context.

Example 1

Solve the following absolute value inequality for *x*. $|x-98.6|\leq 1$.

Example 2

Solve the equation $y=\sqrt{0.93x^2-144.86x+5827.81}$ when y=20.

Groups 2 and 3 (experimental groups). The interest-based approach involved similar equations and the same process for solving as the traditional algebraic approach. However, the problem was verbally stated with context for Groups 2 and 3. The context provided was targeted toward students' interests – their majors, career goals, and hobbies. While the algebraic equation was written on the board, the variables and relationships were discussed as how they applied to a particular situation. Group 3 included the interest-based approach for class examples, as well as for homework, quizzes, and exams. Homework, quizzes, and exams consisted of algebraic problems without context in Group 2 (as in Group 1).

Group 2 homework, quizzes, exams, pretest, and posttest consisted of pure algebraic problems, as in Group 1. Group 2 was given the exact same homework set from the textbook as students in Group 1. All quizzes and exams were parallel in Groups 1 and 2. Unlike in Group 1, however, class examples in Group 2 were related to student hobbies and future career interests. Hobbies and majors were solicited, open-ended, from students on the first day of class. Examples 3 and 4 provide insight into class examples based on student interests, as compared with similar Examples 1 and 2.

Example 3

Physicians consider an adult's body temperature x (in degrees Fahrenheit) to be normal if it satisfies the inequality $|x-98.6| \leq 1$. Determine the range of temperatures that are considered to be normal.

Example 4

The life expectancy table (for ages 48-65) used by the U.S. National Center for Health Statistics is modeled by $y=\sqrt{0.93x^2-144.86x+5827.81}$ where x represents a person's current age and y represents the average number of additional years the person is expected to live. If a person's life expectancy is estimated to be 20 years, how old is the person, according to this model?

Textbook

The textbook used for all courses in this study was the 3rd edition of "College Algebra" written by James Stewart with two of his former graduate students, Lothar Redlin and Saleem Watson (Peterson, 2009; Stewart, et al., 1996). Stewart is a respected mathematician, with a widely-used calculus textbook series. In a 2009 interview, Stewart shared that he was currently writing a "reform" textbook, unlike the algebra text used for the three courses in this study (Peterson, 2009).

Applied class examples were obtained from textbooks emphasizing applications such as Kim, Clark, and Michael's third edition of Explorations in College Algebra (2005) which sought to "develop algebra concepts through real-world questions" (p.v) and Herriott's College Algebra Through Functions and Models (2005) with an Applications Index included in the front cover, indexed by the area of interest the application is based around.

Homework, Quizzes, and Exams

The same textbook was used for all three classes. Students from Groups 1 and 2 used algebraic exercise problems found at the end of each section in the text, while students from Group 3 used some of the application problems which followed. Group 3 problems were also pulled from other textbooks to provide appropriate problems.

Homework in all three groups consisted of eight problems in each of the twenty 20-point homework sets. Three identified problems were each graded on a 5 point rubric, while the other 5 points were given for completion. Each of the eight quizzes were worth 20 points, and consisted of four 5-point problems similar to homework problems given. Each 5-point problem was graded on the same 5-point rubric as the homework problems. This same rubric was used for the each of the four 100-point, 20-question unit exams, and one 200-point, 40-question comprehensive final exam, and also the 50-point 10-question pretest and posttest.

Homework, quizzes, and exams in Group 3 included some application problems based on student careers interests. Students were grouped into career clusters by major.

Survey

A 21-question survey was given to college algebra students at the end of the semester. The first 17 questions and sub-questions were based on a scale from 1-5, with 5 being high. The first four questions to be studied were regarding student perceptions of class examples of various types. Questions 1 and 2 asked students to rate the frequency of each of the following types of examples provided in this college algebra class and then in other math classes taken, on a scale from 1=never, 2=rarely, 3=sometimes, 4=usually, 5=always. The seven types of class examples solicited were:

- Easy algebraic problems
- Difficult algebraic problems
- General application/word problems
- Applications to student hobbies and interests, in general
- Applications to future careers, in general
- Applications to your personal hobbies and interests
- Applications to your future career

Questions 3 and 4 also referred to these seven types of class examples. Questions 3 and 4 asked students about the perceived benefit of each of these seven types of examples in class for the student personally and then for his or her classmates, on a scale from 1=low benefit to 5=high benefit.

Questions 5-8 were adapted from the National Survey of Student Engagement (NSSE) to use as a measure of student engagement. Question 5 asked students to rate how much five particular mental activities were emphasized in class, on a scale from 1=None, 2=Very Little, 3=Some, 4=Quite a bit, and 5=Very Much. The five mental activities surveyed were:

- Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form
- Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components
- Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships

- Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions
- Applying theories or concepts to practical problems or in new situations.

Question 5 was adapted from the NSSE to focus on these mental activities in college algebra rather than semester coursework, in general.

Question 6 asked about the extent the class contributed to knowledge, skills, and personal development in the following seven areas:

- Acquiring a broad general education
- Acquiring job or work-related knowledge and skills
- Writing clearly and effectively
- Thinking critically and analytically
- Analyzing quantitative problems
- Working effectively with others
- Learning effectively on your own

Students rated the extent the class contributed to these seven areas, on a scale from 1=None, 2=Very Little, 3=Some, 4=Quite a bit, and 5=Very Much.

Question 7 asked students to use a scale from 1=Never, 2=Rarely, 3=Sometimes, 4=Usually, 5=Always to rate how often they have done each of the following 14 activities regarding participation and preparation:

- Asked questions in class or contributed to class discussions
- Prepared two or more drafts of a paper or assignment before turning it in
- Come to class without completing readings or assignments

- Worked with other students on projects during class
- Worked with classmates outside of class to prepare class assignments
- Put together ideas or concepts from different courses when completing assignments or during class discussions
- Tutored or taught other students (paid or voluntary)
- Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment
- Used e-mail to communicate with the instructor
- Discussed grades or assignments with the instructor
- Talked about career plans with the instructor
- Discussed ideas from your readings or classes with faculty members outside of class
- Worked harder than you thought you could to meet an instructor's standards or expectations
- Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)

The last two questions were researcher developed as an open-ended evaluation of teaching practices by asking students to comment on techniques that were beneficial to learning and what could be improved to enhance student learning. There was also a space for comments at the bottom of all six pages of the survey.

Strengths, Limitations, and Delimitations

This study was conducted during two semesters at one university, and included three different sections of college algebra, taught by the same instructor. This controls for the instructor, school, and associated demographic variables, but results may be limited to students at that university, or those most similar to that university.

Learning Logs were submitted voluntarily and were not part of a student's grade. Learning Log submissions and survey responses were anonymously included in this study and associated with the class as a whole, rather than with each individual student. Student interests and Learning Log reflections were limited to responses students decided to write and submit to the instructor, but students have no reason not to be honest, accurate, and complete in their reports and disclosures.

Summary of Chapter Three

This investigation used a mixed method approach, with quantitative comparative experimental methods to analyze quantitative data from exams, quizzes, homework, and survey scores, and qualitative case study methods to analyze Learning Log and survey comments. Chapter Four provides analysis of both qualitative and quantitative data and displays the results written verbally and presented visually with accompanying tables and graphs.

Chapter Four

Results

Introduction to Chapter Four

Results and major findings from the investigation are provided and organized by hypothesis and research question. The hypothesis test comparing the difference in performance on a 10-question, 50-point pretest and posttest begins the presentation of results. This is followed by research questions 1 and 2. Research question 1 explored the differences in student learning, reviewing the data from exams, quizzes, homework quantitatively. Student comments regarding learning which were collected from Learning Logs and analyzed qualitatively with codes and themes. Research question 2 explored the differences in student engagement. Data collected from survey questions was analyzed quantitatively for effect sizes between experimental and control comparison groups: Group 3 with Group 1, Group 2 with Group 1, and Groups 2 and 3, combined, with Group 1. Percent of class participation in Learning Logs was reviewed. Qualitative case study methods were used to analyze student comments from survey questions regarding teaching practices.

Background demographic information regarding individual perceptions of student learning was collected at the beginning of the semester along with student interests. Performance scores from a pretest, posttest, five exams, and eight quizzes throughout the course were collected for all three groups of students to measure progress. Learning Logs or journals were also collected periodically from students as a measure of student learning. At the end of the course, survey questions regarding student perceptions of benefits from various types of class examples were collected.

Hypothesis: Pre-Post test Performance

Recall that the hypothesis was to determine any significant differences in the performance growth between pretest scores and posttest scores among Group 1, Group 2, and Group 3. A ten-item pretest was given to students at the beginning of the semester. The pretest consisted of ten questions, two to three from each of the four units, typically found in a college algebra curriculum. A ten-item posttest, which consisted of parallel questions in the same format as the pretest, was given to students at the end of the semester.

Table 4

Descriptive Statistics on Pretest, Posttest, and Change in Performance Scores

		Pretest	Posttest	Difference (post-pre)
Group 1 (Control)	Mean	14.23	31.57	17.25
N = 20	StDev	6.53	8.91	9.77
	Min	5.00	11.00	-2.00
	Max	35.00	45.00	32.00
Group 2 (Experimental)	Mean	13.79	35.50	21.69
N = 21	StDev	4.95	4.91	6.13
	Min	2.00	25.00	10.00
	Max	22.00	43.00	36.00
Group 3 (Experimental)	Mean	14.45	37.18	22.73
N = 11	StDev	5.92	9.06	7.51
	Min	4.00	21.00	11.00
	Max	27.00	46.00	35.00
Group 2 & 3 combined	Mean	14.02	36.14	22.09
N = 32	StDev	5.22	6.69	6.57
	Min	2.00	21.00	10.00
	Max	27.00	46.00	36.00

All students except one scored higher on the posttest than the pretest in all three classes 1,2,&3, and this one student from the control group (Group 1) went from 35 to 33 out of 50. Total pretest scores ranged from 2 to 35 overall, 5 to 35 for the control group (Group 1), 2 to 22 in Group 2, and 4 to 27 in Group 3, with means of 14.2, 13.8, and 14.5 for Groups 1, 2, and 3, respectively. Total posttest scores ranged from 11 to 46 overall, 11 to 45 in Group 1, 25 to 43 in Group 2, and 21 to 46 in Group 3, with means of 31.6 in Group 1, 35.5 in Group 2, and 37.2 for Groups 1, 2, and 3, respectively. Individual differences in scores from pretest to posttest showed an average increase of 17.3 in Group 1, 21.7 in Group 2, and 22.7 in Group 3.

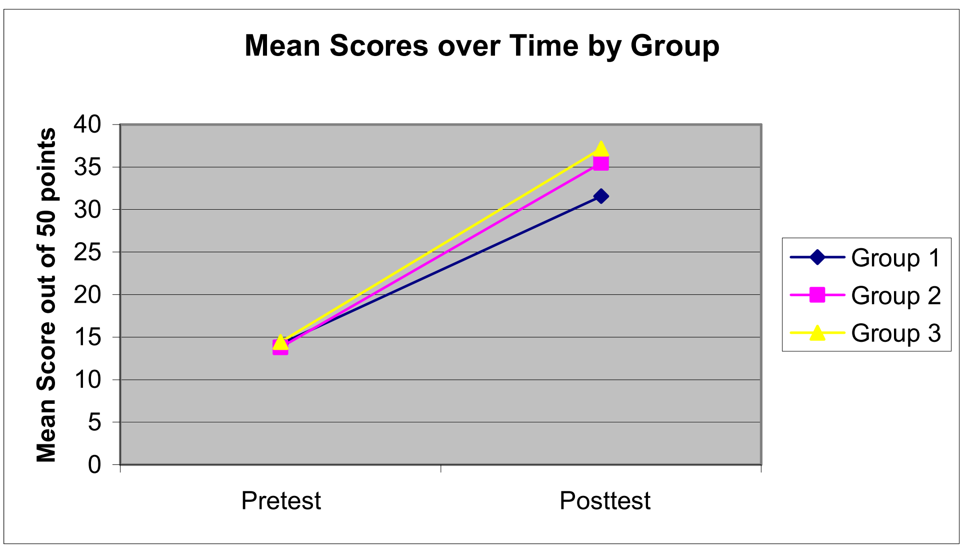

Figure 1. Mean score on pre- & post-tests by group.

A 3 x 2 (group x time), mixed-model ANOVA was used to analyze the data. *Post hoc* tests using Tukey's Honestly Significant Difference (HSD) and repeated measure ANOVA were computed to test main effects and the interaction effect. The alpha level was set at 0.05 for all hypotheses. All statistics were completed using SPSS. The summary for the overall ANOVA can be seen in Table 5.

Table 5

Summary Table for Mixed Model ANOVA

Source	SS	Df	MS	F	Sig
Between Factor (Group 1,2,3)	112.72	2.00	56.36	0.86	0.43
Error (Between)	2551.81	39.00	65.43		
Within Factor (Time)	8394.26	1.00	8394.26	271.25	0.00*
Group x Time Interaction	126.27	2.00	63.13	2.04	0.14
Error (Within)	1206.94	39.00	30.95		

$^{*}p < 0.05$

The means for differences from pretest to posttest when analyzed by group are presented in Table 6.

Table 6

Mean Growth (posttest-pretest score)

Group	Score
Group 1 (control)	17.25
Group 2	21.69
Group 3	22.73

The means for test results when analyzed over time from pretest to posttest are presented in Table 7.

Table 7

Differences Over Time

	Mean
Pretest	14.10
Posttest	34.65

Effect sizes were also computed for analysis and shown in Table 8.

Table 8

Effect Sizes

G1 vs G3	0.63
G1 vs G2	0.56
G1 vs G2&3	0.53
Pre vs Post	3.07*

*Effect sizes >0.80 were considered large.

Effect sizes were computed by taking the difference in means for the two groups compared divided by the pooled standard deviation. For example, the formula for determine effect size between Group 1 and Group 2 is: $ES = \frac{\bar{x}_2 - \bar{x}_1}{\left(\frac{s_1 + s_2}{2}\right)}$.

Effect sizes when comparing differences in posttest minus pretest scores for students in Group 3 versus Group 1 (control), Group 2 versus Group 1, and Groups 2 & 3 combined versus Group 1 were moderate. The mixed-model ANOVA indicated Groups 2 and 3 did not have a significant effect on results from tests [$F(2,39) = 0.86$, $p=.43$]. According to the ANOVA, time did have a significant effect on results from tests [$F(1,39) = 271.25$, $p<.01$]. The overall effect size for differences in posttest minus pretest over time for all students combined from Groups 1, 2, and 3 was large (3.07).

Research Question 1: Performance

Research question one was to investigate differences in performance scores on homework, quizzes, and exams. Thus, in addition to a ten-item pretest and parallel ten-item posttest, performance scores homework, quizzes, and exams were collected for analysis.

Homework, Quizzes, and Exams

The means for HW1-HW20, Quiz 1 – Quiz 8, Exam 1 – 4, and the Final Exam for Groups 1, 2, 3, and 2&3 combined, along with overall homework, quiz, and exam percentages are given in Tables 9, 10, and 11. All scores were recorded as a percentage of total points possible. When computing the mean for each homework, quiz, and exam for Group 1, Group 2, Group 3, and Group 2&3, the average percent correct for nonzero entries was used. This was also true when finding standard deviations which were necessary to determine effect size.

Throughout the semester, 20 homework sets were given. Scores from these assessments for Group 1, Group 2, Group 3, and combined Groups 2&3 are shown in Table 9 as a precentage. Each homework set consisted of eight problems. Three

Table 9

Mean Percent Correct on Homework Sets for Groups 1, 2, & 3 with Effect Sizes Comparing Experimental Groups Against Control Group

Homework	Mean %				Effect Size		
	G1	G2	G3	G2&3	G2 vs G1	G3 vs G1	G2&3 vs G1
HW 1	92.0	86.0	90.0	87.5	-0.40	-0.17	-0.32
HW 2	96.1	95.5	82.5	90.6	-0.07	-1.54	-0.61
HW 3	90.0	83.8	82.1	83.1	-0.35	-0.60	-0.42
HW 4	91.8	89.8	94.2	91.4	-0.16	0.28	-0.03
HW 5	86.2	92.3	92.5	92.3	0.46	0.50	0.48
HW 7	90.5	95.0	84.1	90.7	0.79	-0.65	0.02
HW 8	80.9	87.3	83.8	85.9	0.38	0.18	0.30
HW 9	87.5	86.0	97.1	90.2	-0.13	1.32*	0.24
HW 10	85.8	93.5	84.6	89.7	0.77	-0.08	0.31
HW 11	86.2	86.3	83.8	85.2	0.01	-0.13	-0.06
HW 12	80.3	77.8	82.7	80.0	-0.13	0.2	-0.02
HW 13	85.7	86.7	85.4	86.1	0.06	-0.02	0.03
HW 14	96.1	98.3	95.4	96.9	0.21	-0.07	0.07
HW 15	83.6	81.9	77.7	80.2	-0.15	-0.33	-0.23
HW 16	97.3	89.4	87.1	88.4	-0.28	-0.39	-0.32
HW 17	96.8	97.1	94.6	96.0	0.09	-0.32	-0.15
HW 18	90.0	92.6	85.0	90.0	0.25	-0.37	0.00
HW 19	83.2	88.7	83.3	86.3	0.42	0.01	0.22
HW 20	95.0	100.0	85.0	93.7	0.31	-0.68	-0.09
Overall HW	89.2	89.5	86.2	55.4	0.02	-0.21	-2.27

problems were graded on a five-point scale for accuracy (see Appendix C). The other five problems were scored on completion only. If the group average was 18/20 for a given homework set, then 90.0 would be recorded in the table to indicate 90% of 20 points.

Table 10

Mean Percent Correct on Quizzes for Groups 1, 2, & 3, with Effect Sizes Comparing Experimental Groups Against Control Groups

Quiz	Mean %				Effect Size		
	G1	G2	G3	G2&3	G2 vs G1	G3 vs G1	G2&3 vs G1
Quiz 1	77.4	83.2	95.0	87.6	0.36	1.21*	0.66
Quiz 2	75.2	75.5	87.3	80.0	0.01	1.00*	0.3
Quiz 3	65.3	64.0	82.7	71.4	-0.07	1.31*	0.35
Quiz 4	81.8	86.3	80.0	83.3	0.26	-0.11	0.11
Quiz 5	72.6	74.2	74.6	74.4	0.08	0.13	0.09
Quiz 6	77.8	80.0	82.9	81.2	0.14	0.32	0.22
Quiz 7	95.0	78.7	97.5	86.0	-0.64	0.21	-0.39
Quiz 8	60.8	57.5	88.6	68.5	-0.28	2.45*	0.52
Overall Quiz	76.2	74.9	86.1	79.2	-0.06	0.64	0.16

Overall homework mean and overall homework quiz mean were found by taking the average percent correct for all nonzero homework entries and all nonzero quiz entries, respectively. Overall exam mean was determined from an average percent correct for nonzero exam entries, with the final exam weighted twice as much.

Effect sizes were also computed for analysis. Effect sizes were computed by taking the difference in means for the two groups compared divided by the standard deviation. The formula for Groups 1 and 2 would be: $ES = \frac{\bar{x}_2 - \bar{x}_1}{\left(\frac{s_1 + s_2}{2}\right)}$. A large effect size was found between Group 3 students presented with class examples and homework problems based on student interests and Group 1 (control) students for Homework 9 and Quizzes 1, 2, 3, and 8, with effects over 0.80 standard deviation.

Table 11

Mean Percent for Exams for Groups 1, 2, & 3, with Effect Sizes Comparing Experimental Groups Against Control Groups

Exam	Mean %				Effect Size		
	G1	G2	G3	G2&3	G2 vs G1	G3 vs G1	G2&3 vs G1
Exam 1	85.3	84.1	84.0	84.1	-0.08	-0.10	-0.09
Exam 2	73.4	78.4	78.8	78.6	0.34	0.31	0.33
Exam 3	74.5	78.1	78.7	78.3	0.21	0.23	0.22
Exam 4	73.2	77.1	74.8	76.2	0.20	0.08	0.15
Final Exam	69.1	78.5	68.9	74.6	0.68	-0.01	0.32
Overall Exam	74.2	79.2	75.7	77.8	0.31	0.08	0.21

Learning Logs

Student responses were coded by topic and then organized into more general topic themes. The example used in Table 12 was from the twelve Group 3 students on their 2nd Learning Log entry. As it has 100% participation, it provides insight into student perceptions, learning, and questions when all students in the class are represented.

Table 12 lists codes, themes, and the number of students included in each code. Codes or abbreviated student comments were assigned to Learning Log responses to the second Learning Log question, “I still have questions about…”. These codes were then regrouped into somewhat broader themes. These themes and the number of responses included in each are represented in the following pie chart in Figure 3. Each response included as a "question" was coded very similar to the actual detailed response, and later grouped into slightly larger or more condensed themes, illustrated in Figure 3. "Other"

Table 12

Example of Codes and Themes for Learning Logs

Code	Themes	Frequency
Word problems, esp. setting up equations/inequalities	Word problems	6
Linear inequalities	Inequalities	3
Other types of equations, in general (3.5)	Equations that are not linear or quadratic	3
Quadratic equations, in general	Quadratic Equations	2
Completing the square	Quadratic Equations	1
Equations of quadratic type	Other equations	1
Finding and plugging in for x	Other equations	1
Complex numbers	Complex Numbers	1
Absolute Value Inequalities	Inequalities	1
All except inequalities	Included above - complex numbers, quadratic equations, word problems, other equations	1
No Questions	No questions	1

codes with only one student responding with that "code" included: "completing the square," "equations of quadratic type," "finding and plugging in for x," "complex numbers," "absolute value inequalities," "all except inequalities," and "no questions." Each Learning Log entry might have more than one topic listed as a question; in this case, the entry was recorded and tallied in each applicable area. Figures 2 and 3 provide an illustration of these same 11 codes and six more general themes.

Seven of 12 students responding indicated they still had questions about setting up word problems which included application problems involving quadratic equations, equations of quadratic type, equations involving rational expressions, linear inequalities, and inequalities involving absolute values. Six of 12 (50%) of students responding indicated questions regarding “other” types of equations, which included equations of quadratic type, equations involving rational expressions, equations involving square roots, and equations involving absolute values.

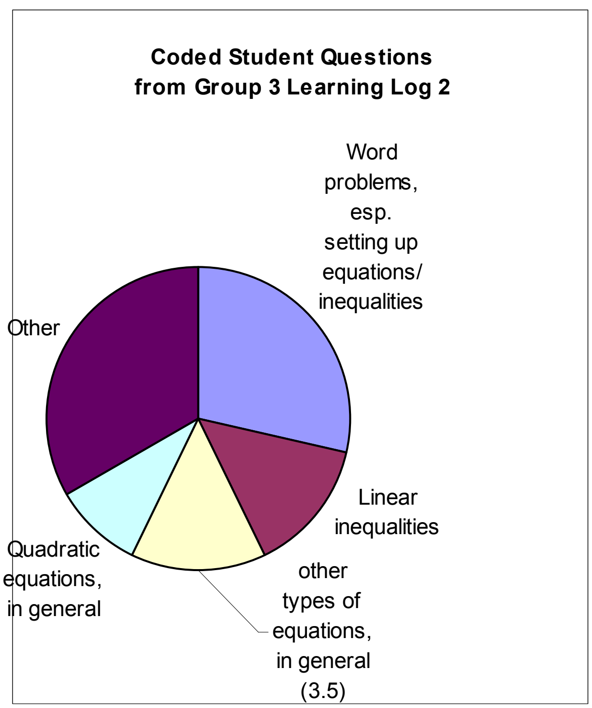

Figure 2. Example of coding.

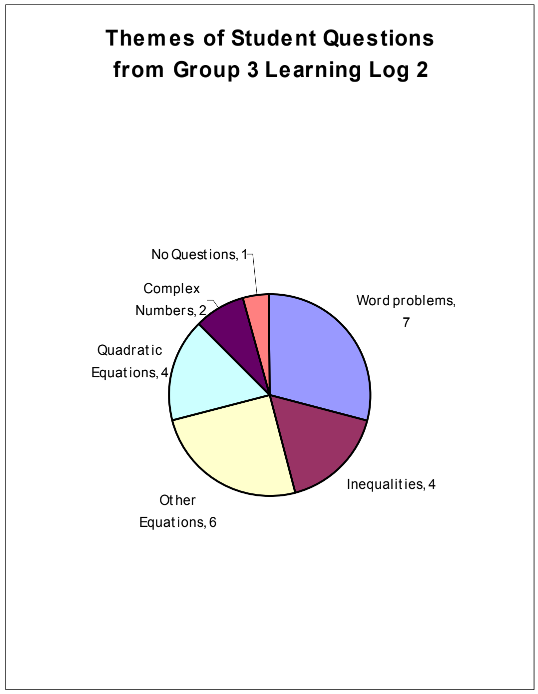

Figure 3. Example of themes.

Research Question 2: Engagement

Research question 2 was to study student engagement in Group 1, Group 2, and Group 3. Student engagement was measured via a student survey collected anonymously from students. Questions from this survey were taken from the National Survey of Student Engagement (NSSE).

Upper triangular correlations in Table 13 and Table 14 are from Groups 1, 2, and 3, combined. Lower triangular correlations are from the 2008 National Survey of Student Engagement national statistics for college students. Students surveyed within this study had generally lower inter-item correlations for educational and personal growth items on the survey than students nationally, with three exceptions. Students in these three college algebra courses had higher inter-item correlations than college students nationally between 6g and 6a (0.42 vs 0.35), 6f and 6c (0.60 vs 0.39), and 6e and 6d (0.74 vs 0.54).

Inter-item correlations for college activities items showed mixed results. Some were higher and some were lower for students participating in this survey from Groups 1, 2, and 3. One notable difference was between 7i and 7j, which had a correlation of 0.80 in this study and 0.12 nationally.

Table 13

Inter-Item Correlation Matrix for Educational and Personal Growth Items on the NSSE

	6a	6b	6c	6d	6e	6f	6g
6a	1.00	0.16	0.35	0.41	0.37	0.16	0.42
6b	0.34	1.00	0.23	0.17	0.30	0.30	0.24
6c	0.45	0.32	1.00	0.25	0.14	0.60	0.21
6d	0.44	0.37	0.54	1.00	0.74	0.12	0.34
6e	0.31	0.35	0.32	0.54	1.00	0.07	0.42
6f	0.35	0.41	0.39	0.44	0.37	1.00	0.25
6g	0.35	0.29	0.37	0.45	0.34	0.42	1.00

Note: upper triangular correlations are from sample studied (Groups 1, 2, and 3, combined). Lower triangular correlations are from the 2008 National Survey of Student Engagement statistics. Survey Question identification numbers are from the survey provided to students in this study. (see Appendix B).

Inter-item correlation matrices in Table 13 and Table 14 were provided to show similarities and differences between college algebra students participating in this study and college students nationally. Therefore, survey responses from students in Group 1, Group 2, and Group 3 were combined and treated as one large group of 43 student participants.

Table 14

Inter-Item Correlation Matrix for College Activities Items on the NSSE

	7m	7a	7d	7e	7g	7n	7j	7k	7l	7b	7c	7f	7h	7i
7m	1.00	0.16	0.24	0.09	0.19	0.41	0.40	0.37	0.40	0.39	0.25	0.22	0.21	0.24
7a	0.20	1.00	-0.13	0.02	0.51	0.06	0.23	0.37	0.06	0.12	0.13	0.38	-0.10	0.15
7d	0.15	0.13	1.00	-0.03	0.10	0.17	0.19	0.18	0.26	0.38	-0.01	0.22	0.34	0.23
7e	0.22	0.17	0.29	1.00	0.37	0.10	0.05	0.15	0.08	0.35	0.09	0.14	0.34	0.11
7g	0.15	0.22	0.08	0.24	1.00	0.31	0.12	0.25	0.26	0.48	-0.03	0.42	0.17	0.15
7n	0.25	0.28	0.10	0.20	0.20	1.00	0.14	0.37	0.46	0.45	0.00	0.51	0.22	0.08
7j	0.31	0.34	0.19	0.27	0.21	0.27	1.00	0.32	0.51	0.08	0.44	0.18	0.38	0.80
7k	0.27	0.29	0.14	0.24	0.25	0.27	0.47	1.00	0.48	0.38	0.34	0.31	0.35	0.30
7l	0.29	0.36	0.14	0.24	0.28	0.36	0.44	0.49	1.00	0.31	0.11	0.35	0.49	0.53
7b	0.28	0.15	0.14	0.11	0.07	0.13	0.19	0.14	0.18	1.00	-0.09	0.39	0.34	0.15
7c	-0.17	-0.10	0.02	0.02	-0.02	-0.06	-0.20	-0.20	-0.08	-0.20	1.00	-0.16	0.27	0.38
7f	0.25	0.29	0.22	0.34	0.25	0.35	0.14	0.49	0.34	0.14	-0.02	1.00	0.24	0.23
7h	0.14	0.11	0.14	0.20	0.13	0.17	0.09	0.16	0.17	0.09	-0.01	0.20	1.00	0.43
7i	0.21	0.19	0.12	0.27	0.16	0.20	0.12	0.30	0.28	0.12	0.01	0.25	0.37	1.00

Note: upper triangular correlations are from sample studied (Groups 1, 2, and 3, combined). Lower triangular correlations are from the 2008 National Survey of Student Engagement statistics. Question identification numbers are from the survey provided to students in this study. See Table 15 of Appendix B for specific survey questions.

Attendance and homework completion records as well as instructor observations and Learning Log participation were collected. Mean and standard deviation for each Group 1, Group 2, and Group 3 of students is listed by survey question in Table 15. Group 2 and Group 3 were both experimental groups with class examples applied to student interests. These two groups were combined for effect size analysis, and identified on tables as G2&3, in order to increase sample size and provide more interesting effects.

Based on survey results, effect sizes were larger when comparing Group 3 versus Group 1 and Group 2 versus Group 1, than when comparing the combined Group 2 & 3 with Group 1. Large effect sizes (ES>0.80) were found from Group 1 to Group 3 in the frequency that students said that they asked questions in class or contributed to class discussions (ES=1.06), put together ideas or concepts from different courses when completing assignments or during class discussions (ES=0.96), and talked about career plans with the instructor (ES=1.07) (Cohen, 1988). When combining Group 2 and Group 3 to form G2&3, a large effect size (ES=0.86) between Group 2&3 and Group 1 for talking about career plans with the instructor.

Students from the experimental Groups 2 and 3, on average, perceived that they had asked more questions in class or contributed to more discussion in class, with means of 3.21 and 3.92 versus control Group 1's mean of 2.78. Students from experimental Groups 2 and 3 responded that on average, they communicated with the instructor more via email (means of 2.79 & 2.92 vs 2.72), regarding grades and/or assignments (means of 2.84 and 2.92 vs 2.81), and about career plans (means of 1.47 and 1.83 vs 1.11) than students from control Group 1. Group 2 which was given applied classroom examples and traditional homework, quizzes, and exams responded with the highest perceived need

Table 15

Mean Response on SQ7 Regarding the Frequency the Student has Done Each Type of Class Participation and Preparation and Effect Size Comparing Experimental Group (G3, G2, and G2&3) with Control Group 1, on a scale from 1 to 5

		Mean			Effect Size		
		G1	G2	G3	G2 vs G1	G2 vs G1	G2&3 vs G1
7a	Asked questions in class or contributed to class discussions	2.78	3.21	3.92	1.06*	0.47	0.70
7b	Prepared two or more drafts of a paper or assignment before turning it in	1.67	1.79	1.58	-0.10	0.14	0.05
7c	Come to class without completing readings or assignments	2.17	1.89	2.42	0.27	-0.30	-0.08
7d	Worked with other students on projects during class	3.22	3.16	2.67	-0.57	-0.09	-0.30
7e	Worked with classmates outside of class to prepare class assignments	2.38	2.95	2.58	0.14	0.35	0.28
7f	Put together ideas or concepts from different courses when completing assignments or during class discussions	2.00	2.11	2.92	0.96*	0.11	0.42
7g	Tutored or taught other students (paid or voluntary)	1.50	2.00	2.17	0.53	0.46	0.49
7h	Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment	1.72	1.58	1.67	-0.05	-0.16	-0.12
7i	Used e-mail to communicate with the instructor	2.72	2.79	2.92	0.18	0.06	0.11

Table 15 continues

		Mean			Effect Size		
		G1	G2	G3	G2 vs G1	G2 vs G1	G2&3 vs G1
7j	Discussed grades or assignments with the instructor	2.81	2.84	2.92	0.09	0.03	0.05
7k	Talked about career plans with the instructor	1.11	1.47	1.83	1.07*	0.71	0.86*
7l	Discussed ideas from your readings or classes with faculty members outside of class	1.39	1.79	1.75	0.35	0.43	0.40
7m	Worked harder than you thought you could to meet an instructor's standards or expectations	2.67	3.00	2.58	-0.08	0.33	0.16
7n	Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)	2.39	2.37	2.50	0.09	-0.02	0.02

to work hard to meet instructor expectations of the three groups with a mean of 3.00 vs 2.67 and 2.58 for Groups 1 and 3, respectively.

Survey: SQ3 – SQ4

As part of a student survey, students were asked which types of class examples they perceived were most beneficial to themselves and to classmates, on a scale from 1 = low benefit to 5 = high benefit.

Means for Group 1, Group 2, and Group 3 for Survey Question 3 and Survey Question 4 are provide in Table 16. Alongside the means for each of the three groups, is a comparison of intervention effect of using class examples applied to student interests in Group 2 and Group 3 and Group 2&3 combined against the control Group 1 using algebra examples not applied. Cohen's (1988) effect size measure was used in determining these figures and determine the 0.80 bar for determining large effect sizes.

Table 16

Mean and Effect Size Comparisons for Groups 1, 2, & 3 Regarding Class Example Types Presented and Preferred, on a scale from 1 to 5

3	What types of class examples would be most beneficial for you?	Mean			Effect Size		
		G1	G2	G3	G3 vs G1	G2 vs G1	G2&3 vs G1
3a	Easy algebraic problems	3.78	3.32	3.42	-0.30	-0.42	-0.37
3b	Difficult algebraic problems	4.28	3.95	3.75	-0.50	-0.37	-0.42
3c	General applications/word problems	3.67	3.68	3.75	0.10	0.02	0.05
3d	Applications to student hobbies and interests, in general	3.19	2.79	3.17	-0.03	-0.40	-0.27
3e	Applications to future careers, in general	3.39	2.79	3.42	0.03	-0.57	-0.35
3f	Applications to your personal hobbies and interests	3.08	2.68	3.33	0.24	-0.33	-0.13
3g	Applications to your personal future career	3.50	3.11	3.75	0.26	-0.36	-0.13
4	What types of class examples would be most beneficial *for your classmates*, in your opinion?	Mean			Effect Size		
		G1	G2	G3	G3 vs G1	G2 vs G1	G2&3 vs G1
4a	Easy algebraic problems	3.72	3.53	3.83	0.10	-0.17	-0.07
4b	Difficult algebraic problems	4.00	4.11	4.08	0.10	0.13	0.12

Table 16 continues

4	What types of class examples would be most beneficial *for your classmates*, in your opinion?	Mean			Effect Size		
		G1	G2	G3	G3 vs G1	G2 vs G1	G2&3 vs G1
4c	General applications/word problems	3.78	3.58	4.00	0.26	-0.22	-0.04
4d	Applications to student hobbies and interests, in general	3.56	3.00	3.83	0.33	-0.62	-0.25
4e	Applications to future careers, in general	3.56	3.11	3.92	0.40	-0.47	-0.14
4f	Applications to your personal hobbies and interests	3.39	3.05	3.67	0.28	-0.33	-0.10
4g	Applications to your personal future career	3.56	3.26	4.17	0.65	-0.27	0.05

When asked about the benefit of various types of class examples in college algebra, students from Groups 1, 2, and 3 were relatively similar in their responses. No large effect sizes (ES>0.80) were found among comparisons between Group 3 with Group 1, Group 2 with Group 1, or Groups 2 & 3 combined with Group 1. Students from Group 1, the control group, perceived more value to themselves from easy algebraic examples and difficult algebraic examples than students from the experimental Groups 2 and 3, with means of 3.78 and 4.28 from students in Group 1 for easy and difficult algebraic examples versus 3.32 and 3.42 from students in Groups 2 and 3 for easy algebraic examples and 3.95 and 3.75 for Groups 2 and 3 for perceived personal benefit of difficult algebraic examples.

Survey: SQ8

Students from Group 1 perceived their algebra exams challenged them more than students in Groups 2 and 3 perceived their algebra exams, with class averages of 4.0 vs 3.82 and 3.67. The reverse was true of student perceptions of exams from other courses this year, with mean challenge of 4.06, 4.29, and 4.25 for Groups 1, 2, and 3, respectively.

Table 17

Mean and Effect Size Comparisons for Groups 1, 2, & 3 Regarding the Challenge of Examinations on a scale from 1 to 5

		Mean			Effect Size		
		G1	G2	G3	G3 vs G1	G2 vs G1	G2&3 vs G1
8a	To what extent did your examinations *during this college algebra course* challenge you to do your best work?	4.00	3.82	3.67	-0.36	-0.24	-0.29
8b	To what extent did your examinations during this school year challenge you to do your best work?	4.06	4.29	4.25	0.25	0.29	0.27

Survey: SQ9

Students rated the level they were well-prepared for class on a daily basis through reading and completing homework. Students from Groups 2 and 3 perceived a higher level of preparation than students in Group 1, with lower deviation between individual responses. These means and standard deviations for Groups 1, 2, and 3 were 3.72 with s=1.02, 4.0 with 0.67, and 4.08 with 0.79. As a result of taking this course, students from Groups 2 and 3 perceived a higher increase in subject interest with means of 2.53 and 2.50 than students from Group 1 with mean 2.28. When asked whether the class

Table 18

Mean and Effect Size Comparisons for Groups 1, 2, & 3 Regarding Preparation for Class, Preparation, Knowledge, Interest and Appreciation of Algebra, on a scale from 1 to 5

9	Please mark how much you agree with each of the next statements, using the following scale.	Mean			Effect Size		
		G1	G2	G3	G3 vs G1	G2 vs G1	G2&3 vs G1
9a	I am well prepared for this class on a daily basis (do homework, readings, etc.)	3.72	4.00	4.08	0.40	0.33	0.36
9b	I actively participate in class (e.g., ask questions, participate in discussions, talk to instructor).	3.06	3.47	4.00	0.97*	0.43	0.63
9c	As a result of taking this course, I have deepened my interest in and/or appreciation of the subject.	2.28	2.53	2.50	0.25	0.24	0.24
9d	As a result of taking this course, I have increased my knowledge and understanding of the subject.	3.75	3.32	3.92	0.24	-0.54	-0.25
9e	This class has challenged me intellectually.	3.75	3.95	3.83	0.07	0.21	0.15
9f	The class examples in this course were interesting.	3.11	3.11	3.42	0.41	-0.01	0.15

challenged students intellectually, students in Group 2 who were presented with context-based examples and given traditional performance assessments responded with the highest class average with a mean of 3.95, followed by Group 3 at 3.83, and Group 1 at 3.75. Students in Groups 1 and 2 from the first semester indicated the same average interest of 3.11 in class examples. However, students in Group 3 during the second semester indicated a higher average interest in class examples at a mean of 3.42.

Learning Logs

Learning Logs were collected throughout the semester and offered a view of student learning through entries by students. Students were asked to write down:

- something they had learned
- something they still had questions about
- plans to answer these question(s)

Learning Logs responses were evaluated regarding participation and type of response. Participation in Learning Log entries was recorded as the proportion of students in class that turned in Learning Log entries. For example, if 9 out of 12 students from Group 3 turn in Learning Log entries, there would be 9/12 or 75% participation.

As illustrated in Table 19, Group 3 Learning Log Entry 2 had 12/12 or 100% participation.

Table 19

Learning Log Participation as Percent of Total Group of Students

Entry	Group 1	Group 2	Group 3
1	83%	100%	67%
2	26%	86%	100%
3	43%	43%	58%
4	9%	33%	67%
5	26%	43%	92%
6	22%	62%	58%
7	22%	52%	75%
8	35%	38%	42%
9	57%	67%	25%
Average	36%	58%	65%

Average participation for Learning Log responses was 36% for Group 1, 58% for Group 2, and 65% for Group 3. In general, students from all three groups began the semester submitting sketchy notes without detailed information regarding material learned, questions remaining, and plans, but had relatively high beginning participation rates of 83%, 100%, and 67%, the highest for Group 1 and for Group 2, and approximately average (65%) for Group 3.

Group 1's highest participation rate was on the first Learning Log and the last of nine Learning Logs at 83% and 57%. The other seven Learning Logs ranged between a 9% and 43% participation rate. The Learning Logs provided information on the class concepts learned, but the questions were not specific nor detached but were conceptual and general in nature. For example, "none" or "symm." (for symmetry) or "domains, rational functions". Every so often, a student might write more detailed information such as “the equation part where r2=d(distance)? I’m still confused about it.” or “I understand general idea of finding equations for lines just not too good at them.” Several did ask some questions and did state their actions were to use “office hours” and did follow through to “ask the teacher or a tutor” Many plans were left blank. Group 1 students did not return the Learning Logs as often as the other groups, with the lowest average participation rate of 36% with a difference of over 20% from average participation in Group 2 and Group 3. A few students in Group 1 completed more detailed responses such as “I learned about the slope intercept and finding the slope. Slope is found by rise/run. Point slope formula is y - y1 = m (x – x1) or y = mx + b.” However, most did not answer as thoroughly as either of the two other groups, giving responses such as “x and y intercepts and symmetry”, often leaving the first questions regarding what they have learned (and plans to obtain answers) blank.

Group 2 submitted Learning Logs more often than Group 1 on average and described issues and concerns in more detail than Group 1 students. Responses regarding questions included “#63, #64 & #75”, “how do I test the points in a scatter plot to find line of best fit?”, and “finding symmetry, although I have learned how to find it I still need practice,” and “Not really anything, this is pretty easy.” Group 2 also spent more visits to the office for assistance and asked questions in class. Group 2 also developed plans for seeking answers, including “ask the instructor” during class, “stop by” the instructor’s office, “work through the homework, and ask for help with questions I don’t understand”, “I’m going to ask my study people,” “attend a math tutor session or come in during your office hours to get help,” or “read/look in the book.”

Group 3 used of the Learning Logs more than Group 2 or Group 1, averaging 65% over nine Learning Log sets. Group 3 wrote detailed responses to material they knew such as "I learned how to graph the piecewise tax table thing. It made more sense after you explained it in class and more about transformations." Group 3 students, in general, provided more detail on questions and issues they needed to figure out such as "I don't really have any questions about transformations. I'm starting to understand the piecewise function graphs now" or "no questions at this time" or "I have a very hard time with equations questions/story problems. I can't understand what it's asking or how to find it. I don't know how to tell what's part of the question or not and which sign to use," and plans they had for acquiring the necessary information. While one student would simply again write "no questions" or "n/a" for their plans, and another might write "studying", a couple might write responses such as "do practice problems" or "ask questions in class and look through book," or "examples from notes and book problems/examples", other students in Group 3 would write "If I have a question later I'll ask in class probably." or "If I need to review those I will look in the book or ask you to set up a time to review" or "can go and get tutor help; I was working all day so that I couldn't go [before]." or "practice more of the questions from the book and also follow the examples from class or in the book."

Table 20

Group 3 Learning Log Individual Participation by Entry

	Entry #								
Student #	1	2	3	4	5	6	7	8	9
1	x	x	x	x	x		x	x	x
2	?	x	x	x	x	x	x		
3		x			x	?	?		
4		?	x		x		?		
5	?	x		x	x	?	?		
6		x		x				?	
7	x	x	?	x	x	x		x	?
8	x	x	x	x	x		x	x	x
9		x			?	?			
10	x	x	x	x		x	x	x	
11	x	x			x	?	x		
12	x	x	x		x		x		

Note: An "x" indicates a student provided his/her name on that particular Learning Log entry. A "?" indicates a Learning Log was submitted without a name on that particular entry, and handwriting analysis suggests it came from this particular student.

Survey: SQ20 – SQ21

Two questions surveyed from students at the end of the semester requested (1) three things that were perceived as beneficial to student learning that semester, and (2) three opportunities for improvement for future classes. Responses from each group were qualitatively analyzed, beginning with codes and ending with larger themes.

When asked what aspects of the course were most beneficial to student learning, students from Group 1 (control) most often identified the class support system of replacement quizzes and the ability to use notecards. Next came working examples in class, taking quizzes, and availability of instructor office hours. Group 2 also most often identified the class support system including replacement quizzes and note cards. This was followed by working examples in class, and specifically practical application examples. Group 3 most often indicated that the most beneficial aspects for student learning was the availability of the instructor and practical application examples, followed by replacement opportunities, taking quizzes, and the notecard system.

When asked about opportunities for course improvement, students from Group 1 wanted more examples, shorter quizzes and exams, and limited/highlighted chapter information. Group 2 suggested more pre-prepared application examples, extension of applications into homework, quizzes, and exams like those given as class examples, more homework given, and going over homework in class. Group 3 also suggested more pre-prepared application examples, more homework problems given, and then more review before exams.

Both Group 2 and Group 3 provided more comments on both beneficial observations and opportunities to improve. Group 2 and Group 3 both mentioned practical examples being beneficial to student learning (Group 1 did not get exposed to this and did not mention it). Group 2 and Group 3 also wanted the practical examples extended more into the examinations. Group 2 and Group 3 both wanted more homework to be assigned, while Group 1 did not indicate this desire. All three groups liked instructor availability and the replacement system.

Overall, Groups 2 and 3 offered better insight to their views of positive things that should continue and opportunities to improve. Groups 2 and 3 wanted more examples and homework but wanted practical examples extended more to the tests with one student from Groups 2 and 3 combined indicating that the attempt to make examples fit career or interests was too difficult and confusing.

Summary of Chapter Four

Hypothesis

The results from a ten-item posttest averaged significantly higher than scores from a parallel ten-item pretest for students overall and for each Group 1, 2, and 3. While mean differences between pretest and posttest scores were higher for Group 3 than Group 2 than Group 1, the differences between the three groups was not statistically significant.

Research Question 1

Learning was measured by performance scores and by student perception through Learning Logs. Most performance scores on homework, quizzes, and exams did not indicate any statistically significant differences between students exposed to applied examples based on student interests and students exposed to algebraic examples without context. However, there was a large effect size (>0.80) between Group 3 students presented with class examples and homework problems based on student interests and Group 1 (control) students for Quizzes 1, 2, 3, and 8, amounting to 50% of quizzes.

Research Question 2

Engagement was measured by participation in class Learning Logs and by responses to survey questions. Students in Group 3 had higher average participation rates than students in Group 2, while students in Group 2 had higher average participation rates than Group 1.

Chapter Five

Conclusions

Introduction to Chapter Five

Chapter Five summarizes the major investigation findings regarding the hypothesis and the research questions. Chapter Five also discusses conclusions and implications of these resultant findings. Concluding this chapter are researcher suggestions for further research studies and a summary of conclusions.

Hypothesis

In testing for the hypothesis to determine whether there was a significant difference among average group change in posttest over pretest scores, pretest and posttest scores were compared across groups. The results from a ten-item posttest averaged significantly higher than scores from a parallel ten-item pretest (see Appendix E) for students overall and for each Group 1, 2, and 3. While mean differences between pretest and posttest scores were higher for Group 3 than the scores from Group 2 and differences in scores were higher in Group 2 than differences in Group 1, the differences among the three groups were not statistically significant. Therefore, the null hypothesis was not rejected; there was no significant difference between students in control Group 1 provided with algebraic class examples, and experimental Groups 2 and 3 provided with class examples applied to student interests. Many students from applications-based high school algebra programs also earned scores similar to students from more traditional algebra – based programs on traditional algebra exams involving pure algebraic manipulation and presented without context (Thompson & Senk, 2001). Control-group students in some studies, however, did better on traditional symbol-manipulation tasks than experimental-group students who learned from an application-based curriculum (Huntley, 2000; Hirschhorn, 1993).

Previous studies have found that students need to understand the relevance of symbols and combinations of symbols such as the equal sign and algebraic rule statements to learn effectively (Knuth, Stephens, McNeil & Alibali, 2006; McNeil & Alibali, 2005; Sleeman, 1984; Kirschner & Awtry, 2004). Students need the symbols to hold meaning for them to be successful. This can be extended to the total concept of the value of algebra as students must understand the relationship of algebra to their areas of interest and/or careers to commit themselves to the task of learning the necessary information to become successful in learning the algebra and concepts that is the key purpose of applied practical algebra. Group 2 and Group 3 also indicated similar concepts in their statements within learning logs.

Research Question 1

To determine the learning effects of college algebra class examples, the learning outcome was measured by performance scores and by student perception through written comments on Learning Logs (see Appendix A). Most performance scores on homework, quizzes, and exams did not indicate any statistically significant differences between students exposed to applied examples based on student interests and students exposed to algebraic examples without context. However, there was a large effect size (>0.80) between Group 3 students presented with class examples and homework problems based on student interests and Group 1 (control) students for Quizzes 1, 2, 3, and 8, representing 50% of all quizzes given. Quiz 8 was specifically application problems. Students in Group 3 were exposed to applied problems more often throughout the semester than students in either Group 1 or Group 2, and performed better on this quiz. In recent studies, high school students who studied with application-based curricula were also able to solve problems from life-situations much better than students who studied traditional algebraic curricula (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993; CRAFTY, 2001). Students tended to do better on algebraic tasks embedded in applied-problem contexts (Thompson & Senk, 2001; Huntley, 2000; Hirschhorn, 1993).

This was also found to be relevant in this study. The students that experienced the relevance of the practical application (Group 3) commented on desiring "more homework" and "more challenging problems" indicating they were looking for higher learning outcomes and less influenced by other factors. When students are encouraged to relate new information to prior knowledge and personal learning experiences, they are more engaged in learning activities and increase performance on exams (Guterman, E., 2002; Zan, R., 2000).

Research Question 2

To determine student engagement differences among groups, engagement was measured by participation in class Learning Logs and by responses to survey questions, including subject and completeness. Group 1 had a mixed review of Learning Logs with most students contributing very little. A few students in Group 1 did however communicate actively regarding lesson material and plans for learning. Overall, students in Group 1 had a low participation rate of 36%.

A higher average percentage of students in Group 2 than Group 1 participated in the Learning Log program by completing and returning Learning Logs. More detailed, longer responses provided better explanation and higher participation provided better representation of material learned and questions needing addressed than for Group 1. Average participation for Learning Log responses was 58% for Group 2 while average participation averaged 36% of students for Group 1. The majority of student in Group 2 class participated in responding on Learning Logs, completing Learning Logs more thoroughly, asking questions of more specific and detailed issue regarding subject matter needing to be reviewed or retaught and developed a useful plan for acquiring the information. The remainder of the class used the Learning Logs some but appeared they were not committed to Learning Log usage.

Group 3 Learning Logs statements had the highest average participation percentage at 65% of student participation within a group, among Groups 1, 2, and 3. Most students in Group 3 were actively committed to the use of the Learning Logs, answering each question thoroughly and leaving completed Learning Logs with the instructor. Learning comments from students in Group 3 were also the most thorough of all three groups of students. Group 3 students filled out the sections more fully than students in Groups 1 and 2, explained learned information and questions in much more detail, and had effective plans for acquiring the necessary information.

Survey: SQ20 - SQ21

Comments from Survey Question 20 (SQ20) and Survey Question 21 (SQ21) were also considered as a measure of student engagement (see Appendix B). Both Group 2 and Group 3 were more thorough in providing comments to both beneficial observations (SQ20) and opportunities to improve (SQ21). Group 2 and Group 3 both mentioned practical examples being beneficial to student learning (Group 1 did not get exposed to this and did not mention it). Group 2 and Group 3 also wanted the practical examples extended more into the examinations. Group 2 and Group 3 both wanted more homework to be assigned, while Group 1 did not indicate that desire. All three groups liked instructor availability and the replacement system.

Overall, Groups 2 and 3 offered better insight to their views of positive things that should be continued and opportunities to improve. Groups 2 and 3 wanted more examples and homework but wanted practical examples extended more to the tests with one student from Groups 2 and 3 combined indicating that the attempt to make examples fit career or interests was too difficult and confusing. Studies have shown that promoting positive attitudes toward mathematics become an important objective in teaching mathematics and other subjects and promoting student learning and achievement in the subject area (Alrwais, 2000; McLeod, 1992; Duncan & Thurlow, 1989).

Survey: SQ5 – SQ19

From the class survey of student engagement, effect sizes were larger when comparing Group 3 versus Group 1 and Group 2 versus Group 1, than when comparing the combined Group 2 & 3 with Group 1. Large effect sizes (ES>0.80) between Group 1 and Group 3 were found for three of the 14 questions from the survey regarding college activity items. Students in Group 3 perceived a higher participation rate on a scale from 1 to 5 than students in Group 1 for these three activities relating to the college algebra class. Students in Group 3 perceived that they asked questions in class or contributed to class discussions, put together ideas or concepts from different courses when completing assignments or during class discussions, and talked about career plans with the instructor more than students in Group 1 perceived that they participated in these activities. When combining Group 2 and Group 3 to form G2&3, students in Group 2&3 combined also indicated a higher frequency of engagement than students in Group 1, specifically for talking about career plans with the instructor.

Implications for Teaching

Students in Group 2 exposed to applied examples based on student interests wanted more practice problems applied to student interests. Even more students in Group 3 exposed to applied examples and some practice problems wanted additional practice problems applied to student interests than students in Group 2. Instructors should, therefore, infuse the curriculum with applied examples based on student interests. Ideally, there should be a rich supply of appropriate examples available as a instant resource, as locating or developing good, effective examples is time-intensive, and textbook-provided examples may not be a perfect match. Grouping students by similar interests, such as majors, helps the instructor by reducing the number of problems necessary to develop homework sets, rather than a unique homework set for each individual student.

Strengths, Limitations, and Delimitations

This study was conducted during two semesters at one university, and included three different sections of college algebra, taught by the same instructor. This controls for the instructor, school, and associated demographic variables, but results may be limited to students at that university, or those most similar to that university. Sample size for this study was small, including only 43 students in all three groups combined.

Learning Logs were submitted voluntarily and were not part of a student's grade. Learning Log submissions and survey responses were anonymously included in this study and associated with the class as a whole, rather than with each individual student.

Student interests and Learning Log reflections were limited to responses students decided to write and submit to the instructor, but students have no reason not to be honest, accurate, and complete in their reports and disclosures.

Recommendations for Further Research

Further research studies may include a larger set of college algebra students from a wide variety of colleges and universities, other undergraduate mathematics courses, and other subjects. A larger sample size with more students and more courses would allow for more detailed analysis and higher chance of significant differences. Average ACT scores for each group of students included in this study were between 20 and 23. Studying the effects of class examples applied to college algebra student interests for students with lower average ACT scores might show larger differences in performance growth among intervention and control groups.

Research shows that student journal reflections can be very beneficial, but they are not very common in mathematics. By completing Learning Logs, students had the opportunity to assess and communicate what they had learned, as well as questions they had, a very beneficial result that is sometimes difficult to achieve. Results from this research regarding students' surveys and qualitative responses were consistent with current research. It would also be an enlightening research project to experiment with various methods of collecting the reflections—email, paper, or blackboard postings. I plan to continue research and practice with student reflections.

Summary of Chapter 5

Students in Group 3 increased their performance scores from pretest to posttest more than students in Group 2 and students in Group 2 improved their difference in scores from pretest to posttest more than students in Group 1 on average. Thompson and Senk (2001) found similar results. Other performance measures (exams, homework, and quizzes) also show higher averages for students in Group 3 than Groups 2 and 1. Group 3 had the highest average participation rate in Learning Logs with 65% participation, followed by Group 2 with 58% participation, and then Group 1 with 36% participation. Differences in performance scores from beginning pretest to ending posttest were noticeable, but not significant among Groups 1, 2, and 3.

This study provides information about three groups of students at one university regarding their academic performance and class engagement, treating examples applied to student interests as the variable across the groups. Further studies with larger sample size, students with a wider range of ACT scores, and separate roles as investigator and instructor are recommended.

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Appendix A

Learning Log

Learning Log

I have learned:

I still have questions about:

Plans I have to obtain the needed answer(s) to my question(s):

Appendix B

Survey

Survey

Survey: SQ1 – SQ19

1. How often were examples of each type presented in *this* class?

	Never	Rarely	Sometimes	Usually	Always
Easy algebraic problems	1	2	3	4	5
Difficult algebraic problems	1	2	3	4	5
General applications/word problems	1	2	3	4	5
Applications to student hobbies and interests	1	2	3	4	5
Applications to future careers, in general	1	2	3	4	5
Applications to your personal hobbies & interests	1	2	3	4	5
Applications to your personal future career	1	2	3	4	5

2. How often were examples of each type presented in *other* math classes you've taken?

	Never	Rarely	Sometimes	Usually	Always
Easy algebraic problems	1	2	3	4	5
Difficult algebraic problems	1	2	3	4	5
General applications/word problems	1	2	3	4	5
Applications to student hobbies and interests	1	2	3	4	5
Applications to future careers, in general	1	2	3	4	5
Applications to your personal hobbies & interests	1	2	3	4	5
Applications to your personal future career	1	2	3	4	5

3. What types of class examples would be most beneficial *for you*? Please indicate the value, or amount of benefit of each type of class example, on a scale from 1-5, where 1 is low and 5 is high.

Type of Class Examples	Perceived Benefit **For You**				
	Low benefit				High benefit
Easy algebraic	1	2	3	4	5
Difficult algebraic	1	2	3	4	5
General applications/word problems	1	2	3	4	5
Applications to typical student hobbies and interests	1	2	3	4	5
Applications to typical future careers, in general	1	2	3	4	5
Applications to your personal hobbies and interests	1	2	3	4	5
Applications to your personal future career	1	2	3	4	5

4. Which types of class examples would be most beneficial *for your classmates*, in your opinion? Please indicate the value, or amount of benefit of each type of class example, on a scale from 1-5, where 1 is low and 5 is high.

Type of Class Examples	Perceived Benefit **For You**				
	Low benefit				High benefit
Easy algebraic	1	2	3	4	5
Difficult algebraic	1	2	3	4	5
General applications/word problems	1	2	3	4	5
Applications to typical student hobbies and interests	1	2	3	4	5
Applications to typical future careers, in general	1	2	3	4	5
Applications to your personal hobbies and interests	1	2	3	4	5
Applications to your personal future career	1	2	3	4	5

5. During the current school year, how much has your college algebra coursework emphasized the following mental activities?

	None	Very Little	Some	Quite a bit	Very much
Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form	1	2	3	4	5
Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components	1	2	3	4	5
Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships	1	2	3	4	5
Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions	1	2	3	4	5
Applying theories or concepts to practical problems or in new situations	1	2	3	4	5

6. To what extent has your experience *__in this college algebra this semester__* contributed to your knowledge, skills, and personal development in the following areas?

	None	Very Little	Some	Quite a bit	Very much
Acquiring a broad general education	1	2	3	4	5
Acquiring job or work-related knowledge and skills	1	2	3	4	5
Writing clearly and effectively	1	2	3	4	5
Thinking critically and analytically	1	2	3	4	5
Analyzing quantitative problems	1	2	3	4	5
Working effectively with others	1	2	3	4	5
Learning effectively on your own	1	2	3	4	5

7. In your experience during the current college algebra course, about how often have you done each of the following?

	Never	Rarely	Sometimes	Usually	Always
Asked questions in class or contributed to class discussions	1	2	3	4	5
Prepared two or more drafts of a paper or assignment before turning it in	1	2	3	4	5
Come to class without completing readings or assignments	1	2	3	4	5
Worked with other students on projects during class	1	2	3	4	5
Worked with classmates outside of class to prepare class assignments	1	2	3	4	5
Put together ideas or concepts from different courses when completing assignments or during class discussions	1	2	3	4	5
Tutored or taught other students (paid or voluntary)	1	2	3	4	5
Used an electronic medium (listserv, chat group, Internet, instant messaging, etc.) to discuss or complete an assignment	1	2	3	4	5
Used e-mail to communicate with the instructor	1	2	3	4	5
Discussed grades or assignments with the instructor	1	2	3	4	5
Talked about career plans with the instructor	1	2	3	4	5
Discussed ideas from your readings or classes with faculty members outside of class	1	2	3	4	5
Worked harder than you thought you could to meet an instructor's standards or expectations	1	2	3	4	5
Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)	1	2	3	4	5

	None	Very Little	Some	Quite a bit	Very much
8a. To what extent did your examinations *<u>during this college algebra course</u>* challenge you to do your best work?	1	2	3	4	5
8b. To what extent did your examinations *<u>during this school year</u>* challenge you to do your best work?	1	2	3	4	5

9. Please mark how much you agree with each of the next statements, using the following scale.
(SA) = Strongly Agree, (A) = Agree, (N) = Neutral, (D)=Disagree, (SD)=Strongly Disagree

	SD	D	N	A	SA
I am well prepared for this class on a daily basis (do homework, readings, etc.)	1	2	3	4	5
I actively participate in class (e.g., ask questions, participate in discussions, talk to instructor).	1	2	3	4	5
As a result of taking this course, I have deepened my interest in and/or appreciation of the subject.	1	2	3	4	5
As a result of taking this course, I have increased my knowledge and understanding of the subject.	1	2	3	4	5
This class has challenged me intellectually.	1	2	3	4	5
The class examples in this course were interesting.	1	2	3	4	5

10. For me, this course is An Elective For Major For Gen Ed For Minor

11. Number of class sessions missed: 0-2 3-6 7-10 11-15 >15

12. I expect to earn a grade of: A B C D F

13. I am taking this class for: Audit Pass/Fail Grade

14. My Cumulative GPA is: NA below 2.5 2.5 to 2.99 3.0 to 3.49 3.5 to 4.0

15. On a scale from 1 (no value) to 5 (essential), what is the value of algebra/math in your chosen profession? No Value 1 2 3 4 5 Essential

16. How many of your hobbies and interests are related to math?

None	Very Few	Some	Most	All
1	2	3	4	5

17. How much is algebra/math related to your average hobby or interest?

None	Very Little	Some	Quite a bit	Very Much
1	2	3	4	5

18a. Approximately how many hours did you spend studying for _college algebra_ per week?

<1 1-1 ½ 2-2 ½ hours 3- 3 ½ hours >4 hrs

18b. Approximate number of hours spent studying for algebra per week: _________

18c. Approximate number of hours spent completing homework problem sets for algebra: __________

19. In a typical week, how many homework problem sets do you complete for your _combined semester courseload?_

a. Number of problem sets that take you more than an hour to complete

None 1-2 3-4 5-6 >6

b. Number of problem sets that take you less than an hour to complete

None 1-2 3-4 5-6 >6

Survey: SQ20 - SQ21

20. Three things that were beneficial to my learning this semester and should not change are:

1) ______________________________

____

____

2) ______________________________

____

____

3) ______________________________

____

____

21. Three constructive ways to improve in order to enhance student learning are:

1) ______________________________

____

____

2) ______________________________

____

____

3) ______________________________

____

____

Other comments:

____

____

____

Appendix C

5-point Grading Rubric

5-point grading rubric

The following rubric will be used to assess every problem from exams and quizzes, and three homework problems from each homework set:

5 points if perfect
4 points if nearly perfect (one minor mistake)
3 points if 2 minor mistakes, or one nonminor/major mistake
2 points if something is accurate, but at least two major/nonminor mistakes
    or at least 3 minor mistakes
1 point if the problem was attempted, but no accurate, related work
    or if the correct answer is listed without explanation
0 points if no accurate, related work is provided and no correct answer is
    provided.

Appendix D

Group 3 Scores by Individual

Group 3 scores by individual

Exam scores for Group 3						
ID #	Exam 1	Exam 2	Exam 3	Exam 4	Final Exam %	Overall Exam %*
1	93.00	99.00	96.00	97.00	93.00	95.17
8	91.00	94.00	90.50	95.00	97.50	94.25
2	94.00	97.50	87.00	98.00	89.50	92.58
7	88.00	85.00	87.00	87.00	85.75	86.42
12	96.00	80.00	79.00	85.00	81.25	83.75
4	92.00	76.00	87.50	83.00	71.50	80.25
10	90.00	60.00	81.50	72.50	78.00	76.67
5	75.00	71.50	84.00	68.50	69.25	72.92
9	78.00	74.00	82.00	78.00	57.50	71.17
6	69.00	79.50	70.50	81.00	52.50	67.50
11	81.00	51.50	56.25	51.00	51.00	56.96
3	82.00	58.50	63.00	49.00	34.00	53.42
13	63.00	98.00	58.50	28.00	34.50	52.75
Mean	84.00	78.81	78.67	74.85	68.87	75.68
* Exams 1, 2, 3, & 4 are 100 points each while the Final Exam is 200 points.						

Group 3 Quizzes								
ID #	1	2	3	4	5	6	7	8
10	95	80	70	95	65	90	95	100
1	95	100	90	95	80	85	100	100
3	95	80	85	85	65	75	100	95
9	95	85	85	80	80	90	95	90
12	95	85	90	75	85	90	90	85
8	95	95	90	75	90	100	100	100
2	95	100	95	85	80	95	100	
6	95	85	80	65	70			70
4	95	90	85	95	65	80	90	
13	95	75	70	45		60	100	90
11	95	80	70	80	60	70	100	80
5	95	90	75	80	75	75	100	65
7	95	90	90	85	80	85	100	100

* Each quiz consisted of 4 questions worth 5 points each.

Group 3 Homework %																				
HW 1	HW 2	HW 3	HW 4	HW 5	HW 6	HW 7	HW 8	HW 9	HW 10	HW 11	HW 12	HW 13	HW 14	HW 15	HW 16	HW 17	HW 18	HW 19	HW 20	All HW
85	85	60	90	65	35	70	100	90	90	55	80	80	100	10	95	75	50	75	70	73
100	100	100	100	100	90	90	85	100	95	95	95	100	100	90	90	100	100	95	100	96.25
80	90	80	100	100	75	75	85	100	85	90	80	70	90	85	80	100	75	90	70	85
70	80	90	90	85	70	90	90	95	80	75	75	90	100	80	90	100	90	50	85	83.75
100	90		100		90	90	75	95	80	95	80	90	100		90	100		85	90	72.5
100	90	100	85	100	95	90	90	100	100	95	85	90	100	85	80	100	90	90	95	93
100	95	85	100	100	85	90	90	100	90	90	100	100	95	80	100	100	95	95	95	94.25
100	80	70	85	90	60	90	85	95	70	95	80	60		90	80	80		70	70	72.5
85	85	95		85	65	100	55	95	90	75	80	75	85		100	100	100		70	72
75	65	80	90	100	65		85	100	85	80	80	100	95	90		100		90	70	72.5
100	65	90	100	95	65	90	75	95	55	85	80	75	85	80	80	80	85	80	95	82.75
75	65	55	95	95	45	50	90	100	90	60	80	85	95	80	75	95	80	90	95	79.75
100		80	95	95	100		85		90	100	80	95	100	85	85	100		90	100	74

ch homework set is worth 20 points.

Effect Size differences in ACT scores among groups

	G2 vs G1	G3 vs G1	G2&3 vs G1
ACT math	20.0	15.8	18.2
ACT comp	17.9	14.9	16.7

Appendix E

Pretest

Pretest

1. (5 points) Find all y-intercepts of the equation $7y^2 + 4x = 28$.

2. (5 points) Find the equation of a line through the point (-9, 8) with slope -7/3. Finish your answer in slope-intercept form.

3. (5 points) Solve the equation $x^2 - 6x - 16 = 0$ for x.

4. (5 points) Solve the equation $-3|4 - 9x| + 1 = 7$ for x.

5. (5 points) Solve the linear inequality $7 - 5(3 - 8x) < 12$ for x. Then write the solution in interval notation.

6. (5 points) Determine whether the equation below represents a function. Justify the answer with work or explanation.

$$7x^2 + 3y = 15$$

7. (5 points) Given the functions $p(x) = 5x - 8$ and $q(x) = 6x^5$, find $(p - q)(x)$.

8. a) (5 points) Sketch the graph of the exponential function below using transformations.

$$g(x) = -4^{x-2} + 3$$

8. b) (5 points) Then state the domain, range, and asymptote of the function above.

9. (5 points) Use the Laws of Logarithms to rewrite the expression in a form with no logarithm of a product, quotient, or power.

$$\ln\left(\frac{x^5 y^8}{wz^2}\right)$$

Appendix F

Course Syllabus

Course Syllabus

Expectations: Students are expected to be respectful of themselves and others at all times, prepared for class, and responsible for absences. Approximately 1-3 hours of studying between each class is expected. Participating in class activities and discussion is also expected.
A scientific calculator is required.

Homework: Homework will be collected daily. It may be delivered early. Each homework set will be worth 20 points. Three problems will be selected from each homework set and will be graded on a 5-point scale. The other five points will be set aside for completion of the rest of the homework set. See the attached grading rubric sheet for details.

*Practice is the key to learning mathematics; students are encouraged to solve as many problems as needed to feel comfortable and confident solving each type of problem.

Quizzes: There will be 8 quizzes. Each quiz will be worth 20 points.

Exams: There will be 4 unit exams worth 100 points each, and 1 comprehensive final exam worth 200 points.

Retake Policy: All homework, quizzes, and exams may be retaken/redone. While homework and quiz scores may be replaced entirely, exam scores will be averaged.

To retake or complete a similar assignment, quiz, or exam, students must:

- Get the similar assignment, or schedule a time to retake the quiz or exam.
- Rework and/or complete the original assignment, quiz, or exam, **and**
- Turn in the completed similar retake assignment, or retake the similar quiz or exam within 1 week of the original's in-class due date, along with the completed original.

University ADA (American Disabilities Act) Statement:

[School] seeks to maintain a supportive academic environment for students with disabilities. To ensure their equal access to all educational programs, activities, and services, federal law requires that students with disabilities notify the university, provide documentation, and request reasonable accommodations. If you need accommodation in this course, please notify me so that I can verify that the required documentation is filed with the Academic Affairs Office and that your accommodation plan is in place. You should also meet with the Services for Students with Disabilities Coordinator [location]

Academic Integrity Policy:

The highest standards of academic integrity are expected of all students. Violations of academic integrity include, but are not limited to: cheating, fabrication, plagiarism, or the facilitation of such activities. Violations of academic integrity will result at least in failure of the assignment and/or course and could result in university judicial proceedings.

Grading: Grades will be assigned according to total points earned as follows:

Assessment	Points
Homework	400 (20 points each)
Quizzes	160 (20 points each)
Unit Exams	400 (100 points each)
Final Exam	200 points
TOTAL POINTS	**1160 points possible**

Letter Grade	Points Earned
A+	1120-1160
A	1050-1119
A-	1027-1049
B+	1004-1026
B	934-1003
B-	911-933
C+	888-910
C	818-887
C-	795-817
D+	772-794
D	702-771
D-	679-701
F	0-678

Absences: It is the student's responsibility to turn in homework, take quizzes, and take exams on or before the due date, and to politely arrange a time with the instructor to do so. Students who fall ill or must dash home for emergencies, etc. must contact me *by the end of the exam day* (as soon as possible) to be eligible to reschedule an exam. Students should provide a copy of appropriate emergency documentation to include in course records, if involved students plan to make up missed work. Missed homework and quizzes will be recorded as a zero for the original work, and may be completed, along with an additional similar homework set or quiz, to replace the score.