

QUASI-EXPERIMENTAL RETROSPECTIVE STUDY: EFFECTS OF FORMAL  
MATH STUDY SKILLS INSTRUCTION ON REMEDIAL COLLEGE MATH  
ACHIEVEMENT

by

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

UNIVERSITY OF PHOENIX

November 2007

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## ABSTRACT

The problem is that over 50% of entering college students must take remedial courses before qualifying for college-level courses (Hodges & Kennedy, 2004). With a quantitative, quasi-experimental, retrospective research design, it was determined whether math study skills instruction had a significant effect on remedial math student achievement. Posttest scores were significantly different among the control group with no math study skills and the experimental group with math study skills intervention. Formal math study skills instruction did not increase remedial math student achievement. In order to determine whether a formal study skills intervention significantly improves remedial math study achievement, an experimental design study with random assignment and a control group is recommended for future research, specifically examining various student demographic groups.

## DEDICATION

This dissertation is dedicated to my family. Sporty would be very proud of my achievement and Gram would worry whether I had enough sleep and enough to eat during the process. To my parents, your tireless support, encouragement, and unwavering belief in me kept me going. Sorry dad there will not be a second one. To my siblings, who reminded me, more than I would have liked, that if the degree wasn't hard everyone would have one. Finally, to my nieces and nephew, who provided me with an escape from typing by encouraging me to just stop by.

## ACKNOWLEDGMENTS

I would like to thank the following people for making a positive impact in my educational journey and for helping me reach the top of the *Dissertation Mountain*: my mentor, Dr. Kimberly Blum; my committee members, Dr. Heath Boice-Pardee, and Dr. Elizabeth Thompson.

I would also like to thank my friends and colleagues for assisting me throughout the doctoral process: Claire Berger who *anon* edited my work whenever needed; Dorothy Brown for her friendly ear over the past three years; Kelly Jackson for the statistical analysis and for patiently explaining the results to me; and Bill Mink for giving me a heads up on upcoming classes and residencies.

## TABLE OF CONTENTS

LIST OF TABLES .....	xii
CHAPTER 1: INTRODUCTION.....	1
Background of the Problem .....	1
Statement of the Problem.....	4
Purpose of the Study .....	5
Significance of the Problem.....	6
Significance to Leadership.....	6
Nature of the Study .....	7
Population and Sample .....	9
Data Analysis.....	11
Research Question .....	12
Hypothesis.....	12
Confounding Variables .....	13
Student Gender .....	13
Student Age .....	14
Student Ethnicity .....	14
Level of Student Motivation.....	14
Level of Math Intelligence.....	15
Intervening or Moderating Variable .....	15
Dependent and Independent Variables .....	16
Theoretical Framework.....	16
Definition of Terms.....	19

Assumptions.....	21
Limitations .....	21
Delimitations.....	21
Summary .....	21
CHAPTER 2: REVIEW OF THE LITERATURE .....	23
Title Searches, Articles, Research Documents, and Journals .....	23
History of Primary and Secondary Math Education .....	24
The Early Republic .....	24
The World Stage .....	26
The Cold War .....	29
Back to Basics: A Prelude to Standards .....	32
Current Primary and Secondary Math Education .....	35
History of Post-secondary Math Education .....	37
Current Remedial College Math Education.....	40
College Success and Study Skills Courses .....	42
General Study Skills Course .....	43
Math Study Skills .....	44
Gaps in Math Education Research Literature .....	46
Summary .....	46
Conclusion .....	47
CHAPTER 3: METHOD .....	48
Research Design.....	48
Appropriateness of Design.....	48

Research Questions.....	50
Population .....	50
Informed Consent.....	51
Sampling Frame .....	52
Confidentiality .....	52
Geographic Location.....	52
Instrumentation .....	52
Data Collection .....	53
Data Analysis .....	54
Validity and Reliability.....	55
Summary .....	56
Conclusion .....	57
CHAPTER 4: RESULTS.....	58
Hypothesis Test Results.....	62
Summary of Findings.....	63
Conclusion .....	64
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS .....	65
Delimitations.....	67
Implications for Leadership .....	69
Future Recommendations .....	73
Summary .....	74
Conclusion .....	75
REFERENCES .....	77

APPENDIX A: MATH FUNDAMENTALS FIRST DAY VERIFICATION  
TEST ..... 90  
APPENDIX B: MATH FUNDAMENTAL – FINAL EXAM ..... 93  
APPENDIX C: SIGNED INFORMED CONSENT: PERMISSION TO USE  
PREMISES ..... 109

## LIST OF TABLES

Table 1 <i>Descriptive Statistics: Pretest</i> .....	60
Table 2 <i>Descriptive Statistics: Posttest</i> .....	63

## CHAPTER 1: INTRODUCTION

With increasing numbers of students not adequately prepared to take college-level math, many college leaders are compelled to rethink current course offerings and modes of instruction (Hortencia, 2003; Jackson, 2004). Math courses are the remediation courses students take most often (Cox, Friesner, & Khayum, 2003). When asked how the public school system could better prepare students for college, nearly 60% of college students surveyed stated that study skills and critical thinking skills should be incorporated in the curriculum (Thompson & Joshua-Shearer, 2002). Cole, Goetz, and Willson (2000) found that 81% of higher education institutions offered various types of college preparedness courses. Often referred to as College Success or University 101, the various college success courses attempt to support under-prepared students to become self-directed learners, especially in affective and cognitive areas of motivation, organization, test-taking and note-taking skills, and time management (Cole et al., 2000).

The purpose of the research study was to determine whether formal math study skills instruction within the college math classroom had a significant effect on subsequent remedial math student achievement scores. Chapter 1 addresses the problem of freshman higher education students entering college without the skills necessary to take college level math without remedial courses (Jacobson, 2004). The theoretical framework for the study and the nature of the study are discussed.

### Background of the Problem

The ACT, formerly known as the American College Testing Program, emerged in 1959 with the two main goals of providing colleges with information regarding student admittance and success and offering assistance to students about colleges and possible

programs of study (ACT, 2004b). The vision of the ACT is to “be the world's leading provider of information for educational and career decisions in support of lifelong learning” (ACT, 2004b, ¶ 4). The ACT reported a 10th of a point increase in the 2004 scores; tests are scored from 1 to 36. Although a 10th of a point is considered a significant increase, the results revealed that 6 out of 10 graduating seniors were not prepared to take college-level math courses (ACT, 2004b).

The Chronicle of Higher Education (Kuo, Hagie, & Miller, 2004) predicted the number of students entering college by the year 2012 would increase by 3 million, bringing the total to 18 million students. The number of students entering college who require remedial instruction continues to increase as well (Rochford, 2004). In 1996, the Department of Education reported that over 40% of community college students needed at least one or more remedial courses (Kozeracki, 2002).

Rochford (2004) approximated the number of incoming freshman needing remediation at 60% (2004). Based on these numbers, many college leaders are compelled to rethink current course offerings and modes of instruction (Hortencia, 2003). The National Center for Education Statistics (NCES) 2001 Report stated that 80% of 2-year colleges and over 70% of all 4-year institutions offered basic skills or remediation courses (Young & Ley, 2005). Brothen and Wambach (2004) updated the findings and reported that 78% of all colleges and universities and 100% of community colleges offered remedial education.

Camden County College (CCC) in Blackwood, New Jersey, is a community college offering remedial education (Jackson, 2004). CCC has a separate Academic Skills Math department to accommodate the large number of remedial math students,

approximately 5000 each year (Jackson, 2004). The Academic Skills Math department offers over 250 sections of the two remedial math courses that are Math Fundamentals and Elementary Algebra (Jackson, 2004). All matriculated freshmen who have not taken or received at least a 530 on the Scholastic Aptitude Test (SAT) are required to take the Accuplacer examination (Jackson, 2004).

The 2003 Academic Program Review, completed by the Academic Skills Math department at CCC in 2004, reported that of the students taking the Accuplacer examination, only 12% tested high enough to directly enter college-level math (Jackson, 2004). Of the 88% who were placed in a remedial math course, 28% tested into Elementary Algebra, and 60% tested into Math Fundamentals (Jackson, 2004). A first-day verification test is offered in all remedial math courses to verify correct placement. In 2004, only 0.5% of the students passed the verification test and moved to the next course level (Jackson, 2004). Students passing the verification test were tracked into the next level math course and were found to “have a higher passing rate than the mean for that level” (Jackson, 2004, p. 34). There is currently no formal math study skills instruction provided in either remedial math course at Camden County College (Jackson, 2004).

Math courses are the remediation courses taken most often (Cox, Friesner, & Khayum, 2003). On a survey given to 156 participants in southern California, over half the participants declared math was the most difficult subject in high school (Thompson & Joshua-Shearer, 2002). Thompson and Joshua-Shearer, when conducting the survey, sought to provide insights on what students thought would improve the quality of a college education, and the authors obtained feedback regarding students’ high school experience. When asked how the public school system could better prepare students for

college, nearly 60% of the students surveyed wished study skills and critical thinking skills were taught (Thompson & Joshua-Shearer, 2002).

Many studies have been conducted that measured student study habits and success in college (White, 2004). One particular study reported study skills and learning styles were good predictors of college success (Sedlacek, 2005). Nolting (2002) found that study skills could be taught and that a student's lack of success in previous math courses could be attributed to the lack of study skills instruction.

Nolting (2002) believed that most students do not know how to study math because they have never been taught how to master study skills. Shearn and Wilding concurred with Nolting's findings and speculated that the lack of success and confidence many students experienced could be attributed to poor math study skills (2000). Smith (1998) confidently asserted, "My experience suggests that by implementing more effective study techniques, *all* students are capable of improving their achievement in mathematics courses" (p. xv). The current research study described an association between formal math study skills instruction and successful completion of remedial mathematics courses at Camden County College. A quantitative, quasi-experimental, retrospective research design method was used to determine whether there was a relationship between success in remedial math courses and formal math study skills instruction.

#### Statement of the Problem

The curriculum-based American College Testing (ACT) Assessment reported that, of the 1.2 million graduating seniors taking the ACT test in 2004, only 22% achieved scores high enough to be considered prepared to take college-level math

(ACT, 2004a). The problem is that over 50% of entering college students must take remedial courses before qualifying for college-level courses (Hodges & Kennedy, 2004). The current study took place at Camden County College in Blackwood, New Jersey. With a quantitative, quasi-experimental, retrospective research design, it was determined whether formal math study skills instruction had a significant effect on remedial math student achievement scores. The study involved comparing the results of the total population of students who had no formal math study skills intervention (i.e., the control group) and the total population of students who had formal math study skills intervention (i.e., the experimental group).

The archival class pretest (see Appendix A) and posttest (see Appendix B) scores of the formal math study population in Math Fundamentals remedial math classes were also compared. An independent *t* test was used to compare posttest scores between groups. The pretest was used to ensure that the two groups were equivalent before data collection.

#### Purpose of the Study

The purpose of the quantitative, quasi-experimental, retrospective research was to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores by comparing the results of the total population of 46 control students who had no formal math study skills intervention and the total population of 44 students who had formal math study skills intervention. Archival class posttest scores in the Math Fundamentals remedial math courses were compared for the control and experimental groups. The study took place at Camden County College in Blackwood, New Jersey.

### Significance of the Problem

Higher education institutions, specifically Camden County College, might benefit from the study since the primary purpose of most colleges and universities is teaching (Wolf, Bender, Beitz, Wieland, & Vito, 2004). The mission of Camden County College is to provide students with an academically excellent education (Camden County College, 2003). Camden County College leaders and teachers strive to provide students with the tools necessary to become successful and continuous learners.

The Academic Skills Mathematics Department at Camden County College endeavors to fulfill the following mission statement: “The philosophy . . . is based on our belief that all students should have the opportunity to prepare for the study of college level mathematics in an *environment that is sensitive and responsive to individual needs*” (Jackson, 2004, p. 2). The outcome of the study can help determine students’ individual needs. The study is significant for the leadership at Camden County College since leaders at Camden County College need to know what to include in the current Math Fundamentals curriculum to support student success.

### Significance to Leadership

The results of the study present thorough, useful information to educational leaders and academics on effective formal math study skills instruction for remedial math educators. The significance of the results of the current study regarding the effects of formal math study skills instruction on student achievement is twofold. Leaders in education depend on research to direct successful decision-making and to justify effective current instructional practices (Research Center, 2006). College professors need specific

standards and a sound basis to initiate changes in the current delivery practices of remedial math instruction (Goya, 2006).

As institutions of higher education continue to offer remedial math courses to an increasing number of students who need these courses, leaders focus on the quality of instruction provided to students (Brothen & Wambach, 2004). Academic deans and college administrators must be willing to “make choices and decisions that will advance and maximize the students' chances for success” (Soney, 2004, ¶ 16) even while seeking to adapt to and survive the changing college environment. Although leaders in higher education cannot be individually held responsible for each student’s achievement, they are charged with creating an environment where students’ goals can be realized (Laufgraben, 2005). Knowledge and appreciation of the current research findings might help foster situations that promote student success (Jonassen & Jonassen, 2004).

#### Nature of the Study

A quantitative, quasi-experimental, retrospective research design was used to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores. The results of a control group who had no formal math study skills intervention and an experimental group of students who had a formal math study skills intervention were compared. The total population of 90 students enrolled in Math Fundamentals remedial classes at Camden County College in Blackwood, New Jersey. Professor Jackson (2004), Department Chair for the Academic Skills Math Department at Camden County College, reported that, each spring semester, there are approximately 700 students who require Math Fundamentals.

As opposed to quantitative approaches, qualitative research is typically used when the variables are uncertain and some exploration is needed (Creswell, 2005). Qualitative studies nearly always involve face-to-face interviews or surveys (Walonick, 2004). Data in a qualitative study are recorded using words or phrases instead of the numbers typically obtained in quantitative research (Neuman, 2003). When using a qualitative research design, the outcomes include themes or extensive topics that characterize the results of the study (Creswell, 2005). “The goal of qualitative research is to develop a hypothesis--not to test one. Qualitative studies have merit in that they provide broad, general theories that can be examined in future research” (Walonick, 2004, p. 11).

Conversely, quantitative research is a methodology used to investigate trends and possible relationships between variables (Creswell, 2005). To conduct the current research, research questions were identified, data to answer the research questions were gathered, and statistical tests were performed (Creswell, 2005). When using a quantitative research design, research questions and a statement of hypothesis are required (Neuman, 2003). Through analysis of the collected data, one tests the hypothesis and answers the research questions (Neuman, 2003).

Quasi-experimental designs “approximate the conditions of the true experiment in a setting which does not allow the control and/or manipulation of all relevant variables” (Issac & Michael, 1997, p. 46). According to Neuman (2003), quasi-experimental designs “make identifying a causal relationship more certain than do preexperimental designs” (p. 247). Quasi-experimental designs, unlike classical experimental designs, allow researchers to test for a causal relationship in a variety of settings and circumstances (Neuman, 2003). Experimental research, by contrast, “determines the impact of an

intervention on an outcome for participants in a study” (Creswell, 2005, p. 591). Isaac and Michael described an experimental design as testing a possible cause-and-effect relationship between two groups, one provided with the intervention, and the other standing as control without intervention.

The use of a quantitative, quasi-experimental, retrospective research design without random assignment to treatments limited the generalizability of the findings. In order to determine whether a formal study skills intervention significantly improves remedial math study achievement, an experimental design study with random assignment and a control group is recommended for future research. The recommended focus of future research includes examining whether formal math study skills instruction is more successful with various student demographics such as age, gender, socio-economic status, full-time as opposed to part-time students, and traditional as opposed to non-traditional students. For the current study, quantitative archival data were available, and a quantitative quasi-experimental statistical analysis was performed in order to identify potential significant differences in the mean scores between groups receiving only math instruction and groups receiving math instruction and formal math study skills (Creswell, 2005; Neuman, 2003).

#### *Population and Sample*

The total population of 90 students enrolled in four Math Fundamental classes was divided into two groups. One group included 46 students who received only math instruction, and the other group included 44 students who received math instruction and formal math study skills instruction. The formula utilized to determine the appropriate sample size was  $n = (zs/e)^2$ , where  $s$  = standard deviation and  $e$  = margin of error.

Therefore, when  $n = (1.96 \times 5 / 2)^2$ , the sample size was 24. With a confidence level of 95% and a standard deviation of 5 from previous final examinations given in the course, the margin of error was 2, a sample mean accurate to within 2 units of the population mean for the accuracy level needed. A smaller sample size would have provided a larger error and a larger sample would have provided a smaller error. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group.

The remedial math courses at Camden County College have a maximum class size of 23 students (Jackson, 2004). A typical Math Fundamental remedial class has a retention rate near 60% (Jackson, 2004). A total of 4 classes were studied in order to obtain the sample size of 24. Two classes, a total of 46 students, received only math instruction and 2 classes, a total of 44 students, received math instruction as well as formal math study skills instruction. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group.

#### *Data Collection*

Pretesting and posttesting students in each section generated some of the data. A pretest was administered to ensure that the two groups were equivalent. The posttest was the department examination that included 40 multiple-choice questions and was administered to measure whether significant differences existed in the mean scores between the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction.

### *Data Analysis*

The null hypothesis stated that the mean posttest scores were not significantly different for the control group with no intervention and the experimental group with a formal math study skills intervention. The alternate hypothesis stated the mean posttest scores were significantly different for the control group with no intervention and the experimental group with a formal math study skills intervention.

The hypotheses were tested using an independent  $t$  test to determine whether there were significant differences between groups after the intervention had taken place. The dependent variable, also known as outcome variable, was the level of remedial math skills achievement as measured by posttest scores. The independent variable was the existence or non-existence of formal math study skills instruction. The results of the test of hypothesis determined the measure of success of formal math study skills intervention.

“When investigating the difference between two unrelated or independent groups on an approximately normal dependent variable it is appropriate to choose an independent samples  $t$ -test” (Morgan et al., 2004, p. 136). There are many different types of  $t$  tests, but the independent samples  $t$  test is one of the most common (Morgan et al., 2004). An independent  $t$  test is used when the study warrants a comparison between two means of independent samples for a given variable (Morgan et al., 2004). An independent  $t$  test was conducted to measure whether significant differences existed in the mean scores of two independent sample groups on the 40-question multiple-choice department examination. The groups were a control group that received only math instruction and an experimental group that received both math instruction and formal math study skills instruction.

The posttest was a 40-question cumulative multiple-choice department examination (see Appendix B). All students placed in Math Fundamentals must pass the department examination by getting at least 24 out of 40 questions correct in order to move to the next course (Jackson, 2004). The scores of the posttest indicated whether there was any significant difference between students who received the formal math study skills intervention and those who received only math instruction.

Moderating variables, also known as intervening variables, interact with the independent and dependent variables being studied (Marsh & Hattie, 2002). In the present study, the moderating variable was the mean scores on the pretest. An independent *t* test was conducted to assess whether significant differences existed in the mean scores of two independent sample groups on the 12-question open-ended first-day verification test between the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction. The data are presented in chapter 4 in the form of results of statistical tests, tables, and charts.

#### Research Question

The following research question guided the study: “What, if any, degree of difference in student achievement occurs with students who received formal math study skills instruction when compared with a control group of posttest scores of students who did not receive formal math study skills?”

#### Hypothesis

The following hypothesis was tested:

$H_{01}$ : Mean posttest scores are not significantly different among results of a control group who had no intervention and the experimental group who had formal math study skills intervention.

$H_{a1}$ : Mean posttest scores are significantly different among results of a control group who had no intervention and the experimental group who had formal math study skills intervention.

This hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups after the intervention had taken place. The results of the test of hypothesis determined the measure of success of formal math study skills intervention.

### Confounding Variables

Confounding variables are sometimes referred to as spurious variables or extraneous variables (Creswell, 2005). These variables represent characteristics or aspects of the research study that cannot be “directly measured because their effects cannot be easily separated from other variables, even though they may influence the relationship between the independent and the dependent variable” (Creswell, 2005, pp. 589-590). Possible confounding variables in the current research study were student gender, age, ethnicity, level of student motivation, and level of math intelligence.

#### *Student Gender*

Sprigler and Alsup (2003) have maintained that gender differences in math achievement are in favor of males. Results from the 2000 study completed by the National Center for Educational Statistics (NCES) indicated that the gap between male and female achievement was decreasing and in certain areas had been eradicated

("Closing the Gender Gap," 2002). Nevertheless, Ercikan, McCreith, and Lapointe (2005) stated, "Even though gender differences in mathematics education seem to be narrowing in many countries, males tend to perform higher on mathematics achievement tests and tend to take advanced level mathematics courses in secondary schools more frequently than females do" (§ 2).

#### *Student Age*

In 2003, the Chronicle of Higher Education reported traditional college students represented only 44% of current college student populations (Pope, Miklitsche, & Weigand, 2005). Results of research studies on academic achievement for non-traditional college students, age 25 and older, compared to traditional college students can vary due to accumulated life experiences and motivation (Kim, 2002).

#### *Student Ethnicity*

Educators have had concerns about academic achievement differences among ethnic groups for many years (Rabiner, Murray, Schmid, & Malone, 2004). Trusty (2002) reported evidence that ethnicity and socio-economic status (SES) had an effect on the choice of math courses and majors. Pacific Islander and Asian men chose math and science regardless of SES whereas African American and Hispanic students were more likely to take math courses in relation to the SES level (Trusty, 2002). "White men were comparatively low in choice of science and math majors. Effects of race-ethnicity were weaker for women" (Trusty, 2002, § 10).

#### *Level of Student Motivation*

Many studies have shown that there was a correlation between student achievement and the student's level of motivation (Halawah, 2006). "Intelligence is not

the only determinant of academic achievement. High motivation and engagement in learning have consistently been linked to reduced dropout rates and increased levels of student success” (Halawah, 2006, ¶ 1).

#### *Level of Math Intelligence*

The Accuplacer test places all incoming students in the math course that corresponds to their skill’s level (Jackson, 2004). The departmental pretest is a verification test administered to verify the Accuplacer results (Jackson, 2004). The department tracked the results of the verification test and found that under 0.5% were inaccurately placed with the initial Accuplacer placement (Jackson, 2004). Students passing the verification test were tracked in the next level math course and were found to “have a higher passing rate than the mean for that level” (Jackson, 2004, p. 34). Even with the verification provided by Accuplacer and the departmental pretest, the possibility existed that students in 1 of the 2 groups in the study might be more capable of grasping mathematical concepts than the students in the other group (Fish, 2002).

#### Intervening or Moderating Variable

Gratton and Jones (2003) defined a moderating variable as a “variable that affects the relationship between the independent and dependent variables” (p. 271). Moderating variables, also known as intervening variables, interact with the independent and dependent variables under study (Marsh & Hattie, 2002). In the present research, the moderating variable was the mean scores on the pretest. Since the pretest was administered initially to make the two groups equivalent, an independent  $t$  test was conducted to assess whether significant differences existed in the mean scores of two independent sample groups. The scores were obtained from the 12-question open-ended

first-day verification test taken by the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction.

#### Dependent and Independent Variables

The dependent variable, also known as outcome variable, was the level of remedial math skills achievement as measured by posttest scores. The independent variable was the existence or non-existence of formal math study skills instruction.

#### Theoretical Framework

The purpose of the research study was to examine the effectiveness of a formal math study skills intervention to increase remedial college math student achievement. The results add to the body of knowledge in remedial college math instruction. Some of the most controversial topics in education relate to math education issues (Lepage & Sockett, 2002). The framework for many teaching methods and approaches that had been developed were pushed aside once new approaches were discovered (Stotsky, 2000).

“The process of learning has been a source of amazement, fascination, and study for centuries” (Post, 1988, p. 1). The process of learning math has no less appeal and can be characterized by the cognitive and behaviorist learning theories (Post, 1988). The importance of *how* a person learns mathematics describes the cognitive view whereas the behaviorist view focuses on *what* students learn (Post, 1988).

“Behaviorism is the belief that instruction is achieved by observable, measurable, and controllable objectives set by the instructor and met by the learners who elicit a specific set of responses based upon a controlled set of stimuli” (Leonard, 2002, p. 16). Many common names are assigned to the behaviorist approach. They are (a) teacher-

centered, (b) conventional wisdom, (c) mimetic, (d) diabolic, and (e) passive and traditional (Grubb, 1999). The monotonous approach to the memorization of skills and concepts has also been referred to as *drill and kill* or the *skills approach* (Grubb, 1999). Math educators sometimes refer to this theory as *skills and drills* because of “its basic impulse to break complex practices . . . (mathematical formulation and problem solving) into component skills and then to drill on these subskills” (Grubb, 1999, p. 28).

Prominent theorists like Thorndike, Skinner, and Gagne all subscribed to the conditioning or behaviorist theories of educational psychology (Post, 1988). Gagne described the behaviorist as being concerned with what the instructor wants the student to learn (Jonassen & Jonassen, 2004). A math educator unravels the most complicated mathematical problems by breaking them into small manageable pieces (Post, 1988). The behaviorist theory is, in essence, “a belief that the whole (the desired goal) is equal to the sum of its parts (the identified component parts) . . . [thereby] teaching and learning should be very specific of goal directed” (Post, 1988, pp. 3-4). The advent of high-stakes testing encourages the use of the behaviorist theory in math education (Pogrow, 2005).

Traditional methods of teaching mathematics are entrenched in behaviorist theories and stress the memorization of formulas and mathematical algorithms (Post, 1988). Conversely, the more cognitive approach emphasizes the understanding of mathematics and the ability to communicate mathematically (Post, 1988). Piaget, Bruner, and Dienes were prominent proponents of learning theories based on cognitive psychology, an approach that was more concerned with the science of *how* students learn than with *what* students learn (Post, 1988). Post reiterated,

Cognitive psychology assumes that the whole is greater than the sum of its parts

and that the learning of large conceptual structures is more important than the mastery of large collections of isolated bits of information. Learning is thought to be more intrinsic to the individual and, therefore, intensely personal in nature. It is the meaning that each individual attaches to an experience that is important. It is generally felt that the degree of the meaning is maximized when individuals are encouraged to interact personally with various aspects of their environment. (p. 7)

Dienes, unlike Piaget and Bruner, was devoted exclusively to the learning of mathematics and math education (Post, 1988). Dienes asserted that a student's ability to understand abstract mathematical concepts was rooted in the various experiences the student had had with the concepts (Post, 1988). In the cognitive approach to teaching math, the emphasis is on teaching mathematical problems that are connected to the everyday lives of students and entail mathematical reasoning in order to solve problems (Post, 1988).

The theory of mathematics learning Dienes created is divided into four main components that are (a) the dynamic principle, (b) the perceptual variability principle, (c) the mathematical variability principle, and (d) the constructivity principle (Post, 1988). There are parallels between the Dienes' basic principles and Piaget's work (Post, 1988). The dynamic principle is based on the premise that mathematical learning is an evolutionary process that focuses on patterns and commonalities rather than isolated bits of information (Lesh, Cramer, Doerr, Post, & Zawojewski, 2003).

The second stage, perceptual variability principle, takes place when students are exposed to a skill through multiple embodiments or physical manipulatives (Lesh et al., 2003). Based on the third principle of mathematical variability, "the generalization of a

mathematical concept is enhanced when variables irrelevant to that concept are systematically very well in keeping the relevant variables constitute” (Post, 1988, p. 10). The fourth stage, the constructivity principle, concerns attempting mathematical analysis after mathematical construction (Post, 1988).

#### Definition of Terms

The following are definitions of terms and phrases specific to the current study.

*Accuplacer.* Accuplacer is a multiple-choice computer generated placement test developed by the College Board to provide students and colleges with accurate information regarding students’ level of knowledge in the areas of reading, writing, English, and mathematics (College Entrance Examination Board, 2002). All Camden County College students must take the Accuplacer examination unless they scored 530 or better on the SAT (Jackson, 2004).

*College-level math.* For the purpose of the present research study, college-level math refers to a math course that obtains college-level credits for students and is not a college remedial math course.

*First-day verification test:* In the current research study, the first-day verification test is the test with 12 open-ended questions given to students on the first day of class. It is referred to as a pretest used by the faculty at Camden County College to verify that Accuplacer placed students in the correct course.

*Math fundamentals.* Math Fundamentals is a basic math course offered at Camden County College to students who do not pass the arithmetic portion of the Accuplacer test (Jackson, 2004). Topics in Math Fundamentals include whole numbers, fractions,

decimals, ratio, rate, proportion, percent, metric and English measurement, area, perimeter, and statistical graphs (Jackson, 2004).

*Math study skills instruction.* Nolting (2005) posited that studying math was different from studying and learning other subjects. For the purpose of the present study, math study skills instruction applies to the specific study skills necessary to learn math.

*Post-secondary education.* Post-secondary education is offered to students who have completed 12<sup>th</sup> grade and are enrolled in an institution of higher education.

*Posttest.* The in the current study posttest refers the departmental final examination consisting of 40 multiple-choice question, given to all students at the end of the Math Fundamentals course (Jackson, 2004).

*Pretest.* The pretest is the 12-question open-ended test given to students on the first day of class. The pretest is referred to as a first-day verification test used by the faculty at Camden County College to verify that the Accuplacer test was accurate (Jackson, 2004).

*Primary education.* Primary education refers to kindergarten through 6<sup>th</sup> grade.

*Remedial math student.* At Camden County College, a remedial math student is a student who does not place into college-level math after taking the Accuplacer examination (Jackson, 2004). Students who do not place into college-level math are placed into Math Fundamentals or Elementary Algebra, depending on the students' scores on the Arithmetic and Algebra portion of the Accuplacer (Jackson, 2004).

*Secondary education.* Secondary education refers to 7<sup>th</sup> through 12<sup>th</sup> grade.

### Assumptions

The research study was based on three assumptions. First, students continue to enter community college unprepared to take college level math. With the current trends in enrollment and placement scores, this assumption appears reasonable. Second, students entering community colleges have received little or no formal math study skills instruction. Third, students put great efforts in taking the tests therefore their results are a valid representation of their math abilities.

### Limitations

The research study was limited by the reliability of the pretest and posttest given to the Math Fundamental students. The potential loss of students because of the option to withdraw from the course was another limitation. The generalizability, of the findings to schools outside of Camden County College and to other non-community college students such as those students directly entering 4-year schools, was limited.

### Delimitations

Only students taking Math Fundamentals at Camden County College were included in the study that focused exclusively on formal math study skills instruction and student achievement. Other colleges or other courses were not evaluated. The sample included 90 students during a 15-week spring semester.

### Summary

A specific problem has been identified in the field of mathematics education. Freshman higher education students enter 2-year community colleges in the United States without the proper skills to take college-level math before completing remedial courses (Jacobson, 2004). The quantitative, quasi-experimental, retrospective research

study was conducted at Camden County College in Blackwood, New Jersey. The design was appropriate to determine whether formal math study skills instruction had a significant effect on 90 remedial math student achievement scores. The posttest scores of remedial math students in Math Fundamentals were compared within a control group without intervention and an experimental group in which students received a formal math study skills intervention. The literature relevant to study skills and remedial math instruction is presented and summarized in chapter 2.

## CHAPTER 2: REVIEW OF THE LITERATURE

Chapter 1 presented the question of whether formal math study skills instruction had a significant effect on the achievement scores of 90 remedial math students. Pretest and posttest scores from remedial math students in Math Fundamentals were obtained at Camden County College in Blackwood, New Jersey. The results from a control group who had no intervention and an experimental group who had a formal math study skills intervention were compared. Related to the research question were the independent variable formal study skills instruction and the dependent variable of impact upon remedial math skills achievement. Chapter 2 addresses the literature pertaining to the research question, hypothesis, independent and dependent variables, and previous research methodology.

### Title Searches, Articles, Research Documents, and Journals

Large amounts of information were available on math education, remedial college math instruction, and general study skills, but previous literature did not address the possible relationship between remedial math student achievement and formal math study skills instruction. A literature review was conducted that focused on the problem statement, purpose statement, and variables. Searches were focused on the four main areas of (a) math education, (b) remedial college math instruction, (c) study skills instruction, and (d) college success courses. The keywords, phrases, and terms related to the four main topics were math achievement, remedial college math instruction, college level math readiness, formal math study skills, math theory, and basic math proficiency.

The search for significant information required the use of many resources, including peer-reviewed journals from the University of Phoenix's ProQuest database,

EBSCOhost database, Digital Dissertations, ERIC database, and InfoTrac database. Numerous online searches were conducted using search engines such as Yahoo and Google. Information was retrieved from over 39 peer-reviewed publications, and 52 books, dissertations, newspapers, and government reports were used to gather relevant information. Articles were retrieved from Questia online library, industry Web sites including American Mathematical Association of Two-Year Colleges, National Council of Mathematics Teachers, Camden County College, Education Commission of the States, National Center for Education Statistics, and the U.S. Department of Education.

### History of Primary and Secondary Math Education

After reading literacy, there is no subject that stirs controversy and is as hotly debated as mathematics education (Lepage & Sockett, 2002). Math education has been 1 of the 3 core components of education in the United States since the mid-19th century (Boutwell, 2001). Traditionally known as the three Rs of education, the inclusion of reading, writing, and arithmetic in a school's curriculum has remained unchallenged, but political, historical, and social events have radically influenced education, especially math education in the United States (Boutwell, 2001).

#### *The Early Republic*

Initially, formal education in the colonial states did not include mathematics (Furr, 1996). Education focused primarily on preparing the privileged college-bound students in the classics and on teaching them literacy (Furr, 1996). The town schools located in the Northeast originally included mathematics in the curriculum, but "Puritan influence replaced this 'non-academic,' 'skill' subject with religion and a greater emphasis on reading" (Furr, 1996, ¶ 2). Larger towns and cities with small industry and

business interests needed mechanical math skills taught in schools (Willoughby, 1967). Benjamin Franklin's influence in promoting a more utilitarian education encouraged the inclusion of arithmetic because of its real world applications and intrinsic value (Furr, 1996).

The first mathematics professor was hired at Harvard in 1726, and soon the prestigious university began requiring competence in mathematics as a prerequisite for college acceptance (Willoughby, 1967).

In response, arithmetic began to be taught in most secondary schools. It is very interesting to note that the order in which various topics in mathematics are taught in today's secondary schools is the same order in which Harvard began requiring such disciplines for entrance: arithmetic, algebra (1820), geometry (1844), and later advanced topics. (Furr, 1996, ¶ 3)

From 1800 through 1860, several states opened public schools, also known as common schools, which increased the number of students learning mathematics (National Museum of American History [NMAH], 2002). "Unfortunately, there were no previous generation of citizens trained in mathematics to be available to teach these students" (Furr, 1996, ¶ 4). Mathematics was initially taught as a series of topics to learn through rote memorization (Bidwell & Clason, 1970). Sometimes referred to as the *rule method* in which rules for a particular type of problem were modeled, students memorized the example and were drilled on the acquired knowledge (Bidwell & Clason, 1970). The focus of instruction was on memorization and students rarely understood the concepts or operations (Furr, 1996). Considered a very difficult subject to master, mathematics was rarely introduced to boys before the age of 12. Girls were never taught mathematics and

relied solely on number sense gathered from real life experiences (Furr, 1996).

Johann Pestalozzi, a Swiss educator, introduced the idea that learners would understand math better if the skills were connected to concrete objects and tangible images (NMAH, 2002). Pestalozzi's ideals were coupled with the availability of textbooks that had become less expensive and offered more reliable content (NMAH, 2002). Warren Colburn's textbook was first introduced in the United States in 1821 (Furr, 1996) and was considered one of the most influential math textbooks ever published (Bidwell & Clason, 1970).

Colburn's program was "designed to lead even very young children (5 or 6 years old) through the discovery of the concepts of numbers and operations" (Furr, 1996, ¶ 5). The discovery method was contrary to previous instruction that introduced abstract concepts followed by practice with problems (Furr, 1996). The conflicts between the two distinct schools of thought still exist (Furr, 1996). According to Furr, "The remaining history of mathematics education is, in part, an ongoing struggle for the realization of Pestalozzi's ideals of learning through understanding first" (¶ 7).

### *The World Stage*

Beginning in the 1870s, many Americans studied overseas, especially in Germany, and they uncovered new mathematical doctrines (NMAH, 2002). Eager to share the new knowledge, scholars in the field of mathematics obtained equipment specifically associated with the advances in the field in order to assist the rising number of high school students in understanding mathematics (NMAH, 2002). Around the same time, the relatively new field of psychological research began focusing on limiting the teaching of mathematics to immediately useful topics (Furr, 1996).

Research in cognitive development, headed by Hall in the 1880s, promoted “the use of manipulatives and experience” (Furr, 1996, ¶ 10) in teaching mathematics and motivating pupils. Hall recommended deferring introduction in mathematics until later years (Furr, 1996). Hall’s suggestions paralleled the post-World War I anti-intellectual sentiment in which the role of mathematics as one of the core curriculum subjects was questioned (Furr, 1996).

In the early 20<sup>th</sup> century, Kilpatrick shared many common views with Hall, mainly that “subjects [mathematics] should be taught to students based on their direct practical value, or if students independently wanted to learn those subjects” (Klein, 2003, ¶ 14). Kilpatrick, deemed by many as the nation’s most significant educational leader of the 20<sup>th</sup> century, majored in mathematics and eventually joined the faculty at Teachers College in 1911 (Klein, 2003). Kilpatrick did not consider mathematics a subject that “contributed to mental discipline” (¶ 14) and encouraged limiting mathematical content to simple utilitarian concepts (Klein, 2003). Kilpatrick believed that geometry, algebra, and other advanced topics should not be taught in primary or secondary education (Klein, 2003). In fact, Kilpatrick claimed that the thinking required for mathematics was detrimental to ordinary living and believed advanced mathematics courses were offered to too many students (Klein, 2003).

Snedden, a former Commissioner of Education for the state of Massachusetts and professor at Teachers College, agreed with Kilpatrick’s view regarding limiting access to algebra and geometry (Klein, 2003). Snedden asserted that algebra was essentially useless to over 90% of the population (Klein, 2003). Since Kilpatrick and Snedden were prominent professors at Teachers College, their opinions regarding mathematics

education were shared with more than 35,000 future educators (Klein, 2003).

In 1915, Kilpatrick was approached by the National Education Association's Commission on the Reorganization of Secondary Education and accepted the challenge to chair a committee charged with investigating the problems of teaching mathematics in secondary institutions (Klein, 2003). The committee's report authored by Kilpatrick and called *The Problem of Mathematics in Secondary Education* includes the following statement:

No longer should the force of tradition shield any subject from scrutiny. . . . In probably no study did this older doctrine of mental discipline find larger scope than in mathematics, in arithmetic to an appreciable extent; more in algebra, and most of all in geometry. (as cited in Klein, 2003, ¶ 17)

Not surprisingly, mathematicians objected to Kilpatrick's attack on mathematics and tried to block the publication of the report (Klein, 2003).

Published in 1920 by the U.S. Commissioner of Education, Philander Claxton, the report triggered vigorous opposition by mathematicians and members of the Mathematics Association of America (MAA) (Klein, 2003). The same year, the National Council of Teachers of Mathematics (NCTM) was formed in response to anti-mathematics opinion (Willoughby, 1967). In 1923, the MAA, with support from the newly formed NCTM, responded with the *Report of the National Committee on Mathematics Requirements*, which suggested a new math curriculum based on psychology research in education, math education in other countries, and successful school mathematics programs (Furr, 1996; Klein, 2003). The improved 6-3-3 curriculum included explanation for the importance of the subject and provided a framework for a variety of junior and senior

high school curricula (Furr, 1996).

“The *1923 Report* was perhaps the most comprehensive ever written on the topic of school mathematics” (Klein, 2003, ¶ 21). The 1923 report stressed the importance of mathematics, specifically algebra, to every knowledgeable citizen (Klein, 2003).

Although the 1923 report had some impact on mathematics education, Kilpatrick’s report had a stronger influence until the 1940s (Klein, 2003). In the 1940s, the army discovered that draftees knew so little about basic mathematics that the military had to begin teaching basic arithmetic so soldiers could perform simple gunnery maintenance and bookkeeping (Stotsky, 2000). As a matter of national defense, especially during World War II, the U.S. government’s interest in math education increased (Furr, 1996). By the mid 1940s, “the deficiency became even more evident when the wartime developments in radar, navigation, operations analysis, cryptology, rockets, and atomic weapons (among others) showed the extent of mathematical accomplishments needed for a modern society, at war or at peace” (Stotsky, 2000, ¶ 4).

The 1950s saw a decline in not only the number of students enrolled in advanced high school mathematics but also in general mathematics courses (Klein, 2003). Algebra enrollment dropped over 30% from 1909 until 1955 (Klein, 2003). In the 1950s, at the beginning of the Cold War and the Sputnik era, the popular progressive education of the early 1900s lost prominence (Klein, 2003).

### *The Cold War*

“About 1950 there arose the beginnings of an attempt at reform (generated by some previously indifferent mathematicians among others), an attempt that burgeoned when the Soviet Sputnik of 1957 plunged Congress into shock” (Stotsky, 2000, ¶ 4).

October 4, 1957, the date USSR launched the satellite Sputnik into space, is believed by many to be the onset of the space race between the United States and the USSR (Walmsley, 2001). Wooten expressed the consequence of Sputnik as raising questions and doubts about the math programs in the United States (as cited in Walmsley, 2001).

Public outcry and panic caused math education to be placed at the forefront of the educational debate (Walmsley, 2001). The federal government increased spending on math education and development (Walmsley, 2001). The budget of the National Science Foundation (NSF), established in 1950, increased from \$15,000,000 before Sputnik to nearly 10 times that amount after Sputnik's launch (Walmsley, 2001). The director of the NSF at the time, Waterman, compared the Sputnik predicament as a "scientific Pearl Harbor" (as cited in Walmsley, 2001, p. 33).

During this unsettling time, the public became aware of the New Math movement and was skeptical (Amit & Fried, 2002). Although much different from what parents and the general public were used to, New Math was embraced as a solution to the math crisis (Walmsley, 2001). The new curriculum referred to as New Math quickly became extremely controversial (NMAH, 2002).

The uniqueness of math education during the New Math era is credited to the active involvement of mathematicians (Furr, 1996). Hoping to train students in higher mathematics before their entrance in college, mathematicians concentrated on the importance of math education for all ages (Furr, 1996). The mathematicians' involvement, a job market requiring increased technical knowledge, and research proving that "children were capable of learning quite advanced topics at much younger ages" (Furr, 1996, ¶ 21) spurred the New Math era.

In the New Math era, educators, mathematicians, and psychologists worked together to revisit various methods of teaching math (NMAH, 2002). Reformers agreed that “students would benefit from a more abstract approach to arithmetic and algebra that incorporated more sophisticated mathematical ideas” (NMAH, 2002, ¶ 3). The New Math movement introduced new topics, but the emphasis was on new teaching techniques (Walmsley, 2001).

“Despite all the talk of radical reform, the changes amounted to shifts in emphasis” (Furr, 1996, ¶ 25). Furr identified five categorical emphasis changes in the New Math movement. First, topics were rearranged in a more logical sequence (Furr, 1996). Second, advanced mathematical ideas were presented to students at a much earlier age (Furr, 1996). Third, superfluous topics were removed in order to create time to cover new subject matters (Furr, 1996). Next, set theory (i.e., the mathematical science of the infinite) was introduced in the classroom as a unifying theme. Finally, Furr explained the New Math movement placed a “greater emphasis on formal logic, applications, and manipulatives for analytical induction” (¶ 25). Barlage believed the only *new* portion of the New Math consisted of contemporary topics presented by specialized teachers who were trained through workshops, conferences, college courses, and in-service days (Furr, 1996).

“By the early 1970s New Math was dead” (Klein, 2003, p. 35). Klein identified two main reasons for the failure of the New Math movement. The main reason was the underlying belief that all students could be taught more advanced mathematics at an earlier age and with less time (Klein, 2003). The second explanation was the unrealistic conviction that teachers could be trained in New Math overnight. Klein asserted, “The

true attempts at reform hadn't traveled very widely, and despite the incessant journalistic debates concerning New Math and its successes and failures, the great majority of students never saw more than slogans" (p. 37).

*Back to Basics: A Prelude to Standards*

The Back to Basics ideals, predominant from 1970 to 1990, took math education to where it was in the 1950s (Jones, Langrall, Thornton, & Nisbet, 2002). The child-centered progressive approach leading math education in the 1960s shifted to a more traditional approach in the 1970s (Boutwell, 2001). The experts agreed that the progressive new math initiative had caused rising school dropout rates, increases in school violence, and declining standardized test scores (Boutwell, 2001). A Back to Basics philosophy ensued (Boutwell, 2001).

In 1972, the federal government created the National Institute of Education with the intent to "conduct research towards improvement" (Stotsky, 2000, p. 38). The Back to Basics movement continued when the National Council of Mathematics Teachers (NCTM) published *An Agenda for Action* in 1980 (Stotsky, 2000). The brief report urged educators to have problem solving as the main focus of math education (Stotsky, 2000). Still without contributions from mathematicians, the report was similar to reports published in the 1950s other than the mention of the importance of computers and calculators as "tool[s] for the future" (Stotsky, 2000, p. 39). The NCTM's report "did not portray mathematics in any way as an intellectual adventure, or as a preparation for scientific studies, or as a thing of beauty" (Stotsky, 2000, p. 39).

The decade following NCTM's 1980 publication of *An Agenda for Action*, the NCTM created numerous committees charged with satisfying the specifics of math

education (Stotsky, 2000). The work of the committees culminated in 1989 with the release of the first of three documents, the *Curriculum and Evaluation Standards for School Mathematics* (Stotsky, 2000). Often referred to as the NCTM standards, the first volume spurred the National Science Foundation to financially support a similar study, which resulted in each state compiling a similar set of standards. Many states already had standards in place, but with the 1980s federal legislation, many states adopted the NCTM standards or adapted a shorter version of the standards to meet the particular needs of the individual state (Stotsky, 2000).

The Agenda, as well as *A Nation at Risk*, created the backdrop for the encroachment of national standards on state standards (Klein, 2003). In August 1981, Secretary of Education T. H. Bell formed the National Commission on Excellence in Education (National Commission on Excellence in Education [NCEE], 1983). The committee was given 18 months to make a report to the nation regarding the quality of education in the United States (NCEE, 1983). The report referred to mathematics 10 times and made recommendations regarding the status of math education (NCEE, 1983). First, the report recommended that students be obligated to take at least 3 years of high school mathematics as a requirement for graduation (NCEE, 1983). Next, the report suggested that high school mathematics would enable students to

(a) understand geometric and algebraic concepts; (b) understand elementary probability and statistics; (c) apply mathematics in everyday situations; and (d) estimate, approximate, measure, and test the accuracy of their calculations. In addition to the traditional sequence of studies available for college-bound students, new, equally demanding mathematics curricula need to be developed for

those who do not plan to continue their formal education immediately. (NCEE, 1983, Recommendations, ¶ 8)

The report encouraged the work of professional groups to continue to update and make available innovative curricula (NCEE, 1983). Finally, the shortage of mathematic teachers was addressed (NCEE, 1983).

The NCTM standards and the *Nation at Risk* report published in 1983 triggered a domino effect of change in education (Boutwell, 2001). In 1989, President Bush hosted an Educational Summit for the governors of all 50 states (Boutwell, 2001). The goal of the summit was “to establish a set of national educational goals and to reallocate educational policy responsibilities among the federal, state, and local governments” (as cited in Boutwell, 2001, ¶ 26). Following the work of the summit, President Clinton endorsed the Goals 2000: Educate America Act (Boutwell, 2001).

Goals 2000 created a standard for elementary and secondary education in the United States (Odland, 1993). Six educational goals were identified in the act, and 2 of the 6 goals specifically mentioned math education (Odland, 1993). Goal 3 required students leaving grades 4, 8, and 12 to be proficient in “English, mathematics, science, history and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning and productive employment in our modern economy” (Odland, 1993, p. 32). Goal 4 compelled U.S. students to be ranked first in the world in math and science achievement (Odland, 1993).

George W. Bush’s *No Child Left Behind Act of 2001* followed President Clinton’s Goals 2000 (Books, 2004). George W. Bush’s policy, No Child Left Behind, was the

most ambitious federal guideline for education in decades (Finn & Hess, 2004). In signing the No Child Left Behind Act of 2001, George W. Bush confidently affirmed,

Today begins a new era, a new time for public education in our country. Our schools will have higher expectations—we believe every child can learn. From this day forward, all students will have a better chance to learn, to excel, and to live out their dreams. (Committee on Education and the Workforce, 2002, ¶ 3)

### Current Primary and Secondary Math Education

George W. Bush’s policy, No Child Left Behind (NCLB), is the most ambitious federal guideline for education (Finn & Hess, 2004). One major aspects of NCLB that directly affects mathematics education is the new guideline for teacher preparation programs (Riddle, 2003). The No Child Left Behind Act declares that all public school teachers who teach core academic subjects will be *highly qualified* by the end of the 2005 – 2006 school year (Riddle, 2003).

In his report to Congress, Secretary of Education Rod Paige stated, “Schools of education and formal teacher training programs are failing to produce the types of highly qualified teachers that the No Child Left Behind Act demands” (U.S. Department of Education, 2002, p. viii). The report declared that states must revamp teacher preparation and certification requirements because the current academic standards were too low (Cochran-Smith, 2002). Preparing highly qualified teachers of mathematics is necessary to meet the mandates proposed by NCLB (Bybee & Stage, 2005).

Accountability and testing are not new ideas in education (Bybee & Stage, 2005), but the No Child Left Behind Act has given testing and accountability renewed importance (Charp, 2003). Connecting student achievement through high-stakes testing

as a measure of effective instructional practices is daunting yet necessary (Bybee & Stage, 2005). Chappard stated, “Standardized testing has eliminated many innovative approaches to learning, as teachers teach to the test--knowing that their careers, as well as those of their principals and superintendents, depend on good scores” (p. 8). The dilemma widens with mathematics education because not only do students need to know the operational facts but must also be accomplished problem solvers (Horn, 2004)

The National Council of Teachers of Mathematics (NCTM) led the professional mathematics associations in providing standards to assist school districts implement quality mathematics education programs (Anhalt, Ward, & Vinson, 2004). “The NCTM has long sought to improve and strengthen preK-12 mathematics curricula through the creation of rigorous and substantive standards documents, including those related to teaching, content, and assessment (as well as others)” (Anhalt et al., 2004, p. 58). The organization published *Principles and Standards for School Mathematics* in 2000 (Anhalt et al., 2004). The principles, in conjunction with local and state standards, offered a solid framework for current math education strategies (Anhalt et al., 2004).

*Principles and Standards for School Mathematics* provided six overall themes referred to as principles. The six principles are equity, curriculum, teaching, learning assessment, and technology (NCTM, 2000). Along with the six principles, the 2000 document offered numerous standards described as follows:

The Standards for school mathematics describe the mathematical understanding, knowledge, and skills that students should acquire from prekindergarten through grade 12. Each Standard consists of two to four specific goals that apply across all the grades. For the five Content Standards, each goal encompasses as many as

seven specific expectations for the four grade bands considered in Principles and Standards: prekindergarten through grade 2, grades 3–5, grades 6–8, and grades 9–12. For each of the five Process Standards, the goals are described through examples that demonstrate what the Standard should look like in a grade band and what the teacher's role should be in achieving the Standard. Although each of these Standards applies to all grades, the relative emphasis on particular Standards will vary across the grade bands. (NCTM, 2000, Standards, ¶ 1)

Although criticized for not providing specific mastery requirements, claims outlined in NCLB were that the standards would provide a vision for current mathematics education (Clements, Sarama, & Dibiase, 2003). The overarching vision supported the goals outlined by the federal NCLB Act (Mabry, 2004). The federal government's interest in improving school performance was grounded in wanting to maintain the nation's worldwide competitive edge (Stimson, 2003). "Currently, most educators and parents know little more about education in other countries than 'we are not number one in mathematics and science'" (Stewart & Kagan, 2005, p. 241). The elaborate No Child Left Behind document showed the desire to lessen the perceived gap between the United States and other industrialized nations (Anhalt et al., 2004).

#### History of Post-secondary Math Education

"The history of higher education in the United States has been fraught with continual change" (Brown, 2001, p. 1). Changes included modes of instruction, curricular changes, student access, and the varying types of institutions (Brown, 2001). The over 350-year history of higher education in the United States started with the founding of Harvard University in 1636 and continued with the opening of virtual universities at the

end of the 20th century (Brown, 2001). Innovative programs have been put in place to meet the demands of the ever-changing student population (Brown, 2001).

In 1726, Harvard University hired the first mathematics professor (Willoughby, 1967). The prestigious university immediately began requiring competence in mathematics as a prerequisite for college acceptance (Willoughby, 1967). Since Harvard was primarily established to train the clergy, the focus of the curriculum was Latin and Greek. Nevertheless, the first mathematical thesis was presented in 1693 (Smith, 1934).

In 1692, William and Mary College was founded in Williamsburg, Virginia (Smith, 1934). As at Harvard, little or no attention was paid to the teaching of mathematics at William and Mary College (Smith, 1934). “Thus the encouragement to mathematics given by the colonial governments in the seventeenth century amounted to nothing, and the achievements in the colleges were of no moment” (Smith, 1934, p. 10). The main progress in math education during the colonial era was due to individuals pursuing interests in astronomy and almanac creation (Smith, 1934).

The interest in math education during the 18th century was slight (Smith, 1934). By 1776, there were nine colleges in the United States, and mathematics instruction was combined with the study of astronomy and physics (Smith, 1934). “Modern mathematics was substantially unknown in America in the eighteenth century, but that questionable manners then and later existed both in the Mother Country and in her offspring” (Smith, 1934, p. 64). Smith further explained,

The first three centuries of our history were, as we have seen, barren of achievement in the domain of mathematics. The first half of the nineteenth century was a time of preparation for action. The third quarter closed with

evidence that a period of awakening was at hand. The last quarter saw the beginning of the period which, in the first third of the twentieth century, placed the mathematics of the New World in a more favorable position than had been anticipated either in Europe or in America. (p. 65)

In the early to mid 1800s, tremendous growth in the number of small religion-based colleges was evident. The purpose of the colleges was to train clergymen and educate men regarding the doctrine of the particular denomination (Smith, 1934). Even though there was still a limited acceptance of an all-inclusive liberal education, the importance of math education started gaining some acceptance (Smith, 1934). Many mathematics professors were little more than missionaries with a zeal to teach; instruction continued to be incorporated with physics and astronomy education (Smith, 1934). Math requirements for college entrance were little more than basic arithmetic (Smith, 1934).

During college, students progressed through algebra, geometry, trigonometry, surveying, mensuration, and navigation in order to reach the desired higher level of study in astronomy (Smith, 1934). The last 25 years of the 19th century spurred many changes in post-secondary math education (Smith, 1934). The American Mathematics Society (AMS) was created in 1888 with a core of 6 interested members and was fully established in 1894 (Smith, 1934). The AMS was the parent organization that encouraged the growth of other professional math organizations such as the Mathematical Association of America and the National Council of Mathematics Teachers (Smith, 1934).

Gumport and Snyderman (2002) agreed that changes in the academic programs at institutes were ongoing, yet the composition and structure of the changes were rarely analyzed and recorded in professional literature. Gabler and Frank (2005) studied the

evolving academic priorities of higher education in the field of social sciences, including mathematics education. By means of data collected from 1915 through 1995, Gabler and Frank showed that some fields of study, mathematics included, “performed much more robustly” (p. 183) than other disciplines within the social sciences.

In the early 1900s, mathematics was given great importance in the academic universe, and it has been taught continuously in colleges and universities since then (Gabler & Frank, 2005). Mathematics provides the basic logical and abstract thinking necessary to study other areas in the social sciences such as astronomy, chemistry, biology, and physics (Gabler & Frank, 2005). As a prerequisite, “mathematics has found itself much freer to shed its emphasis on great thinkers of the past than has philosophy; accordingly, mathematics is seen as being more readily applicable to a broad variety of disciplines in the modern university” (Gabler & Frank, 2005, p. 203).

#### *Current Remedial College Math Education*

Higher education became an official part of the field of education in 1636 at Harvard with math instruction following nearly a 100 years later, in 1726 (Willoughby, 1967). Originally designed to serve a homogeneous group of elite white males, institutions of higher education serve a very different student population at the beginning of the 21<sup>st</sup> century (Phelps & Evans, 2006). Colleges students are a heterogeneous group, not only with regards to race, gender, and class but also academic ability and readiness (Phelps & Evans, 2006).

The ACT, formerly known as the American College Testing Program, was established in 1959 with the two main purposes of providing colleges with information regarding student admittance and success and offering assistance to students about

colleges and possible programs of study (ACT, 2004b). The vision of the ACT is to “be the world’s leading provider of information for educational and career decisions in support of lifelong learning” (ACT, 2004b, ¶ 4). ACT reported a 10th of a point increase in 2004 scores; tests are score from a 1 to 36. Although statistically considered a significant increase, the results revealed that 6 out of 10 graduating seniors were not prepared to take college level math courses (ACT, 2004b).

The Chronicle of Education (Kuo et al., 2004) predicted the number of students entering college by the year 2012 would increase by 3 million, bringing the total to 18 million. The number of students who require remedial instruction upon entering college continues to increase as well (Rochford, 2004). In 1996, the Department of Education reported that over 40% of community college students needed at least one or more remedial courses (Kozeracki, 2002). Rochford approximated the number of incoming freshman needing remediation at approximately 60%.

With these large and increasing percentages, many college leaders are compelled to rethink current course offerings and modes of instruction (Hortencia, 2003). The National Center for Education Statistics (NCES) 2001 report stated that 80% of 2-year colleges and over 70% of all 4-year institutions offered basic skills or remediation courses (Young & Ley, 2005). Brothen and Wambach updated the findings in the 2004 article and posited that 78% of all colleges and universities and 100% of community colleges offered remedial education.

Camden County College (CCC) in Blackwood, New Jersey, is a community college that offers remedial education (Jackson, 2004). CCC has a separate Academic Skills Math Department to accommodate the large number of remedial math students,

approximately 5000 a year (Jackson, 2004). The Academic Skills Math department offers over 250 sections of the two remedial math courses, Math Fundamentals and Elementary Algebra (Jackson, 2004). All matriculated freshmen who have not taken or received a 530 or better on the SAT are required to take the Accuplacer examination (Jackson, 2004).

The 2003 Academic Program Review at CCC, completed by the department in 2004, reported that, of the students taking the examination, only 12% tested directly into college level math, 28% test into Elementary Algebra, 60% into Math Fundamentals, and 88% were placed in a remedial math course (Jackson, 2004). Jackson reported a first day verification test is offered in all remedial math courses to verify correct placement. Only 0.5% of students passed the verification test and moved to the next course (Jackson, 2004). Students passing the verification test were tracked into the next level math course and were found to “have a higher passing rate than the mean for that level” (Jackson, 2004, p. 34). There is no formal study skills instruction provided currently in either remedial math course (Jackson, 2004).

#### College Success and Study Skills Courses

Effective study skills are paramount to success in college (White, 2004). Moses (2006) reported that 62% of college freshman devoted fewer than 15 hours during the week to studying. “A great deal of difficulty youngsters experience in college could be averted by programs that instill good work habits, study skills, self-regulation and organization” (Moses, 2006, ¶ 42).

More than ever before, students must learn appropriate time management and study skills (Lambert & Nowacek, 2006). Teachers often assume that students come to

class armed with the essential study skills needed to be successful (Lambert & Nowacek, 2006). Unfortunately, few students come to class with essential study skills. Teachers must “incorporate these study skills in their instruction so all students . . . [can] acquire these necessary skills” (Lambert & Nowacek, 2006, ¶ 1).

Many studies have been conducted that measured student study habits and success in college courses (White, 2004). Gettinger and Seibert (2002) asserted that academic proficiency paralleled the understanding and use of effective study skills. Good study habits have been found not only to improve academic performance but also students’ overall confidence as learners (Gettinger & Seibert, 2002). Amenkhienan and Kogan (2004) equated student achievement with the student’s level of persistence, which parallels effective work habits and study skills.

White (2004) claimed good study skills caused students to “tend to approach their schoolwork with a positive attitude, rather than a negative and anxious one; whereas, students with poor study skills tend to assume a passive role in learning and rely on others” (¶ 15). Hoover and Patton maintained the process of studying encompassed note taking, organizing, amalgamating, recalling, and applying the information (as cited in White, 2004). Although instructors can teach such skills, students must be motivated to learn study skills, recognize the need to study, and have a study plan (White, 2004).

#### General Study Skills Course

Study skills and learning styles are good predictors of college success (Sedlacek, 2005). Good study habits “are essential to educational success” (Fishman, 2006, ¶ 1). Unfortunately, many students do not possess strong study habits (Rauschart, 2003). Fallon-Marinelli, a faculty member at University of Maryland stated, “Our students are

very bright, but they haven't learned to study" (as cited in Rauschart, 2003, ¶ 10). Most colleges and universities attempt to improve student college readiness by mandating a college success or study skills course (Simpson & Rush, 2003). Cole et al. found 81% of higher education institutions offered college preparedness courses (2000).

Southeastern University offers a Survival Skills for College course to first-semester or at-risk students (Commander & Valeri-Gold, 2003). The learning strategies taught incorporate overall study skills strategies such as time management, concentration, memorization, test taking, note taking, and comprehension (Commander & Valeri-Gold, 2003). The course assists college freshmen with the transition from high school to college and provides tips for college success but has no specific focus on math (Commander & Valeri-Gold, 2003).

Other courses, sometimes referred to as University 101 or Freshmen Seminar, focus on training and supporting under-prepared students to become self-directed learners, especially in the affective and cognitive areas of motivation, organization, test taking, note taking skills, and time management (Cole et al., 2000). Although well intentioned, the effectiveness of the various University 101 courses is often questioned (Bender, 2001). The fact that "general instruction in study skills may not transfer would argue for approaches that provide for the direct transfer of skills to course content through assistance in closely related material, in addition to attempting to change habits and behaviors" (Bender, 2001, p. 209).

### *Math Study Skills*

Several effective study techniques and approaches are available (White, 2004). In 1941, the SQ3R technique was created and is now widely used and accepted (White,

2004). SQ3R is an acronym that can be easily taught to students where the S represents survey, the Q represents question, and the 3 Rs represent read, recite, and review (White, 2004). The SQ3R approach helps students organize large quantities of written information (White, 2004). Since math does not have a large written requirement, the SQ3R is not useful for math (White, 2004).

“Studying and learning math is different from most other courses” (Nolting, 2002, p. xi). Math courses are the remediation classes taken most often (Cox et al., 2003). On a survey given to 156 participants in southern California, over half the participants declared math was their most difficult subject in high school (Thompson & Joshua-Shearer, 2002). The purpose of the survey was to provide insights on what students thought would improve the quality of their college education and obtain feedback regarding students’ high school experience. When asked how the public school system could better prepare students for college, nearly 60% said study skills and critical thinking skills should be taught (Thompson & Joshua-Shearer, 2002).

Nolting (2002), the author of *Winning at Math: Your Guide to Learning Mathematics through Successful Study Skills*, posited that study skills could be taught and that a student’s lack of success in previous math courses could be attributed to the lack of study skills instruction. Nolting claimed that most students did not know how to study math because they had never been taught. Shearn and Wilding concurred with Nolting’s findings and speculated that the lack of success and confidence many students experienced could be attributed to poor math study skills (2000). In *Mastering Math: How to Be a Great Math Student*, Smith (1998) confidently asserted, “My experience

suggests that by implementing more effective study techniques, *all* students are capable of improving their achievement in mathematics courses” (p. xv).

For most subjects other than math, students can pass a course by being able to peruse, comprehend, and recollect information (Nolting, 2005). Nolting asserted that unique study approaches were needed for mathematics because it is a unique subject. The additional step required to pass a math course is that students must be able to apply the information in order to solve a problem (Nolting, 2002). Nolting (2002) advised students, “Learning general study skills can help you pass most of your courses, but special math study skills are needed to help you learn more and get better grades in math” (p. 7).

#### Gaps in Math Education Research Literature

“The real challenge in producing change lies both in articulating problems and posing theoretical solutions, and in providing the means by which the change can be implemented” (Lepage & Sockett, 2002, ¶ 1). A large amount of information is available on mathematics education, college remedial mathematics education, and study skills, but it does not address the relationship between the effects of formal math study skills instruction on remedial math achievement.

#### Summary

The purpose of the current research was to measure quantitatively potential correlations between formal study skill instruction and successful completion of remedial mathematics courses at Camden County College. A quantitative quasi-experimental design method was used to determine whether there was any relationship between success in remedial math courses and study skills instruction.

## Conclusion

Chapter 1 offered insight into remedial math courses and how formal study skills instruction might be critical to improving student achievement. Included were the purpose of the study and the background of the problem. Chapter 2 provided literature findings on the subjects of remedial math courses, math achievement, and study skills instruction.

Based on the literature reviewed, the need for the present study was established. There is a lack of information on the relationship between formal math study skills instruction and the effect on student achievement in remedial math courses. Chapter 3 includes the rationale for the use of the chosen research design with a discussion of the appropriateness of the design to discover the crucial factors in realizing improved remedial math student achievement.

## CHAPTER 3: METHOD

The purpose of the study, carried out with a quantitative, quasi-experimental, retrospective research design, was to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores. The method included comparing the results of the total population of 46 control students who had no formal math study skills intervention and the total population of 44 students who had formal math study skills intervention. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group. Archival class posttest scores in the Math Fundamentals remedial math courses were compared to the scores of a control group and the group that had formal math study skills instruction at Camden County College in Blackwood, New Jersey.

### Research Design

The purpose of the study was to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores. At Camden County College in Blackwood, New Jersey, the total population of 90 students in Math Fundamentals remedial classes was given a pretest and a posttest. The scores from a control group who had no formal math study skills intervention and an experimental group of students who had formal math study skills intervention were compared.

### Appropriateness of Design

Qualitative research is typically used when the variables are uncertain and some exploration is needed (Creswell, 2005). Qualitative studies nearly always involve face-to-

face interviews or surveys (Walonick, 2004). Data in a qualitative study are recorded using words or phrases instead of the numbers typically found with quantitative research (Neuman, 2003). When using a qualitative research design, the outcomes can include themes or extensive topics that characterize the results of the research (Creswell, 2005). “The goal of qualitative research is to develop a hypothesis--not to test one. Qualitative studies have merit in that they provide broad, general theories that can be examined in future research” (Walonick, 2004, p. 11).

Conversely, quantitative methodology is appropriate to investigate trends and possible relationships between variables (Creswell, 2005). When using a quantitative research design, research questions and a hypothesis are required, and analysis of the statistics in order to test the hypothesis and answer the questions is completed (Neuman, 2003). To execute the present research, specific research questions were identified, data to answer the research questions were gathered, and statistical analysis of the numbers was conducted (Creswell, 2005).

Quasi-experimental designs “approximate the conditions of the true experiment in a setting which does not allow the control and/or manipulation of all relevant variables” (Issac & Michael, 1997, p. 46). According to Neuman (2003), quasi-experimental designs “make identifying a causal relationship more certain than do preexperimental designs” (p. 247). Quasi-experimental designs, unlike classical experimental designs, allow the researcher to test for a causal relationship in a variety of settings and circumstances (Neuman, 2003). Experimental research, by contrast, “determines the impact of an intervention on an outcome for participants in a study” (Creswell, 2005, p. 591). Isaac and Michael described the use of experimental designs as testing possible cause-and-

effect relationships between two groups, one provided with the intervention and the other with no intervention.

The quantitative, quasi-experimental, retrospective research design did not include random assignment to treatments, limiting the generalizability of the findings. In order to determine whether a formal study skills intervention significantly improves remedial math study achievement, an experimental design study with random assignment and a control group is recommended for future research that would specifically examine whether formal math study skills instruction works better for various student demographic groups such as age, gender, socio-economic status, full-time as opposed to part-time students, and traditional as opposed to non-traditional students. Because quantitative archival data were available for the study, a quantitative quasi-experimental statistical analysis was performed in order to examine significant differences in the mean scores between groups receiving only math instruction and groups receiving math instruction and formal math study skills.

#### Research Questions

The following research question guided the study: “What, if any, degree of difference in student achievement occurs with students who received formal math study skills instruction when compared with a control group of posttest scores of students who did not receive formal math study skills?”

#### Population

The total population of 90 students enrolled in four Math Fundamental classes was divided into two groups. One group included 46 students who received only math instruction, and the other group included 44 students who received math instruction and

formal math study skills instruction. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group. The formula utilized to determine the appropriate sample size was  $n = (zs/e)^2$ , where  $s$  = standard deviation and  $e$  = margin of error. Therefore, when  $n = (1.96 \times 5/2)^2$ , the sample size was 24. With a confidence level of 95% and a standard deviation of 5 from previous final examinations given in the course, the margin of error was 2, a sample mean accurate to within 2 units of the population mean for the accuracy level needed. A smaller sample size would have provided a larger error and a larger sample would have provided a smaller error.

The remedial math courses at Camden County College have a maximum class size of 23 students (Jackson, 2004). A typical remedial class has a retention rate near 60% (Jackson, 2004). With a sample size of 24 needed, a total of 4 classes were studied. Two classes, a total of 46 students, received only math instruction and 2 classes, a total of 44 students, received math instruction as well as formal math study skills instruction. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group.

#### Informed Consent

Because the study used archived data and the individual results were not analyzed, informed individual consent was not needed. Consent was obtained from the college to use the mean pretest and posttest scores for each class included in the study. A copy of the institutional letter of consent is attached as Appendix C.

### Sampling Frame

The total population of 90 students enrolled in four Math Fundamental classes was divided into two groups. One group included 46 students who received only math instruction, and the other group included 44 students who received math instruction and formal math study skills instruction. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group. Students self-selected the course by independently registering for Math Fundamentals. Students were not specifically selected for participation in the course.

### Confidentiality

Confidentiality of all participants was ensured since no individual data were recorded. The class mean was calculated to measure any relationship between formal math study skills instruction and college remedial math achievement.

### Geographic Location

The study was conducted at Camden County College in Blackwood, New Jersey.

### Instrumentation

Any significant difference between students who received formal math study skills intervention and those who have received only math instruction was measured by the scores on the posttest. The posttest was a 40-question cumulative multiple-choice department examination (see Appendix B). All students placed in Math Fundamentals at CCC must pass the department examination by achieving at least 24 out of 40 questions correct (Jackson, 2004). The Math Fundamentals course is designed for the college student who needs training in basic numerical processes with whole numbers, fractions,

decimals, ratios, proportions and percents, and their applications (Jackson, 2004). The 40 question test measures the desired learning outcomes from the Math Fundamentals course at Camden County College (Jackson, 2004).

The first day verification test was the 12-question open-ended test given to students on the first day of class. The first day verification test is referred to as a pretest. The first day verification test was administered by the faculty at Camden County College to verify that students were placed into the correct course by Accuplacer. The test measures basic numerical processes with whole numbers, fractions, decimals, ratios, proportions and percents, and their applications (Jackson, 2004). The 12 question test measures the desired learning outcomes from the Math Fundamentals course at Camden County College (Jackson, 2004). If a student can correctly answer 9 or more correct on the test, the student is prepared to enter the next course (Jackson, 2004). The pretest was administered to make sure the two independent groups were equivalent.

#### Data Collection

In this retrospective research study, an examination of previously administered tests provided data for analysis. Pretests and posttests administered to students in four Math Fundamental sections generated the data. The pretest was administered to ensure that the two groups were statistically equivalent before collecting comparison data. The 40-question multiple choice department examination was administered to measure whether significant differences existed in the mean scores between the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction.

## Data Analysis

The null hypothesis stated that the mean posttest scores were not significantly different among results of the control group with no intervention and the experimental group that received a formal math study skills intervention. The alternative hypothesis stated that the mean posttest scores were significantly different among results of the control group with no intervention and the experimental group that received a formal math study skills intervention.

The hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups before and after the intervention had taken place. The dependent variable, also known as outcome variable, was the level of remedial math skills achievement as measured by posttest scores. The independent variable was the existence or non-existence of formal math study skills instruction. Testing the hypothesis determined the measure of success of formal math study skills intervention.

“When investigating the difference between two unrelated or independent groups on an approximately normal dependent variable it is appropriate to choose an independent samples  $t$  test” (Morgan et al., 2004, p. 136). There are different types of  $t$  tests, but the independent samples  $t$  test is one of the most common (Morgan et al., 2004). An independent  $t$  test is used when the study warrants a comparison between two means of independent samples for a given variable (Morgan et al., 2004).

An independent  $t$  test was conducted to measure whether significant differences existed in the mean scores of two independent sample groups on the 40-question multiple-choice department examination between the control group that received only math instruction and the experimental group that received both math instruction and

formal math study skills instruction. The moderating variable was the mean score on the pretest. An independent *t* test was administered to assess whether significant differences existed in the mean scores of two independent sample groups on the 12-question open ended first day verification test between the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction.

### Validity and Reliability

Validity indicates that researchers can “draw meaningful and justifiable inferences from scores about a sample or population” (Creswell, 2005, p. 600). Internal and external validity are two concerns in experimental research (Neuman, 2003). Internal validity is the capability to eradicate any alternate reasons or possible affects on the dependent variable (Neuman, 2003). “The logic of internal validity is to rule out variables other than the treatment by controlling experimental conditions and through experimental designs” (Neuman, 2003, p. 251).

External validity involves the generalizability of the findings to populations and settings outside the research (Neuman, 2003). “Threats to external validity are problems that threaten our ability to draw correct inferences from the sample data to other persons, settings, and past and future situations” (Creswell, 2005, p. 293). The generalizability of the findings to schools outside of Camden County College and to other non-community college students such as those students directly entering 4-year schools, private universities, and public colleges limit the research.

Dependability or uniformity defines reliability (Neuman, 2003). Reliability in research suggests that the same test score persists when administered under similar

situations (Neuman, 2003). Test scores “should be nearly the same or stable on repeated administrations of the instrument and that they should be free from sources of measurement error and consistent” (Creswell, 2005, p. 597). The research study was limited by the reliability of the pretest and posttest given to the Math Fundamental students and by the potential loss of students because of the option to withdraw from the course. The research study included students taking Math Fundamental at Camden County College in Blackwood, New Jersey. The focus of the study was on formal math study skills instruction and student achievement. Other colleges or other courses were not evaluated. The study was limited to 90 students during a 15-week spring semester.

### Summary

The purpose of the quantitative, quasi-experimental, retrospective study was to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores. The scores of the total population of 46 control students who had no intervention and the total population of 44 students who had formal math study skills intervention were compared. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group.

Archival class posttest scores in the Math Fundamentals remedial math courses were compared to the scores from the control group that had no formal math study skills intervention and the experimental group that had formal math study skills instruction at Camden County College in Blackwood, New Jersey. The archival data are held in the Camden County College Academic Math Skills department database. The null hypothesis ( $H_0$ ) stated that mean posttest scores were not significantly different among results of the

control group that had no intervention and the experimental group that had formal math study skills intervention. The alternate hypothesis ( $H_{1A}$ ) stated that the mean posttest scores were significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

A quantitative, quasi-experimental research design was appropriate for the study because quantitative research is a methodology that investigates trends and possible relationships between variables (Creswell, 2005). A retrospective approach was appropriate because the study involved archival data (Gómez-Bellengé, 2002). Since quantitative archival data were available, a quantitative quasi-experimental statistical analysis was performed in order to examine any significant differences in the mean scores between groups receiving only math instruction and groups receiving math instruction and formal math study skills intervention (Creswell, 2005; Neuman, 2003).

### Conclusion

Chapter 3 outlined the research methodology and design used to carry out the study. The research was designed to test the null hypothesis stating that mean posttest scores were not significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

Chapter 4 presents the research findings.

## CHAPTER 4: RESULTS

The purpose of the research study was to determine whether formal math study skills instruction affected student achievement in remedial college math courses. Chapter 1 included reports indicating that, in 2004, only 22% of the 1.2 million graduating seniors taking the ACT test achieved scores high enough to be considered prepared to take college-level math (ACT, 2004a). Brothen and Wambach (2004) reported that 78% of all colleges and universities and 100% of community colleges offered remedial education.

When asked how the public school system could better prepare students for college, nearly 60% of the students surveyed wanted classes in study skills and critical thinking skills (Thompson & Joshua-Shearer, 2002). At Camden County College, 88% of incoming students test into remedial math, and there is currently no formal math study skills instruction provided in either remedial math course (Jackson, 2004). Chapter 2 concentrated on the literature concerning the research hypothesis, current findings and research, the dependent and independent variables, and the gaps in the related literature. Chapter 3 provided a framework outlining the research methodology for the study and confirmed supporting literature for the following hypothesis that were tested in the study:

$H_{01}$ : Mean posttest scores are not significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

$H_{a1}$ : Mean posttest scores are significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

The hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups after the intervention had taken place. The results of hypothesis testing determined the measure of success of formal math study skills intervention. The purpose of chapter 4 is to communicate the research findings obtained from the hypothesis test. Chapter 4 includes a graphic display of data demographics and the resulting statistical results.

#### Data Collection Procedures

In the present retrospective quasi-experimental research study, scores from previously administered tests were analyzed. A pretest and a posttest administered to students in four Math Fundamental sections generated the archived data. The pretest (see Appendix A) was administered to ensure that the two groups were equivalent before collection of comparison data. The independent  $t$  test was conducted to determine whether there were statistically significant differences between the control group and the experimental group before the implementation of the formal math study skills intervention.

The pretest results produced a benchmark from which to judge the comparative success or failure of the formal math study skills intervention. When significant differences are not found between groups on pretest scores, it is concluded that the two groups are roughly equal before the intervention, and the difference must be included in the interpretation of the results (Neuman, 2003). Table 1 presents the descriptive statistics for both groups in the pretest. The pretest determined the two groups were statistically equal before the intervention,  $t(62) = .13; p = .89$ .

Table 1

*Descriptive Statistics: Pretest*

GROUP	N	Mean	SD	SE Mean
Control	31	3.06	1.93	.35
Experimental	33	3.00	1.94	.34

The 40-question multiple choice department examination (see Appendix B) was administered to measure whether significant differences existed in the mean scores between the control group that received only math instruction and the experimental group that received both math instruction and formal math study skills instruction. The statement of null hypothesis was that the mean posttest scores were not significantly different among results of the control group that had no intervention and the experimental group that had formal math study skills intervention. The statement of alternate hypothesis was that the mean posttest scores were significantly different among results of the control group that had no intervention and the experimental group that had formal math study skills intervention.

The hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups before and after the intervention had taken place. The dependent variable, also known as outcome variable, was the level of remedial math skills achievement as measured by posttest scores. The independent variable was the existence or non-existence of formal math study skills instruction. Testing the hypothesis determined the measure of success of formal math study skills intervention.

“When investigating the difference between two unrelated or independent groups on an approximately normal dependent variable it is appropriate to choose an

independent samples  $t$  test” (Morgan et al., 2004, p. 136). There are many different types of  $t$  tests, but the independent samples  $t$  test is one of the most common (Morgan et al., 2004). An independent  $t$  test is used when the study warrants a comparison between two means of independent samples for a given variable (Morgan et al., 2004). An independent  $t$  test was used in this research study to measure whether significant differences existed in the mean scores of two independent sample groups on the 40-question multiple choice department examination. There were a control group that received only math instruction and an experimental group that received both math instruction and formal math study skills instruction.

#### Findings: Demographics

Archived data from the total population of 90 students enrolled in Math Fundamental classes at Camden County College in Blackwood, New Jersey were compared. Forty-six students received only math instruction and 44 students received math instruction and formal math study skills instruction. Students without scores on both the pretest and the posttest were eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group. Each student participating in the study was enrolled by individually registering for the class. Students were not specifically selected for participation in the study. A pretest was administered to both the control group and the experimental group to ensure that the two groups were equivalent.

Since archived data were used for the study, specific demographic information on the 90 students enrolled in Math Fundamentals was not available. Overall demographic data on Camden County College students follows. County College is “one of the regions largest public post-secondary institutions of higher education and [New] Jersey’s second

largest county college” (Camden County College, 2007, ¶ 4). Camden County College students have a mean age of 27 (Camden County College). Full-time students account for 49% of the total enrollment and 51% of the students attend the college part-time (Camden County College). The college reported that 61% of the student population are female and 37% are male with 2% not recording a gender (Camden County College). The ethnic background for the students attending the college is varied with 62% Caucasian, 21% African-American, 8% Hispanic, 6% Asian, and 3% not reported (Camden County College).

### Hypothesis Test Results

The hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups after the intervention had taken place.

$H_{01}$ : Mean posttest scores are not significantly different among results of the control group that had no intervention and the experimental group who had a formal math study skills intervention.

$H_{a1}$ : Mean posttest scores are significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

Testing the hypothesis of the mean posttest scores among results of the control group that had no intervention and the experimental group that had formal math study skills intervention determined the measure of success of formal math study skills intervention by measuring if there were significant differences between groups after the intervention.

The hypothesis was tested using an independent  $t$  test to determine whether there were statistically significant differences between the experimental group ( $M = 25.64$ ,  $SD = 8.12$ ) provided with formal math study skills instruction and the control group ( $M = 29.52$ ,  $SD = 6.27$ ), which had no formal math study skills instruction. Testing the hypothesis determined whether the experimental group scores on the posttest were significantly higher than the control group scores on the posttest. Testing the hypothesis determined a benchmark to analyze the comparative success or failure of providing formal math study skills instruction to remedial math college students. The results of the posttest using an independent  $t$  test indicate that the experimental group scored significantly lower on the posttest than the control group,  $t(62) = 2.13$ ;  $p = .04$ . See Table 2. The null hypothesis that mean posttest scores are not significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention is rejected. Students in the control group that had no intervention were significantly higher on posttest scores.

Table 2

*Descriptive Statistics: Posttest*

GROUP	N	Mean	SD	SE Mean
Control	31	29.52	6.27	1.13
Experimental	33	25.64	8.12	1.41

## Summary of Findings

The posttest scores are significantly different among the control group with no formal math study skills intervention and the experimental group with formal math study

skills intervention. Formal math study skills instruction did not increase remedial math student achievement.

### Conclusion

Chapter 4 described the data collection, demographics, and data analysis process. For the present study, data from 2 groups representing 90 students for the pretest and posttest were utilized. The archived data were retrieved from the math skills department office. The methodology outlined in chapter 3 was implemented, and the results were displayed using tables and a narrative. Chapter 5 includes discussion of the findings and recommendations. The chapter is organized in the four main sections of (a) research hypothesis, (b) conclusions, (c) implications of findings, and (d) recommendations.

## CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

Many college leaders are re-evaluating current course offerings and modes of instruction because the number of students who are not adequately prepared to take college level math is increasing (Hortencia, 2003; Jackson, 2004). Math courses are the remediation courses taken most often, and when asked how the public school system could better prepare students for college, nearly 60% of college students surveyed said that study skills and critical thinking skills should be incorporated into the current curriculum (Thompson & Joshua-Shearer, 2002). Cole et al. (2000) found 81% of higher education institutions offered these types of college preparedness courses. Often referred to as College Success or University 101, study skills courses support under-prepared students to become self-directed learners, especially in affective and cognitive areas of motivation, organization, test taking and note taking skills, and time management (Cole et al., 2000).

The curriculum based American College Testing (ACT) Assessment reported that, of the 1.2 million graduating seniors taking the ACT test in 2004, only 22% achieved scores high enough to consider the student prepared to take college-level math (ACT, 2004a). The problem is that over 50% of entering college students must take remedial courses before qualifying for college-level courses (Hodges & Kennedy, 2004). The purpose of the current quantitative, quasi-experimental, retrospective research design was to determine whether formal math study skills instruction had a significant effect on remedial math student achievement scores by comparing the results of 46 control students who had no intervention and 44 students who had a formal math study skills intervention. Students without scores on both the pretest and the posttest were

eliminated, leaving a final sample of 31 in the control group and 33 in the experimental group. Archival class posttest scores in the Math Fundamentals remedial math courses were compared for the control group and the experimental group at Camden County College in Blackwood, New Jersey.

The following hypothesis was tested:

$H_{01}$ : Mean posttest scores are not significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

The hypothesis was tested using an independent  $t$  test to determine whether there were statistically significant differences between groups after the intervention had taken place. Testing the hypothesis determined the measure of success of formal math study skills intervention. Chapter 5 includes an examination of the limitations and delimitations of the study, a discussion of the implications of the findings, recommendations based on the results of the data analysis and potential areas for further research, a summary, and a conclusion.

### Limitations

Validity indicates that researchers can “draw meaningful and justifiable inferences from scores about a sample or population” (Creswell, 2005, p. 600). Internal and external validity are two concerns in experimental research (Neuman, 2003). Internal validity is the capability to eradicate any alternate reasons or possible affects on the dependent variable (Neuman, 2003). “The logic of internal validity is to rule out variables other than the treatment by controlling experimental conditions and through experimental designs” (Neuman, 2003, p. 251).

External validity involves the generalizability of the findings to populations and settings outside the research (Neuman, 2003). “Threats to external validity are problems that threaten our ability to draw correct inferences from the sample data to other persons, settings, and past and future situations” (Creswell, 2005, p. 293). The generalizability of the findings to schools outside of Camden County College and to other non-community college students such as those students directly entering 4-year schools, private universities, and public colleges limit the research.

The research study was limited by the reliability of the pretest and posttest given to the Math Fundamental students. Two words synonymous with reliability are dependability or uniformity (Neuman, 2003). Reliability in research suggests that the same test score persists when administered under similar situations (Neuman, 2003). Test scores “should be nearly the same or stable on repeated administrations of the instrument and that they should be free from sources of measurement error and consistent” (Creswell, 2005, p. 597). The potential loss of students because of the option to withdraw from the course, 90 students enrolled 64 completed the course, was an additional limitation. The possible generalizability to schools outside of Camden County College and to non-community college students, such as those students directly entering 4-year schools, was limited.

#### Delimitations

Only students taking Math Fundamental at Camden County College were included in the research study. The focus was on formal math study skills instruction and student achievement. Other colleges or other courses were not evaluated. The study was limited to 90 students during a 15-week spring semester.

## Findings

Data analysis led to rejecting the null hypothesis that there were no significant differences between groups. Formal math study skills instruction did not increase remedial math student achievement. Archived data from the total population of 90 students enrolled in Math Fundamental classes at Camden County College in Blackwood, New Jersey were compared. Thirty one students received only math instruction and 33 students received math instruction and formal math study skills instruction. Students enrolled in the Math Fundamentals classes participating in the study independently registered for the class. Students were not specifically selected for participation therefore the unit of analysis was the class group, not individual students. A pretest was administered to both the control group and the experimental group to ensure that the two groups were equivalent.

The hypothesis was tested using an independent  $t$  test to determine whether there were significant differences between groups after the intervention had taken place.

$H_{01}$ : Mean posttest scores are not significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

$H_{a1}$ : Mean posttest scores are significantly different among results of the control group that had no intervention and the experimental group that had a formal math study skills intervention.

Testing the hypothesis of the mean posttest scores among results of a control group who had no intervention and an experimental group who had formal math study skills intervention determined the measure of success of formal math study skills

intervention by measuring differences between groups after the intervention. Because the control group scored significantly higher on the posttest scores, it can be concluded that instruction in formal math study skills does not improve remedial math student achievement.

The hypothesis was tested using an independent  $t$  test to determine whether there were statistically significant differences between the experimental group ( $M = 25.64$ ,  $SD = 8.12$ ) provided with formal math study skills instruction and the control group ( $M = 29.52$ ,  $SD = 6.27$ ) with no formal math study skills instruction. Testing the hypothesis determined whether the experimental group scores on the posttest were significantly higher than the control group scores on the posttest. Testing the hypothesis determined a benchmark to analyze the comparative success or failure of providing formal math study skills instruction to remedial math college students.

The experimental group scored lower on the posttest. The results indicate a significance difference in posttest scores for students who received formal math skills intervention. The null hypothesis was rejected since the results of the mean posttest scores indicated a significant difference between the control group that received no formal math study skills intervention and the experimental group that had a formal math study skills intervention. The conclusion is that formal math study skills instruction does not increase remedial math student achievement.

#### Implications for Leadership

The primary purpose of most colleges and universities is teaching (Wolf et al., 2004). The mission of Camden County College is to provide students with an academically excellent education (Camden County College, 2003). Camden County

College strives to provide students with the tools necessary to become successful, continuous learners.

The Academic Skills Mathematics Department at Camden County College endeavors to fulfill the following Mission Statement: “The philosophy . . . is based on our belief that all students should have the opportunity to prepare for the study of college level mathematics in an *environment that is sensitive and responsive to individual needs*” (Jackson, 2004, p. 2). In an attempt to assist the Academic Skills Mathematics department in determining students’ individual needs, the experimental group received formal math study skills instruction.

As institutions of higher education continue to offer remedial math courses to an increasing number of students who need these courses, leaders focus on the quality of instruction provided to students (Brothen & Wambach, 2004). While seeking to adapt to and survive the changing college environment, academic deans and college administrators must be willing to “make choices and decisions that will advance and maximize the students' chances for success” (Soney, 2004, ¶ 16). Although higher education leaders cannot be individually held responsible for each student’s achievement, leaders are charged with creating an environment where student goals can be realized (Laufgraben, 2005). Knowledge and appreciation of the current research findings will help to foster situations that promote student success (Jonassen & Jonassen, 2004).

While the current research suggests there is no need to alter the remedial math fundamentals curriculum to include formal math study skills instruction, leaders should consider (a) conducting further research to determine whether there are differences in attrition rates for students receiving formal math study skills; (b) examining the use of

other formal math study skills programs to determine the effectiveness in increasing student achievement; (c) confirming the results of the study by implementing independent testing; (d) studying the generalizability of the findings to schools outside of Camden County College and to other non-community college students such as those students directly entering 4-year schools, private universities, and public colleges; (e) tracking students into the next math course to measure significant differences in math achievement; and (f) examining the results of formal math study skills instruction for specific demographic groups such as age, gender, socio-economic status, traditional as opposed to non-traditional student, and full-time as opposed to part-time student. Educational leaders and teachers need to be aware of the cultural differences, experiences, and background of students, which significantly impact how they respond in the classroom and to formal math study skills instruction.

Further research to determine whether there are differences in attrition rates for students receiving formal math study skills should be conducted. Jackson (2004) reported an overall retention rate of 68.5%. The overall retention rate with for the current research is 71%. The control group averages a retention rate of 67% whereas 75% of the students in the experimental group completed the course.

Examining the use of other formal math study skills programs to determine the effectiveness in increasing student achievement should also be considered. In the current research student were provided with a formal math study skills workbook. Formal math study skills were taught in class and students were required to complete study skills assignments at home. Time spent on study skills may have taken away from time spent

on actually doing math homework. Other programs and alternate ways to teach formal math study skills should be explored.

Implementing independent testing should be performed to confirm the results of the study. Reliability in research suggests that the same results persist when administered under similar situations (Neuman, 2003). Results “should be nearly the same or stable on repeated administrations of the instrument and that they should be free from sources of measurement error and consistent” (Creswell, 2005, p. 597). Administering independent testing would confirm study results and establish reliability.

Studying the generalizability of the findings to schools outside of Camden County College and to other non-community college students such as those students directly entering 4-year schools, private universities, and public colleges is warranted. The current research focused exclusively on Math Fundamental students at a two-year open enrollment community college. External validity involves the generalizability of the findings to populations and settings outside the research (Neuman, 2003). “Threats to external validity are problems that threaten our ability to draw correct inferences from the sample data to other persons, settings, and past and future situations” (Creswell, 2005, p. 293).

Further research should also be conducted by tracking students into the next math course to measure significant differences in math achievement. Although formal math skills instruction did not increase math achievement in the current research, students may show a significant increase in achievement in future math courses.

Confounding variables are sometimes referred to as spurious variables or extraneous variables (Creswell, 2005). These variables represent characteristics or

aspects of the research study that cannot be “directly measured because their effects cannot be easily separated from other variables, even though they may influence the relationship between the independent and the dependent variable” (Creswell, 2005, pp. 589-590). Possible confounding variables in the current research study were student gender, age, ethnicity, level of student motivation, and level of math intelligence. Leaders in education should also consider examining the results of formal math study skills instruction for specific demographic groups such as age, gender, socio-economic status, traditional as opposed to non-traditional student, and full-time as opposed to part-time student.

#### Future Recommendations

Quasi-experimental designs “approximate the conditions of the true experiment in a setting which does not allow the control and/or manipulation of all relevant variables” (Issac & Michael, 1997, p. 46). According to Neuman (2003), quasi-experimental designs “make identifying a causal relationship more certain than do preexperimental designs” (p. 247). Quasi-experimental designs, unlike classical experimental designs, allow researchers to test for a causal relationship in a variety of settings and circumstances (Neuman, 2003). Experimental research, by contrast, “determines the impact of an intervention on an outcome for participants in a study” (Creswell, 2005, p. 591). Isaac and Michael described an experimental design as testing for a possible cause-and-effect relationship between two groups, one provided with the intervention the other with no intervention.

The study was carried out with a quantitative, quasi-experimental, retrospective research design without random assignment to treatments, limiting the generalizability of

the findings. In order to determine whether a formal study skills intervention significantly improves remedial math study achievement, an experimental design study with random assignment and a control group is recommended for future research, specifically examining whether formal math study skills instruction works better for various student demographic groups such as age, gender, socio-economic status, full-time as opposed to part-time students, and traditional as opposed to non-traditional students.

### Summary

With increasing numbers of students not adequately prepared to take college-level math, many college leaders are compelled to rethink current course offerings and modes of instruction (Hortencia, 2003; Jackson, 2004). Math courses are the remediation courses taken most often, and when asked how the public school system could better prepare students for college, nearly 60% of college students surveyed said that study skills and critical thinking skills should be incorporated into the current curriculum (Thompson & Joshua-Shearer, 2002). Cole et al. (2000) found 81% of higher education institutions offered these types of college preparedness courses. Often referred to as College Success or University 101, these courses support under-prepared students to become self-directed learners, especially in affective and cognitive areas of motivation, organization, test taking and note taking skills, and time management (Cole et al., 2000).

The National Center for Education Statistics (NCES) 2001 report stated that 80% of two-year colleges and over 70% of all four-year institutions offer basic skills or remediation courses (Young & Ley, 2005). Brothen and Wambach (2004) updated these findings and reported that 78% of all colleges and universities and 100% of community colleges offered remedial education. Camden County College (CCC) in Blackwood, New

Jersey, is one of the 100% of community colleges offering remedial education (Jackson, 2004).

On a survey given to 156 participants in southern California, over half the participants declared math was their most difficult subject in high school (Thompson & Joshua-Shearer, 2002). Thompson and Joshua-Shearer, when conducting the survey, sought to provide insights on what students thought would improve the quality of their college education, and the authors obtained feedback regarding students' high school experience. When asked how the public school system could better prepare students for college, nearly 60% of the students surveyed wished study skills and critical thinking skills were taught (Thompson & Joshua-Shearer, 2002).

White (2004) reported that many studies have been conducted that measured students' study habits and success in college. One particular study reported study skills and learning styles were good predictors of college success (Sedlacek, 2005). In an attempt to prepare students to take college-level math courses, college leaders across the country are compelled to rethink their current course offerings and modes of instruction (Hortencia, 2003). Key findings in the present study reveal that formal math study skills instruction does not successfully raise the mean posttest score on the departmental final exam. Formal math study skills instruction does not increase remedial math student achievement.

### Conclusion

Math courses are the remediation courses taken most often (Cox, Friesner, & Khayum, 2003). Leaders in higher education are reviewing course offerings and reassessing their current modes of instruction while attempting to determine how to

formulate and deliver a successful remedial math course that adequately prepares students for college-level math (Hortencia, 2003). The Academic Skills Mathematics Department at Camden County College endeavors to fulfill the following Mission Statement: “The philosophy . . . is based on our belief that all students should have the opportunity to prepare for the study of college level mathematics in an *environment that is sensitive and responsive to individual needs*” (Jackson, 2004, p. 2).

The present research adds significant findings for educational institutions in higher education, particularly the Academic Skills Mathematics department at Camden County College. The findings indicate the posttest scores are significantly different among the control group with no formal math study skills intervention and the experimental group with formal math study skills intervention. Formal math study skills instruction did not increase remedial math student achievement.

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## APPENDIX A: MATH FUNDAMENTALS FIRST DAY VERIFICATION TEST

## MATH FUNDAMENTALS SCREENING TEST (SPRING)

NAME \_\_\_\_\_ DATE \_\_\_\_\_

MTH-011- \_\_\_\_\_ STUDENT ID \_\_\_\_\_

Use the available space to do your work. Then place your answers in the blanks provided. PRESENT ALL FRACTION ANSWERS IN SIMPLEST FORM. NO CALCULATORS. NO SCRAP PAPER.

1) Find the average (mean) of the four test grades. Round the answer to the nearest tenth. 1) \_\_\_\_\_

95 87 72 89

2) A 6-ounce tube of toothpaste sells for \$2.94. What is the price per ounce? 2) \_\_\_\_\_

3) Compute:  $5 + 4(3 + 1)^2$  3) \_\_\_\_\_

4) Reduce to lowest terms:  $\frac{36}{48}$  4) \_\_\_\_\_

5) Compute:  $6.2 + 0.031 + 5$  5) \_\_\_\_\_

6) Divide:  $\frac{4.5}{0.09}$  6) \_\_\_\_\_

7) Divide:  $1\frac{1}{4} \div \frac{10}{7}$

7) \_\_\_\_\_

8) Add:  $\frac{1}{8} + \frac{5}{12}$

8) \_\_\_\_\_

9) Subtract:  $7 - 3\frac{5}{6}$

9) \_\_\_\_\_

10) 12 is 30% of what number?

10) \_\_\_\_\_

11) A \$180 jacket is on sale for 30% off. What is the price of the coat after the discount?

11) \_\_\_\_\_

12) It takes 34 minutes to run 5 miles. How many minutes will it take to run 10 miles at the same pace?

12) \_\_\_\_\_

## APPENDIX B: MATH FUNDAMENTAL – FINAL EXAM

Name \_\_\_\_\_

# MATH FUNDAMENTALS

## Final Exam

TIME: 90 minutes

**CUTOFF SCORE: 24**

**NO CALCULATORS**

NO SCRAP PAPER

Please do all your scrap work inside the booklet. Make sure you record your answers on the answer sheet provided.

Camden County College  
Math Skills Department  
Spring 2/07

<b>NO CALCULATORS</b>
-----------------------

**MATH FUNDAMENTALS: FINAL EXAM**

TIME – 90 minutes  
40 questions

**DIRECTIONS:** Solve each of the following problems and indicate your answer choice in the appropriate space on the answer sheet. You may use any blank space in this section for scratch work. However, **mark all of your answers on the separate answer sheet.**

1. Find the prime factorization of 75.

- (A)  $3 \cdot 25$
- (B)  $3 \cdot 5^2$
- (C)  $3 \cdot 5$
- (D)  $5 \cdot 15$

2. What is the Greatest Common Factor (GCF) for 45 and 60?

- (A) 3
- (B) 5
- (C) 15
- (D) 20

3. What is the Least Common Denominator (LCD) for

$$\frac{1}{10} \text{ and } \frac{2}{15}.$$

- (A) 5
- (B) 150
- (C) 30
- (D) 100

4. Round to the nearest thousandth.

$$5379.23765$$

- (A) 5379.237
- (B) 5379.2377
- (C) 5000
- (D) 5379.238

5.  $.36 + 7 + 3.746$
- (A) 12.106
  - (B) 1.4346
  - (C) 11.106
  - (D) 4.806
6.  $3 \bullet (3^3 - 3 \bullet 4) - 1$
- (A) 8
  - (B) 44
  - (C) 287
  - (D) 78
7.  $30 \div 5 \bullet 2 + 3$
- (A) 6
  - (B) 15
  - (C) 30
  - (D)  $\frac{3}{4}$
8. Write  $\frac{8}{9}$  as a decimal rounded to the hundredths place.
- (A) .80
  - (B) .88
  - (C) .89
  - (D) 1.13

9. Write 6% as a fraction in simplest form.
- (A)  $\frac{1}{6}$
  - (B)  $\frac{3}{5}$
  - (C)  $\frac{1}{50}$
  - (D)  $\frac{3}{50}$
10. Last year there were 400 scholarship applications. This year there were 425 applications. What is the percent increase?
- (A) 25 %
  - (B) 6.25 %
  - (C) 5.9 %
  - (D) 20 %
11. If 7 pounds of grapes cost \$7.56, how much will 5 pounds cost at the same rate per pound?
- (A) \$2.16
  - (B) \$3.24
  - (C) \$3.42
  - (D) \$5.40

12.  $\frac{1}{4} + \frac{3}{8} =$

(A)  $\frac{3}{32}$

(B)  $\frac{3}{12}$

(C)  $\frac{5}{8}$

(D)  $\frac{1}{2}$

13.  $\frac{7}{8} - \frac{1}{5} =$

(A) 2

(B)  $\frac{6}{40}$

(C)  $\frac{27}{40}$

(D)  $\frac{17}{20}$

14.  $(1.3)^2$

(A) 1.69

(B) .169

(C) 16.9

(D) 2.6

15. What is 25 percent of 60 ?

- (A) 1.5
- (B) 15
- (C) 240
- (D) 2400

16.  $30 \div \frac{1}{5}$

- (A)  $\frac{1}{150}$
- (B) 6
- (C)  $\frac{1}{6}$
- (D) 150

17.  $0.32 + \frac{2}{5} =$

- (A) 0.36
- (B) 0.324
- (C) 4.32
- (D) 0.72

18.  $3\frac{3}{7} \times 14 =$

- (A)  $42\frac{3}{7}$
- (B) 24
- (C) 48
- (D) 168

19. John won \$2028 in a lottery. If he spent  $\frac{1}{4}$  of

the money on clothes and  $\frac{1}{3}$  for a TV, how much money did he have **left**?

- (A) \$845.00
- (B) \$507.00
- (C) \$676.00
- (D) \$1183.00

20.  $4\frac{1}{3} - 2\frac{5}{7} =$

- (A)  $1\frac{2}{7}$
- (B)  $1\frac{13}{21}$
- (C)  $2\frac{2}{7}$
- (D)  $2\frac{13}{21}$

21.  $3\frac{1}{2} + 2\frac{2}{3} - 1\frac{3}{4} =$
- (A)  $4\frac{5}{12}$
- (B)  $4\frac{1}{4}$
- (C)  $7\frac{11}{12}$
- (D)  $8\frac{1}{12}$
22. Carl worked  $3\frac{1}{2}$  hours on Monday,  $4\frac{1}{4}$  hours on Tuesday and  $5\frac{3}{4}$  hours on Thursday. If he is paid \$15 per hour, how much did he earn for the 3 days?
- (A) \$13.50
- (B) \$67.50
- (C) \$202.50
- (D) \$2025
23. In his first 12 pitches, a pitcher threw 7 strikes. If he continues at this rate, how many strikes will he throw in 72 pitches?
- (A) 42
- (B) 36
- (C) 21
- (D) 6
24. What is 45 divided by 0.15 ?
- (A) 0.3333
- (B) 0.0033
- (C) 3
- (D) 300

25. This year the number of seniors taking mathematics is 12 percent greater than it was last year. If there were 50 seniors taking mathematics last year, how many seniors are taking mathematics this year?

(A) 44  
(B) 56  
(C) 62  
(D) 6

26.  $5 \cdot \left( \frac{1}{5} + \frac{1}{2} \right) =$

(A)  $\frac{10}{7}$

(B) 1

(C)  $3\frac{1}{2}$

(D)  $3\frac{7}{10}$

27.  $15 \div \frac{5}{7}$

(A)  $\frac{3}{7}$

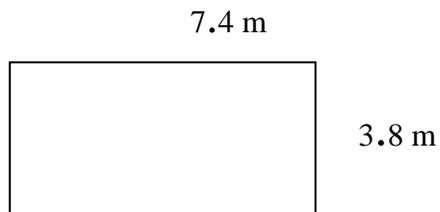
(B) 21

(C)  $10\frac{5}{7}$

(D)  $\frac{1}{7}$

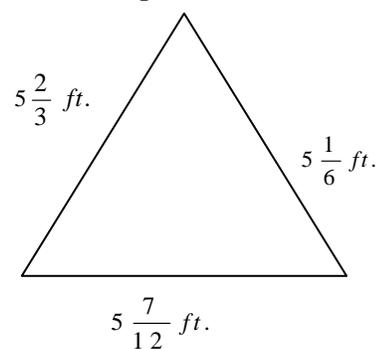
28. Last year John's salary was \$35,000. If he receives a \$700 raise for this year, what percent of last year's salary is his raise?
- (A) 2%
  - (B) 5%
  - (C) 20%
  - (D) 50%
29. 24 is 8 percent of what number?
- (A) 33.3
  - (B) 192
  - (C) 300
  - (D) 1.92
30. Over the past week, the low temperatures were  $78^\circ$ ,  $62^\circ$ ,  $72^\circ$ ,  $69^\circ$  and  $65^\circ$ . What is the mean of the low temperatures?
- (A)  $69^\circ$
  - (B)  $69.1^\circ$
  - (C)  $69.2^\circ$
  - (D)  $72^\circ$
31. Over the past week, the high temperatures were  $78^\circ$ ,  $84^\circ$ ,  $89^\circ$ ,  $90^\circ$ ,  $86^\circ$ , and  $74^\circ$ . What is the median for high temperatures?
- (A)  $85^\circ$
  - (B)  $89.5^\circ$
  - (C)  $83.5^\circ$
  - (D)  $90^\circ$
32. How many cups are in 12 quarts?
- (A) 4 cups
  - (B) 16 cups
  - (C) 48 cups
  - (D) 6 cups

33. If a cooler holds 25 liters, how many gallons will it hold?
- (A) 6.25 gallons
  - (B) 6.5 gallons
  - (C) 96.15 gallons
  - (D) 100 gallons
34. If a table is 2.5 meters high, how many millimeters high is it?
- (A) 0.0025 mm
  - (B) 25 mm
  - (C) 25000 mm
  - (D) 2500 mm
35. The high temperature in Arizona was  $95^{\circ}$  F, what was the temperature in degrees Celsius?
- (A)  $70.6^{\circ}$
  - (B)  $35^{\circ}$
  - (C)  $55.6^{\circ}$
  - (D)  $63^{\circ}$
36. What is the **area** of the rectangle below?



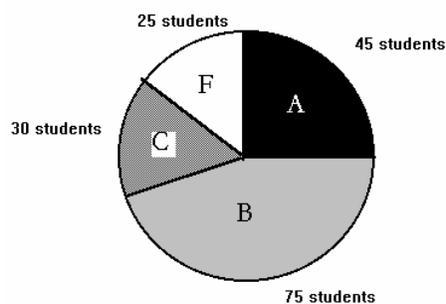
- (A) 11.2 m<sup>2</sup>
- (B) 22.4 m<sup>2</sup>
- (C) 14.83 m<sup>2</sup>
- (D) 28.12 m<sup>2</sup>

37. What is the perimeter of the triangle below?



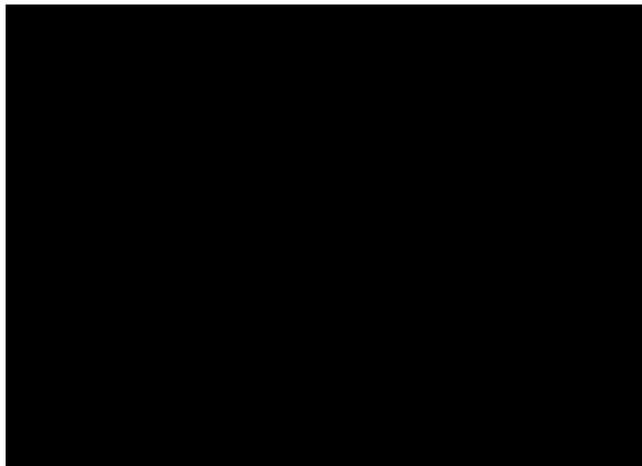
5

- (A)  $15\frac{5}{12}$  ft.      (C)  $15\frac{5}{6}$  ft.  
 (B)  $16\frac{5}{12}$  ft.      (D)  $16\frac{5}{6}$  ft.
38. Use the pie chart to find the percent of all students who earned a “C”. Round to the nearest tenth of a percent.



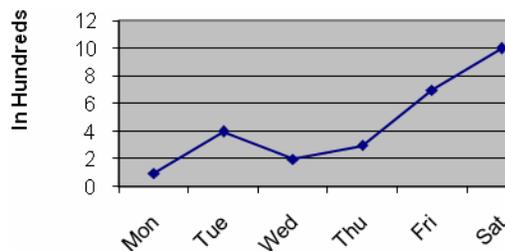
- (A) 17.1 %      (B) 30 %  
 (C) 175 %      (D) 583.3 %

39. Use the bar chart below to determine the ratio of the least expensive model to the most expensive model computer



- (A)  $\frac{3}{7}$                       (B)  $\frac{7}{3}$   
 (C)  $\frac{1}{8}$                         (D)  $\frac{3}{5}$

40. Use the line graph below to determine the difference between the number of students who registered on Friday and the number of students who registered on Monday.



- (A) 6  
 (B)  $2\frac{1}{2}$   
 (C) 600  
 (D) 5

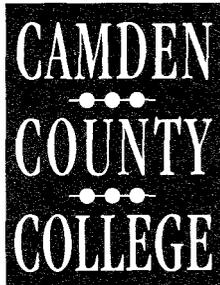


## Formulas

$\square$ $A = lw$	$\square$ $P = 2l + 2w$	$C^{\circ} = \frac{5(F^{\circ} - 32)}{9}$
$\frac{1}{2}$  $A = bh$	$s_3$  $P = s_1 + s_2 +$	$F^{\circ} = \frac{9 \cdot C^{\circ}}{5} + 32$

APPENDIX C: SIGNED INFORMED CONSENT: PERMISSION TO USE PREMISES

CHAPTER 2.



November 30, 2005

Ms. Elena Bogardus

XXXXXXXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXXX

Dear Elena:

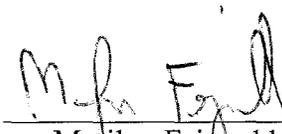
The Camden County College Institutional Review Board has reviewed your proposal entitled: *The Influence of Math Study Skills Instruction on Remedial Math Achievement*.

Your request to conduct a survey of Camden County students has been approved. We hope that you will share the results of the survey with your Department and at a workshop in the Teaching Learning Center.

Very truly yours,

  
Wendy, M. Blume

  
Kathleen Carter

  
Marilyn Feingold

Institutional Review Board

