THE EFFECTS OF USING SELECTED METACOGNITIVE STRATEGIES ON ACT MATHEMATICS SUB-TEST SCORES

by

Jeffrey W. LeMay

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

This quasi-experimental post-test only control group designed quantitative study examined whether or not members of an experimental group of participants who utilized two metacognitive strategy training regimens experienced a significant increase in their ACT mathematics sub-test scores compared to a group of students who did not utilize either of the study's metacognitive strategy training regimens. Using a post-test only control group design required 2 groups of participants: 1) the experimental group, and 2) the control group. Participants began the study's treatment on October 26, 2015, and the study ended on December 12, 2015, when all participants of the study took the regularly nationally scheduled ACT examination. The study's treatment was comprised of a series of worksheets of mathematical problems constructed similarly to those found in the ACT study guide published by ACT, Inc., and a set of 6 metacognitive relevant questions that were required to be answered after participants of the experimental group completed each worksheet. Both of these metacognitive strategies have previously been shown to help improve users' metacognitive processes and, by extension, their mathematics achievement. The control group did not receive the study's treatment. According to Campbell and Stanley (1963, p. 26), independent sample *t* test analysis is the preferred method of analyzing data generated in a post-test only control group design study. Accordingly, the ACT mathematics sub-test scores of the experimental and control groups were analyzed using independent sample *t* test analysis once the data were collected at the end of this study.

Key Word: Metacognition, ACT Examination Scores, Metacognitive Skills

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Table of Contents

List of Tables

List of Abbreviations

ACT – American College Test.

SAT – Scholastic Aptitude Test

CEEB – College Entrance Examination Board

ETS – Educational Testing Service

ACSI – Association of Christian Schools International

IRB – Institutional Review Board

CHAPTER ONE: INTRODUCTION

Background

Each year, millions of newly graduated high school students plan to attend college. While the reasons high school seniors desire to attend college are many, according to research conducted by members of the Cooperative Institutional Research Program at the Higher Education Research Institute at UCLA, the two most common reasons are 1) for a better job, and 2) to make more money (Pryor, Eagan, Blake, Hurtado, Berdan, & Case, 2012). There may be many other reasons a person chooses to attend college in addition to the potential of a better job or to make more money. Whatever the reason may be, however, a would-be college student has to apply to and be accepted by the college in order to attend. For the academic year 2013-2014, approximately 71% of 4-year degree-granting institutions had admission requirements for applicants to meet in order to gain admission to their university. Some of the most common admission requirements included 1) secondary school record; 2) test scores (including ACT, SAT, or other admission tests); 3) secondary school grades; 4) college preparatory programs; 5) secondary school class rank; 6) recommendation letters; and 7) demonstration of competencies. Among these requirements, student test scores (ACT, SAT, or other admissions test scores) were used by 76% of public universities and 61% of private universities as part of their admissions process in the 2013-2014 academic year (U.S. Department of Education, 2015).

In Georgia, the University System of Georgia has established that high school graduates must score at least a 430 on the SAT critical reading sub-test and a 400 on the SAT mathematics sub-test, or a 17 on both the ACT English and ACT mathematics sub-tests (Freshman Requirements–Standardized Test Score Requirements, 2015). At selected Georgia universities, however, the 25-50% average ACT examination composite scores of incoming freshman ranged from a low of 18 to a high of 33. These data seem to suggest that many of the colleges in Georgia required an ACT score higher than the state-mandated minimum ACT score of 17 on both the ACT English and mathematics sub-tests. The ACT Condition of College and Career Readiness 2014 Georgia Report (2014) showed that Georgia high school graduates' average ACT composite score was 20.8. These findings seem to indicate that average Georgia high school seniors need to improve their ACT composite scores in order to gain admittance to many of the universities in Georgia. In fact, average Georgia high school seniors will likely need to improve their ACT composite scores in order to gain access to the more selective public and private universities in the state.

Because of the important role college entrance examination scores play in the admissions process, it seems prudent that most high school students and their parents should seek ways to help increase these critical test scores. For example, according to one report, approximately 73% of high school students participated in at least one college entrance examination preparatory program before they attended college (Buchmann, Condron, & Roscigno, 2010). One result of so many high school students wanting to go to college and the corresponding high percentage of these students wanting to participate in a college entrance examination preparatory program has been the development of a multi-billion-dollar industry (Buchmann et al., 2010).

For all the money being spent to help high school students improve their college entrance examination scores, though, there is considerable debate as to whether or not most preparatory programs help increase ACT examination scores to an acceptable level (Briggs, 2009; Powers, 1993). The Task Force on Standardized College Admission Testing (2002) indicated that the effects of examination preparation coaching for either the SAT or ACT are within the standard of errors measurement for the tests. Similar studies have also reported questionable results for college entrance examination preparatory programs (Effects of Coaching on SAT Scores, n.d.; What Kind of Test Preparation Is Best? 2005).

Knowing that people are often spending substantial amounts of money on college entrance examination preparatory programs, and at the same time the effectiveness of such programs seems questionable, it is reasonable to suggest that a more effective method of helping students improve their college entrance examination scores should be sought.

Problem Statement

More than 3 million students have graduated from high school in the United States each year for the past several years, and more than 1.6 million students took the SAT and 1.8 million took the ACT college entrance examinations (National Center for Education Statistics, 2013; National ACT Profile, 2014). The results of college entrance examinations commonly play a vital role in the college admission process, scholarship award determinations, and other college cost abatement program decisions. To help improve their SAT or ACT examination scores, many students participate in a wide variety of college entrance examination preparatory programs (Wiener, 2000). The total amount of money spent on such programs in the United States exceeds several billions dollars a year (Buchmann et al., 2010). However, how well college entrance examination preparatory programs help increase student SAT or ACT examination scores is questionable (Task Force on Standardized College Admission Testing, 2002).

The problem is this: To help students increase their college entrance examination scores, those students and their parents are collectively paying billions of dollars a year for college entrance examination preparatory programs. The results of many of these programs, however, are questionable as to whether or not they help students achieve a higher SAT or ACT examination score than if they did not participate in such a program.

Statement of Purpose

The purpose of this study is to determine if using two specific metacognitive skills, 1) repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test, and 2) a form of directed journaling by participants answering a series of six metacognitive relevant questions, will increase participants' ACT mathematics sub-test scores. This quasi-experimental quantitative study used a post-test only control group design to assess any ACT mathematics sub-test score improvement experienced by participants using these two metacognitive strategies prior to taking the ACT mathematics sub-test examination.

Significance of Study

The significance of this study could be substantial to high school seniors applying to college. When one considers the key role college entrance examination scores have on the college admissions process, the awarding of scholarships, and other cost abatement programs, it is important to most high school students to score as high as possible on these admission examinations. To help prepare to attain their highest score possible, the vast majority of high school students and their parents pay money to participate in one or more college examination preparatory programs. However, the questionable results of most preparatory programs should have parents wondering whether they should continue spending large sums on such programs or not. If improving metacognitive strategies can lead to an improved level of college entrance examination scores, students and parents may find the costs for such programs easier to justify.

Research Questions and Hypotheses

This study sought to determine if using two specific metacognitive skills can increase students' scores on their ACT mathematics sub-test.

RQ1: What effect did calculating five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answering a set of six provided metacognitive relevant questions 5 days a week for 7 weeks have on the participants' ACT mathematics sub-test scores?

H_1: Students who calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks would score significantly higher on the ACT mathematics sub-test that served as the study's post-test instrument than students who did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

H_{O1}: Students who took the ACT examination as the study's post-test and calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks did not score significantly higher on the ACT mathematics sub-test than students who took the ACT examination as the study's post-test but did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

Identification of Variables

Following the proposed use of the terms *independent* and *dependent variables* suggested by Campbell and Stanley (1963) for this study, the ACT examinations that students took served as the independent variable. The study's dependent variable was the ACT mathematics sub-test scores students receive after taking the ACT examination.

Definitions

ACT Examination – One of two standard college entrance examinations used in the United States.

ACT Mathematics Sub-test – One of four subject tests given within the ACT college entrance examination.

College Entrance Examinations – Tests required by many colleges to help determine a student's readiness for college admission.

College Entrance Examination Preparatory Programs – Any assistance SAT or ACT test-takers may use to help them improve their college entrance examination scores.

Metacognition – One's knowledge of one's own cognition and control and monitoring of one's own cognition.

Metacognitive skills – Various skills used to help improve a person's metacognition.

SAT Examination – One of two standard college entrance examinations used in the United States.

Shadow Education – Any educational activity that takes place outside the normal educational system that is meant to assist a student's ability to successfully move through the educational system itself.

Summary

Millions of students in the United States graduate from high school each year, with more than 60% immediately enrolling into college the first academic semester after they graduate (Kena et al., 2015). Certainly, there are a number of reasons students enroll in college, but most high school students believe if they graduate from college, they will have better jobs and make more money than their high school peers who do not graduate from college. In Georgia, the average ACT score of high school seniors may not be high enough to gain entrance to many of the state-supported colleges or universities, let alone high enough to get into selective state colleges or universities. To counter this college entrance examination score deficit, the majority of high school seniors participate in at least one college entrance examination preparatory program in an effort to increase their college entrance examination scores. Unfortunately, the benefit of these programs may not be sufficient to increase participants' scores enough for them to gain entrance into their choice of college. This study's research served to evaluate whether or not training participants in two selected metacognitive skills can help improve participants' ACT mathematics sub-test scores.

CHAPTER TWO: REVIEW OF THE LITERATURE

With slightly more than 3 million seniors attending public high school in the United States during the 2012-2013 school year (National Center for Education Statistics, 2013), more than 1.8 million students took the ACT examination (National ACT Profile, 2014). In addition, slightly more than 1.6 million high school students took the SAT examination (Total Group Profile, p. 1) during the same school year. Inasmuch as most colleges and universities in the United States use the results of one or both of these college entrance examinations as part of the new student college admission process, this clearly portends the critical nature of these examinations. In addition to playing a vital role in the college admission process, often the results of the ACT and/or the SAT examination play an integral part in determining which college-bound students will receive scholarships, special funding, or monies from other cost abatement programs that are often available at many colleges and universities (Moss, Chippendale, Mershon, & Carney, 2012).

In response to the importance placed on a student's college entrance examination scores, there seems to be an ever growing demand for formal and informal preparation programs meant to help students raise their ACT or SAT examination scores (Moss et al., 2012). Over the years, college entrance examination preparation services have become a multi-billion-dollar industry in the United States. Such programs include examination study guides, computer programs, and online programs, as well as private and group in-person tutoring; all of these are designed to help test-takers improve their college examination scores (Buchmann et al., 2010). The costs for these test preparation services can range from $20 for a review book, to $1,000 or more for a classroom program conducted at a school facility, or in some cases a cost of $6,000-$10,000 for private, one-on-one tutoring programs (Buchmann et al., 2010).

As a result of college entrance examination preparation programs becoming the norm, a considerable debate has developed regarding the overall effectiveness of these programs relative to whether or not they can help increase student ACT or SAT examination scores as much as most students or parents would want. In 2002, the Task Force on Standardized College Admission Testing reported that the effect of examination preparation coaching for the SAT and ACT was “minimal and within the standard of errors measurement for the tests” (p. 6). The College Board, the owners of the SAT examination, reported that “coached students are only slightly more likely to have large score gains than un-coached students” (Effects of Coaching on SAT Scores, n.d.). Briggs (2009) wrote that studies evaluating ACT examination preparatory programs indicated that only the private tutoring type of examination preparation program had an effect on ACT examination scores, and that increase affected only one section of the ACT examination (0.4 points on the mathematics section). In fact, commercial courses preparing students to take the ACT examination have been shown not to increase test scores even a full point (What Kind of Test Preparation Is Best?, 2005).

Even so, students and their parents continue to spend billions of dollars a year on college entrance examination preparatory programs even if there is only a slight increase in examination scores. One key reason why hopeful college students might want to take the time and spend the money to take a college entrance examination preparatory course is to make as high a score as possible on their college entrance examination in an effort to be better positioned to enter the career they hope to pursue after graduation from college. In today’s job market and globalization, there is little doubt that high school graduates need to be prepared for college-level work and that the level of preparedness for college-level academic rigor is assessed by the SAT and ACT examinations. As has been the case for some time, the demand for an educated workforce will continue to increase in size and specialty for the foreseeable future (Byrd & McDonald, 2005; Hoyt & Sorensen, 2001). Accordingly, many times college-bound students need to achieve high SAT or ACT test scores so that they can attend a college that offers a degree plan leading into their desired career path. Table 1 illustrates the range of ACT examination scores of incoming freshmen at selected universities in Georgia.

Table 1

ACT Exam 50th Percentile Scoring for Incoming Freshmen at Selected Georgia Universities

Name of university	25th %	75th %	Reference
Georgia Institute of Technology	30	33	http://www.admission.gatech.edu/pdf/2014%20Incoming%20Class%20Profile.pdf
Emory University	30	34	http://apply.emory.edu/discover/fastfacts.php
Southern Polytechnic University	21	26	http://fac-web.spsu.edu/home/prospective/apply/freshmen.html
Morehouse College	18	23	http://www.morehouse.edu/admissions/home/freshmen.shtml
Mercer University	23	28	http://www.bethebear.com/freshman-admissions.cfm
University of Georgia	28	32	https://www.admissions.uga.edu/prospective-students/first-year/fy-profile

Georgia State University	20	25	http://admissions.gsu.edu/how-do-i-apply/high-school-students/freshman-requirements/
Georgia Southern University	21	25	http://admissions.georgiasouthern.edu/requirements/freshman/
Georgia College & State University	23	27	http://www.gcsu.edu/admissions/applying/profile.htm
Kennesaw State University	21	24	http://www.collegedata.com/cs/data/college/college_pg02_tmpl.jhtml?schoolId=1503

In many instances, which college a student gains admission to, and graduates from, has a direct bearing on salary and career path once the student graduates from college and throughout the student's career. Table 2 provides the average beginning and mid-career salaries of graduates from selected universities and colleges in Georgia.

Table 2

Average Starting and Mid-Career Incomes of Graduates of Selected Georgia Universities

Name of university	Average starting salary of graduates	Average mid-career salary of graduates
Georgia Institute of Technology	$ 61,700	$ 111,700
Emory University	$ 51,000	$ 86,100
Southern Polytechnic University	$ 51,000	$ 83,600
Morehouse College	$ 50,300	$ 71,500
Mercer University	$ 47,100	$ 70,100
University of Georgia	$ 45,900	$ 83,600

Georgia State University	$ 44,200	$ 72,900
Georgia Southern University	$ 42,700	$ 70,900
Georgia College & State University	$ 41,200	$ 63,200
Kennesaw State University	$ 40,900	$ 69,300

(Payscale.com – Georgia).

It should be noted that the three Georgia universities that reported the highest first-year student ACT examination scores were also the three Georgia universities that reported having graduates with the highest mid-career salaries.

With the need for an increased ACT or SAT examination score to gain admission into the college of a student's choice, the awareness that most college entrance examination preparatory programs typically result in only a minimal increase in ACT or SAT examination scores, and the awareness that the average income levels of graduates from selected universities in Georgia often are historically relative to the college the person graduated from, it seems reasonable to suggest that a different approach to college preparatory examination programs may be warranted. Research is replete with studies that demonstrate teaching metacognitive strategies to students increases their academic achievement, including their mathematical academic achievement. For example, by using the metacognitive strategy of repetitively calculating a series of mathematics questions similar to those used by ACT, students may experience an improvement in their metacognitive skills to the point that they realize an increase in their ACT examination mathematics sub-test scores. Likewise, students journaling their answers to six metacognitive relevant questions might realize an increase in their ACT mathematics examination scores. Both these metacognitive strategies have been suggested by researchers to improve students' mathematics academic achievement (Papinczak, Peterson, Babri, Ward, Kippers, & Wilkinson, 2012; Pressley, 1986).

Theoretical Background

The results of purposefully training students to improve their metacognitive skills and strategies is the principal consideration of this study. One of the leading pioneers of metacognitive research, John Flavell, defined the concept of metacognition as "one's knowledge of one's own cognition and control and monitor of one's own cognition" (Ozcan, 2014, p. 49). Research has shown that there is a significant relationship between metacognition and academic success (Ozsoy, 2010). Participants in the experimental group in this study will utilize two metacognitive strategies in their preparation to take the ACT examination mathematics sub-test. Members of the experimental groups will be provided worksheets that will have five separate mathematics problems worded similarly to those found on the ACT examination, each weekday throughout the study. For each of these five problems, there will be a set of six additional, like-worded questions for each problem that participants will successfully complete each day (Monday-Friday) for 7 consecutive weeks. In addition, members of the experimental groups will answer six metacognitive questions that are provided on each worksheet. The control group will not utilize either of the study's treatments and will, instead, prepare to take their ACT examination as they normally would. These two metacognitive strategies--the use of repetitive questions and directed journaling--have been shown to positively influence an individual's mathematics academic achievement (McDonald, 2007; Alveen & Koedinger, 2002).

Related Literature

History of College Entrance Examinations

The SAT and ACT examinations have been designed to measure a student's readiness for college. The ways in which the two examinations are designed to measure a student's readiness for college are vastly different. The ACT measures a student's current level of educational development in four subject areas–English, mathematics, reading, and science. The ACT is a curriculum-based achievement test, whereas the SAT, an aptitude test, is designed to measure a student's academic abilities as a predictor of academic performance in college (Briggs, 2009).

The SAT Examination. In the early 1900s, the admissions process for most colleges was confusing to many would-be college students. During this time, there was no universal standard for college admission, as most individual colleges had their own admissions criteria. Not only were admissions criteria a mish-mash of requirements, but in many cases a student who applied to more than one college would be required to take a different admission test for each college. In 1900, the College Entrance Examination Board (CEEB) was formed by the leaders of 12 northeastern universities to bring about some order to the college admissions process at their collective institutions. One practice the CEEB created was the development of a set of standard examinations that were given to college applicants seeking admission at each participating university. Once completed, the examination would be sent back to the CEEB for grading, and the results were made available to each of the 12 universities. This admission test consisted of essay tests in nine subject areas including, but not limited to, English, Greek, Latin, and history. Sometime later, the CEEB created a new admissions test that was comprised of mostly multiple choice questions, and at that time the CEEB renamed the examination the Scholastic Aptitude Test. The first time this "new" Scholastic Aptitude Test (SAT) was administered was in 1926 (Zwick, 2004).

When initially developed, the SAT grew out of the experience of creating the IQ test given to military inductees during World War I. The results of an IQ test helped military leaders determine where and to which military job a person would be assigned during the war. One reason the SAT examination became the test of choice for college admissions was that it was a standardized test. Obviously, college applicants' high school grades were not standardized. In addition, college admissions officials had grown to appreciate the SAT examination as being a tool for predicting which students were most likely to perform well in college (Atkinson & Geiser, 2009).

The Educational Testing Service (ETS) was founded in 1947 when the College Entrance Examination Board, the Carnegie Foundation for the Advancement of Teaching, and the American Council on Education merged as a result of their combined college admission testing activities. Currently, the SAT examination is developed and administered by ETS on behalf of the College Board. The SAT examination is owned by the College Board (Zwick, 2004).

In its current form, the SAT consists of 10 sections made up of an essay for which students have 25 minutes to complete; six 25-minute sections of critical reading, mathematics, and writing sub-tests; two 20-minute sections of critical reading, mathematics, and writing; and one 10-minute multiple-choice writing section (SAT, FAQs about the SAT, http://sat.collegeboard.org/about-tests/sat/faq). The critical reading sub-test consists of three sections, each of which includes multiple-item questions and individual-item questions designed to test the student's ability to discern the meaning and appropriate construction of a common reading passage. The mathematics sub-test is made up of three sections that consist of both multiple-choice questions and questions that require student-produced answers. The writing sub-test also includes three sections; one section of the writing test is made up of individual items and item sets, as well as two non-essay sections (Wiley, Shavelson, & Kurpius, 2014).

The ACT Examination. ACT, Inc., was founded by E. F. Lindquist, a statistician at the University of Iowa. The ACT test was first used in 1959 and was chiefly designed as a competitor to the SAT examination (Atkinson & Geiser, 2009). From its beginning, the ACT examination has always been dissimilar to the SAT examination since the ACT is more closely associated with high school curriculum and the instructional objectives utilized by most secondary schools in the United States than the SAT examination has been. The content of the ACT examination is based on research conducted by ACT, Inc., in determining what is taught in grades 7-12 in the subject areas of English, mathematics, reading, and science (Zwick, 2004).

ACT, Inc., follows the philosophy that students' preparation for college is best assessed by measuring the academic skills they will need to perform college-level work. In addition, ACT, Inc., has stated that the required academic skills for college-level work can be most directly evaluated by reproducing the complexity of college-level work. With that in mind, ACT, Inc., has claimed that its tests are designed to help determine how well students "solve problems, grasp implied meanings, draw inferences, evaluate ideas, and make judgments in subject-matter areas important to success in college" (ACT Technical Manual, 2007, p. 3).

The ACT examination is structurally different from the SAT examination, in large part due to its being a true achievement test and not an aptitude test, as the SAT examination is. ACT, Inc., has indicated that the advantage of achievement tests over aptitude tests chiefly lies in the fact that achievement tests measure many of the same skills that are taught in high school and as such, achievement tests are the best predictors of college readiness by high school students (ACT Technical Manual, 2007, p. 3).

ACT, Inc., has argued that the ACT examination is an excellent predictor of academic success in college inasmuch as it assesses how well prepared high school students are for college-level academic work. The contents of the ACT examination were determined through a detailed assessment of relevant information by ACT, Inc. The curriculum frameworks for grades 7-12 are gathered from all states in the United States that make such frameworks public. In addition, textbooks on state-approved lists for courses are reviewed by ACT, Inc. Finally, educators of both secondary and postsecondary levels are consulted on the knowledge and skills included in the reviewed frameworks and textbooks (ACT Technical Manual, 2007).

On an ongoing basis, ACT, Inc., evaluates proposed new tests for content and fairness by conducting thorough review processes. The preliminary versions of new tests are reviewed to ensure items contained on the tests are accurate and fair and conform to good test construction practices. The first review, performed by ACT, Inc., staff, checks for content accuracy and conformity to the ACT style. The tests are then reviewed by external content and fairness experts. Next, a content review panel and a fairness review panel are convened to discuss with ACT staff the members' reviews of the new ACT examinations. The review panels are comprised of high school teachers, curriculum specialists, and college/university faculty members. Where appropriate, ACT will make changes to the new tests as needed. ACT, Inc., claimed that "at least sixteen independent reviews" are made of each test item before it appears on a national form of the ACT examination (ACT Technical Manual, 2007, p. 14).

The ACT examination is a multiple-choice, time-limited test that is made up of four sub-tests: English, mathematics, reading, and science. There is an optional writing test that can be included with the standard ACT examination. Students are given an allotted time for each sub-test: 45 minutes for the English sub-test (75 questions), 60 minutes for the mathematics sub-test (60 questions), 35 minutes for the reading sub-test (40 questions), and 35 minutes for the science sub-test (40 questions). The ACT writing sub-test is an optional test in which students are allotted 30 minutes to respond to one prompt (The ACT, http://www.actstudent.org/faq/numb questions.html). Overall, the ACT examination is designed to assess the students' content knowledge and their ability to analyze, infer, solve problems, and reason (Lane, Kalberg, Mofield, Wehby, & Parks, 2009).

Student test scores are incorporated into the ACT College Readiness Benchmark program. This program has enabled ACT, Inc., to develop the ability to project the minimum ACT test scores required for students to achieve in order have a high likelihood of success in first-year college courses in English composition, social science courses, algebra, and biology. The benchmarks are calculated so that students who meet a benchmark ACT score in one of the subject areas assessed would have a 50% chance of making a B or better or a 75% chance of making a C or better in the corresponding college course(s) (ACT Technical Manual, 2007).

The ACT Condition of College and Career Readiness Report: Georgia is an annual report produced by ACT, Inc., that provides the percentage of a given year's high school graduates who took the ACT examination; their average composite score; and the percentage of graduates who met ACT's benchmark for English, reading, mathematics, and science, both nationally and by state (2014). The 2014 report showed that 53% of all 2014 high school graduates in Georgia took the ACT examination. The report also showed that 2014 high school graduates in Georgia made an average ACT Composite Score of 20.8. The following table provides the breakdown of the average sub-test score of each of the four subject areas tested by the ACT examination for the state of Georgia's 2014 high school graduates. In addition, the table shows the number of 2014 high school graduates in Georgia who met ACT's benchmark ACT examination scores for the same four subject areas tested by the ACT examination.

Table 3

2014 Georgia Percentage of High School Graduates Tested, Average Composite Score, Percent Meeting Benchmarks by Subject

Subject area	ACT test scores by Georgia 2014 graduates	Percentage of Georgia 2014 graduates who met ACT test subject area benchmark scores
English	23	64
Reading	22	44
Mathematics	17	38
Science	18	34

(ACT, Inc., The Condition of College and Career Readiness Georgia 2014, p. 14).

When evaluating the percentage of U.S. 2014 high school graduates who took the ACT examination in 2014, Georgia ranked 23rd in ACT composite scores. The highest subject area for Georgia's 2014 high school graduates was English (23%), and the lowest subject area was mathematics (17%) (ACT, Inc., The Condition of College and Career Readiness Georgia 2014).

Shadow Education for College Entrance Examinations

The concept of "shadow education" has been described as any educational activities that take place outside the normal educational system and are meant to improve a student's ability to successfully move through the educational system (Buchmann et al., 2010). One area in which shadow education exists is college examination preparatory programs--those programs designed to assist high school students in improving their college entrance examination scores. There are many contributors to the equation used to determine whether or not an applicant is admitted to a particular college or university, such as family background, socio-economic status of the student's family, and the culture in which the student was raised (i.e., linguistic skills, behavioral skills, etc.). However, in the event there are any perceived negative contributors affecting a prospective student's application, often there are offsetting positive contributors in favor of the applicant and his or her admission (Buchmann et al., 2010), including ACT or SAT examination scores.

A particular example of shadow education includes the myriad college entrance examination preparatory programs, some private and some public. The costs associated with these college entrance examination preparatory programs run the gamut. Public preparatory programs are typically associated with public schools. These programs might include informal teacher-led preparatory sessions or an established course provided by the school, both of which are typically provided free of charge to the school's students. Both organizations that administer college entrance examinations, the College Board and ACT, Inc., offer their own study guides to would-be test-takers to purchase and be used to prepare for their examinations. One selling point for the College Board and ACT's study guides is that the questions contained in the books are touted to be similarly written as those on the actual tests. In addition, both organizations offer Internet-based test preparatory programs, a question of the day, or video and DVD study opportunities (ACT, Inc. The Real ACT Prep Guide, 2016; The College Board, 2016).

Commercial college entrance examination preparatory programs are offered to would-be SAT and ACT test takers nationwide. One publically available college entrance examination program is the free online preparatory program provided by the company Number 2. This web site offers test preparation questions for both the SAT and ACT examinations. In addition, there is an abundance of other commercially available test preparatory programs, some of which are printed study guides, other online test prep websites, and group and individual tutoring programs. The costs associated with commercial test preparatory coaching programs can range from as little as $20 to several thousand dollars.

Outcomes of coaching college entrance examination preparatory programs. There can be positive outcomes derived from a student participating in a college entrance examination preparatory program that utilizes a coaching process, regardless of whether the program is live or delivered via video, or within a group or individual tutoring process. Such positive outcomes from a coaching process might include improved student study behaviors, better student effort in all testing categories, greater familiarity with questions types, or perhaps simply encouragement to students to begin their test preparation earlier than they otherwise might (Loken, Radlinski, Crespi, Millet, & Cushing, 2004). However, there is little objective evidence that demonstrates actual examination score gains that can be directly linked to a particular preparatory program (Moss et al., 2012).

Derek Briggs, in a National Association for College Admission Counseling discussion paper, described the results of three large-scale studies that evaluated coaching for college entrance examinations. He reported a consensus on the average effect that coaching programs had on these examinations:

> Coaching has a positive effect on SAT performance, but the magnitude of the effect is small. The effect of coaching is larger on the math section of the exam (10-20 points) than it is for the critical reading section (5-10 points). There is mixed evidence with respect of coaching on ACT performance. Only two studies have been conducted. The most recent evidence indicates that only private tutoring has a small effect of .4 points on the math section of the exam. (2009, p. 12)

Other research regarding ACT test preparatory programs has suggested that short-term test preparation might provide a small positive impact on a student's overall score. However, long term interventions, such as taking core college courses or taking Advanced Placement courses in high school, could potentially produce greater ACT composite score increases than short-term test preparation might (Lane et al., 2009).

Metacognition

Metacognition can be conceptually described as "one's knowledge concerning one's own cognitive processes and products" (Flavell, 1976, p. 232). Alan Schoenfeld (1992), in a chapter he contributed to the book *A Handbook for Research on Mathematics Teaching and Learning*, described metacognition as having "multiple and almost disjoint meanings (e.g., knowledge about one's thought processes, self-regulation during problem solving) which makes it difficult to use as a concept" (pp. 334-370).

Adrian Wells, in his book entitled *Emotional Disorders in Metacognition* (2000), further defined metacognition as a multi-faceted concept comprised of knowledge, processes, and strategies that help monitor, control, or appraise one's cognition. Wells also noted there is a basic distinction between two principal components of metacognitive strategies: metacognitive regulation and metacognitive knowledge. Whereas metacognitive regulation refers to a person's executive functions, metacognitive knowledge is made up of the information individuals have about their own cognition and about learning strategies that affect their cognition.

The following table is a series of concepts described in literature about metacognition, and is provided to help explain metacognition more accurately than perhaps a single definition might afford.

Table 4

Common Concept Descriptions of Metacognition

Concept	Description
Metacognitive knowledge about persons	Includes a person's beliefs about intra- and inter-individual differences and cognition
Metacognitive knowledge about tasks	The information individuals have available to apply to a cognitive activity and their knowledge about the task demands of a given situation
Metacognitive knowledge about strategies	An individual's awareness of and beliefs about strategies available to complete a task
Level of conscious awareness of one's metacognitive knowledge	Retrieval and construction of one's metacognitive knowledge that can be either unconscious or conscious
Limits of one's metacognitive knowledge	Can be accurate or inaccurate; may not always be activated when needed, may not have a great deal of influence when activated, and may not provide a beneficial effect when it is influential
Duration of metacognitive experiences	Can be lengthy or momentary and when a person is consciously working through a challenging problem
Occurrence of metacognition	Likely to occur when one is engaged in intentional and reflective intellectual activities such as problem solving
Effects of metacognitive Experiences	Can lead to the establishment of new goals or to revise or abandon old goals; can add to a person's existing metacognitive knowledge base
Memory-monitoring, self-regulation, consciousness, awareness, meta-reasoning	Other terms for metacognition
Transfer	Use of a metacognitive skill learned in one context to solve a problem in a different context
Cognition	A general term for thinking and which can be distinguished from metacognition, which is thinking about thinking

(Dawson, 2008, p. 4).

Metacognitive regulation. Metacognitive regulation involves the process that helps one facilitate and support the evaluation and control of the learning process and is considered to be especially important to facilitate problem solving (Tarricone, 2011). Metacognitive regulation can also be thought of as "self-management" of cognition that can involve reflective "self-appraisal," which supports the awareness of metacognitive experiences and has been labeled executive control (Tarricone, 2011). Metacognitive regulation has been described as a "secondary cluster" of metacognition (Tarricone, 2011). Metacognition regulation is associated with how students may regulate and arrange their learning processes and memories (Eker, 2014).

Self-regulation, a sub-process of metacognition, involves processes such as self-control, planning, organizing, self-instruction, self-monitoring, and self-evaluation (Tarricone, 2011). The important interaction between metacognition and self-regulation is the regulation and monitoring of metacognitive strategies. These strategies include processes such as identifying task demands and tasks goals, determining plans and actions, and reviewing and monitoring strategies (Tarricone, 2011).

Metacognitive knowledge. Kramaski and Zoldan (2008) described metacognitive knowledge as representing what a person knows about his or her own cognition; how a person uses procedures and strategies; and when and why a person uses a particular strategy. Monique Boekaert, as quoted in Panaoura and Philippou (2007), defined metacognitive knowledge as referring "to aspects of student's theory of mind, theory of self, theory of learning, and learning environments" (p. 150). The authors continued their description of metacognitive knowledge by writing that it enables students to better monitor and access their conceptual and procedural knowledge related to a particular education domain.

Gregory Schraw (1998), an early advocate of the concept of metacognition, suggested there are three different kinds of metacognitive knowledge: declarative knowledge, procedural knowledge, and conditional knowledge. Table 5 provides a brief description of Schraw's ideas associated with the three different kinds of metacognitive knowledge.

Table 5

Categories of Metacognitive Knowledge

Sub-categories of metacognitive knowledge	Description
Declarative knowledge	Knowing "about" things
Procedural knowledge	Knowing "how" to do things
Conditional knowledge	Knowing the "why" and "when" aspects of cognition

(Schraw, 1998, p. 114).

Declarative knowledge. Tarricone (2011) described declarative knowledge as a sub-category of metacognitive knowledge. Declarative knowledge includes a person's knowledge of self and others as cognitive beings, knowledge of task demands, and strategy knowledge, as well as knowledge informed by one's feeling and knowing the requisite information needed to meet task demands. Declarative knowledge can also be considered as stable knowledge and is constant and well-established, yet it can also be fallible (Tarricone, 2011).

Procedural knowledge. Procedural knowledge "refers to knowledge of processes and actions or essentially knowing how" (Tarricone, 2011, p. 160). Additionally, procedural knowledge can be further thought of as a person's effectiveness in identifying strategies that match the task the person is attempting to complete and knowing how to address the task's demands (Tarricone, 2011). Tarricone (2011) stated that procedural knowledge can be developed through application and experience and can subsequently become an automatic process or exemplified as skills invoked by a person in familiar problem-solving situations.

Conditional knowledge. This sub-category of metacognitive knowledge engages a person's ability to know why and when to use declarative and procedural knowledge. Conditional knowledge can be thought of as one's knowledge and awareness of conditions that affect learning--specifically the "why" strategies and "when" strategies that should be applied when appropriate (Tarricone, 2011). Conditional knowledge can be limited by inadequate domain knowledge, weak monitoring, lack of awareness, or ineffective strategies of task demands. Indeed, conditional knowledge can support a person's ability to transfer and apply strategies in complex problems and contexts (Tarricone, 2011).

Metacognitive strategies. Metacognition is typically regulated by three top-domain strategies: planning, monitoring, and evaluation (Eker, 2014). Planning can be thought of as learners evaluating their own strengths and weaknesses and then making a plan on how to address their weaknesses and continue to improve areas of academic strength. As students begin their planning process, they will consider many factors including time requirements, necessary materials, and the best ways to organize the materials they will use to successfully complete the process they are planning (Zimmerman & Pons, 1986).

Monitoring enables students to focus their attention on learning. This ability to focus allows for students to distinguish their efficient and inefficient efforts, which then can provide a means by which the students might choose the necessary and appropriate skills to succeed academically (Eker, 2014).

Finally, evaluation provides a means for people to evaluate themselves at the conclusion of the learning process. As students become aware of their ability to use metacognitive strategies and how to put them into practice at the right place and time, metacognitive strategies can become effective tools in increasing the students' academic achievement. To enhance these metacognitive strategies, it is very important that students learn to control their attention, study environment, and motivation (Eker, 2014). Research has often demonstrated "the importance of extensive practice followed by explicit guidance in the class by using self-questioning strategy of what, when, why, and how" (Kramarski & Zoldan, 2008, p. 138).

Eker (2014) noted that Winnie and Perrier (2000) stated that metacognitive strategies could be considered important to the process of becoming self-aware of one's strengths and weaknesses. This can be accomplished when collected information is used to understand how a task is performed and as a person's knowledge about his or her own individual learning processes and tendency to control these processes in a learning environment. Additionally, Livingston (2003) stated that metacognitive strategies are sequential processes that people utilize to control their cognitive activities and to ensure that a cognitive goals has been met.

Studies have demonstrated how metacognitive strategies can have a positive impact on mathematics academic achievement (Schneider & Artelt, 2010; Yang & Lee, 2015). While students often use different metacognitive strategies, their use has consistently been demonstrated to help improve student mathematics achievement. Even if a student is not strong in every metacognitive strategy, using limited metacognitive strategies is sufficient for students to attain better academic performance, even if only one metacognitive strategy is practiced by the student (Yunus & Ali, 2008).

For example, once students have acquired the ability to perform mathematical computations, their ability to "think through" the problem-solving calculus can be successful based on their ability to utilize one, two, or all three metacognitive strategies. Table 6 provides an example of what metacognitive strategies may be employed in a mathematics problem-solving process.

Table 6

Problem Solving Steps and Related Metacognitive Strategy

Problem solving steps	Metacognitive strategy category
Clarifying goals	Planning
Understanding the problem solving process	Planning
Understanding important concepts	Planning
Clarifying any confusion solving a problem	Monitoring
Predicting how best to solve the problem	Monitoring
Choosing the correct mathematical actions	Evaluation

(Gourgey, 2002, p. 22).

As noted above, metacognitive knowledge refers to a person's declarative knowledge (knowing about things), procedural knowledge (knowing how to do things), and conditional knowledge (knowing the why and when aspects of cognition). These three distinct delineations of the overarching concept of metacognitive knowledge require that they interact between person, task, and strategy characteristics (Flavell, 1979). Metacognitive knowledge and skills (also known as metacognitive procedural knowledge) are unique in the cognitive system in that they are both forms of declarative and procedural knowledge, as well as being a mechanism by which both forms of knowledge may be modified (Walters & Schneider, 2010).

Table 7 provides a partial list of metacognitive strategies that can be taught or may be routinely utilized by school-aged children and adults. The purpose of this table is to provide a ready resource of possible metacognitive strategies that may be used to help increase a student's academic achievement.

Table 7

Description of Selected Metacognitive Strategies

Metacognitive strategies	Description
Planning	Learners know the rules and steps involved in problem solving, time requirements, and goals.
Generating questions	Learners ask themselves what they do not know and what they do know at the beginning of problem solving.
Choosing consciously	Learners understand the consequences of their choices and actions, promoting self-awareness so that they learn from their mistakes.
Setting and pursuing goals	Goals are defined as "expectations about the intellectual, social, and emotional outcomes for students as a consequence of their classroom experiences."
Evaluating the way of acting and thinking	A guided self-evaluation process utilizes checklists that focus on the thinking process and self-evaluation that will increase when applied more independently.
Paraphrasing, elaborating, and reflection of ideas	Learners will restate, translate, and paraphrase other learners' ideas.
Clarifying learners' terminology	Learners clarify vague terminology when making judgments.
Problem solving	Application of existing knowledge to an unfamiliar situations gains new knowledge for

	the learner--an excellent activity to enhance metacognitive strategies.
Thinking aloud	Learners talk about their thinking aloud, which helps them identify their thinking skills.
Journal keeping	Use of a diary throughout the learning experience can facilitate the creation and expression of thoughts and actions.
Cooperative learning	Creation of opportunities for learners to work together in small groups enhances learning.
Modeling	This occurs when teachers demonstrate the process involved in performing difficult tasks.

(du Toit & Kotze, 2009, pp. 58-61).

Briggs (1988) said, “Teaching students how to use metacognitive strategies increases academic achievement,” as quoted in Akturk and Sahin (2011, p. 3735) when they summed up the importance of metacognitive strategies. Students with advanced metacognitive skills are aware of what they know and what they do not know. Typically, students with advanced metacognitive skills monitor their own learning, express their thoughts and opinions about the information they are learning, update their knowledge base, and develop and implement new learning strategies. According to Jones, Farquhar, and Surry, the more students’ awareness of metacognition increases, the more students’ effectiveness increases (Akturk & Sahin, 2011).

Metacognition and Cognition

The relationship between metacognition and cognition is one of coexistence. Paris and Winograd (1990) described how metacognition is embedded in cognitive development and is the kind of knowledge and executive ability that develop with experience and schooling. As such, metacognition is both a product and a producer of cognitive development. The two researchers also noted that metacognition provides "cognitive tools for accomplishing the craft of schooling" (p. 22) and that metacognition can be domain specific, as exemplified in mathematics by using algorithms to check computations or using general heuristics for solving problems. Aukrust (2011) cautioned against the temptation of concluding that the relationship between cognition and metacognition is unidirectional. Aukrust noted not only that metacognitive training can promote greater mathematics achievement, but also that reciprocal causation is most likely; improvements in metacognition contribute to improvements in cognition, which in turn can contribute to further improvements in metacognition. To further illustrate the relationship between metacognition and cognition, Kaur (2013) noted that problem solving involves the interplay of four factors: domain-specific knowledge, heuristic methods, metacognitive knowledge, and affection (beliefs and emotions).

The interplay between cognition and metacognition can also be illustrated by research that has suggested a more successful approach to improved mathematics achievement requires teaching heuristics concurrently with metacognitive skills, while exposing students to a variety of situations, so that learners may understand when and how to use a certain heuristic (Aukrust, 2011). Finally, there are three aspects of cognitive training that may contribute to the effectiveness of metacognitive instruction: 1) students and teachers have common goals in coaching situations; 2) coaching involves ongoing assessment of students' levels of performance so that tasks' difficulty can be adjusted; and 3) coaching involves the metacognitive strategy of regulation used by both teacher and student (Paris & Winograd, 1990).

Metacognition and Mathematics

Gourgey (2002) wrote that Schoenfeld described his theory on the interaction of cognitive and metacognitive processes in mathematical problem solving by identifying four categories of knowledge and behavior. These categories are "resources (mathematical knowledge), heuristics (problem-solving techniques), control (metacognition), and belief systems (attitudes)" (p. 23). To this point, Schoenfeld, in what many consider to be a seminal description of the relationship between the cognitive and the metacognitive, indicated that mathematics instruction often focuses on mathematical knowledge and problem-solving techniques. However, Schoenfeld believed that all too often student failure in problem solving is due to a lack of emphasis on metacognitive skills and attitudes. Students often possess the knowledge required to complete the mathematical problem; however, they fail to use it appropriately because they do not know how to evaluate and monitor their decisions, nor do they realize it is to their advantage to do so (Gourgey, 2002).

An analysis of literature shows an individual's mathematical ability can be enhanced with purposeful metacognitive training (Hudesman, Crosby, Flugman, Issac, Everson, & Clay, 2013; Pennequin, Sorel, & Mainguy, 2010; Throndsen, 2010). While many studies concentrated on different metacognitive skills and strategies, the outcome of these studies consistently indicated an improvement in participant mathematics achievement. In addition, Papinczak, Peterson, Babri, Ward, Kippers, and Wilkinson (2012) stated that specific metacognitive skills, including self-regulation and problem-solving were important factors in both academic success and self-confidence when used with student-generated questions.

Metacognitive skills' impact on early elementary school students' mathematical proficiency. Elementary-aged children experience development of the metacognitive skill of self-regulation over time. Young students' self-regulation ability becomes an important factor in their academic achievement in multiple domains, including mathematics (Throndsen, 2010). Throndsen (2010) evaluated students' (second grade) strategy of using the think-aloud metacognitive skill while they worked with addition and subtraction problems. The think-aloud metacognitive skill uses the students' audible self-report as a means to reflect their actual mathematical processing and enables students to report the contents of their working memory (Throndsen, 2010). Throndsen reported that this metacognitive skill can be learned by young children and can lead to an improvement in their mathematical achievement.

Metacognitive skills' impact on middle school-aged students' mathematical proficiency. In a study conducted by Kramarski, Mevarech, and Lieberman (2001), a group of seventh-grade students were given metacognitive instruction in which they were made explicitly aware of the problem-solving process and the metacognitive strategy of regulation. As students worked through their mathematics problems, they were instructed to ask themselves three kinds of metacognitive questions: comprehension questions (describing the type of problem), strategic questions (justifying the strategy they choose for solving the problem), and connection questions (specifying how the problem was different from and similar to prior problems they had encountered working through their mathematics assignments). When compared to their classmates who did not receive the metacognitive instructions, student given the metacognitive instructions did significantly better on measures of their understanding of how to solve the mathematics problems.

Metacognitive skills' impact on secondary school-aged students' mathematical proficiency. In a follow-up study, Bracha Kramarski, along with fellow researcher, Vered Dudai (2009), studied a group of ninth-grade students who also utilized metacognitive questioning that typically encourages students to engage in self-regulating their learning. For this study, however, the researchers added a fourth type of question students used in the metacognitive questioning process: reflection questions. Kramarski and Dudai noted that 1) comprehension questions help students understand the information of the task/problem to be solved; 2) connection questions prompt students to understand tasks' deeper-level relational structures by articulating thoughts and explicit explanations; 3) strategic questions encourage students to plan and to select the appropriate problem-solving strategy. The researchers also suggested that reflection questions help students monitor and evaluate their problem-solving processes, encouraging students to consider various perspectives and values regarding their selected solutions (Kramarski & Dudai, 2009). Again, participants in the experimental group "significantly outperformed" students in the study's control group in solving mathematical problems (Kramarski & Dudai, 2009).

Metacognitive skills' impact on college-aged adults' mathematical proficiency. Hudesman, Crosby, Flugman, Issac, Everson, and Clay (2013) studied a metacognitive skill development process used by selected students enrolled in a community college mathematics developmental course. The researchers evaluated the effects on an experimental group of students completing a self-reflection form for questions they originally answered incorrectly on mathematics quizzes. The results of the research demonstrated that students who were in the experimental group improved their mathematics achievement more than students who did not complete the self-reflection form. In fact, the researchers concluded by reporting that students in the experimental group passed their college-level mathematics course at the same rate as students who were not required to take a developmental mathematics course (Hudesman et al., 2013).

Metacognitive skills' impact on older adults' mathematical proficiency. Pennequin, Sorel, & Mainguy (2010) wrote that there is a general consensus that the effect of age on mathematical problem-solving processes declines over time. Even so, a person's metacognitive skills continue to develop with age. Many metacognitive skills become linked with age, which can often help solidify people's problem-solving abilities as they grow older. This is true even to the point that the more people control and monitor their metacognitive skills, the better their ability to solve mathematical word problems becomes (Pennequin et al., 2010). In a study of 32 participants with an average age of over 81 years old, Pennequin et al. demonstrated that participants who completed a 5-week metacognitive training program showed significantly higher mathematical performance than those in the study's control group. Additionally, the researchers found a link between metacognition, executive functions, processing speed, problem-solving abilities, and the importance of teaching general strategies for solving mathematical problems as people age.

Metacognitive Strategies in Mathematics

Self-assessment. Self-assessment is a metacognitive strategy that has been described as "the involvement of students identifying standards and/or criteria to apply to their work and make judgments about the extent to which they have met these criteria and standards" (McDonald, 2007, p. 25). McDonald (2007) proposed that self-assessment is not only comprised of testing and grading one's own understanding of a topic, but it also involves an active process for the student to evaluate what is a good, mediocre, or poor effort within the learning process. In other words, according to McDonald, self-assessment can be thought of as an act of evaluating one's own level of understanding, performance, and knowledge within a metacognitive framework.

Additionally, the feedback received through self-assessment may confirm the correctness of low-confidence answers to some questions being assessed. This could then enable learners to reduce the difference between their perceived performance and actual performance, ultimately allowing them to adjust their subjective assessments of their knowledge (Butler, Karpicke, & Roediger, 2008). This phenomenon could enhance students' subjective assessments of their knowledge and correct any initial metacognitive errors (Butler et al., 2008). Furthermore, Logan, Castel, Harber, and Viehman (2012) suggested that there is a long-term retention benefit when using metacognitive strategies such as self-assessments and feedback if they are spaced apart in time, rather than massed together. This "spacing effect" has been documented in a number of instances and has been considered a highly robust phenomenon (Cepeda, Pashlar, Vul, and Wixted, 2006, p. 354; Glenberg, 1976, p. 1). On an applied level, Logan et al. (2012) indicated that spaced schedules would be ideal for students when studying for tests or exams. However, the authors admitted that spaced strategies are often not used by school-aged children and that additional evidence suggests that participants often fail to appreciate the benefits accrued by spaced practice (Logan et al., 2012). Indeed, research in the area of metacognition has suggested that individuals typically prefer massed practice (or fail to understand the benefits of spacing) (Logan et al., 2012).

Part of a self-assessment process may include the student noting answers to questions being assessed as either being correct or incorrect. Granott and Parziale (2002) found that when students were asked to explain why answers to some test questions were correct and why answers to other questions were incorrect, the students who were able to adequately explain their answers learned more than those who were not able to explain their correct and incorrect answers. The researchers also found that when they encouraged students to explain problem-solving exercises, there was an increase in the probability that the students would seek an explanation to the problem. In fact, when students were told that their answer to a problem was incorrect and were not encouraged to explain why the answers were incorrect, often they simply accepted the fact and did not think about why it was wrong or how they might generate correct answers in the future. However, when students learned their answers were wrong and were subsequently encouraged to explain how the researcher generated the correct answer, the student's accuracy in problem-solving increased. The researchers found that children who showed the highest increases in successfully explaining the researcher's reason, also showed the largest increase in generating the correct answers on their own (Granott & Parziale, 2002). Last, the researchers found when students were asked to explain both correct and incorrect answers on a test or worksheet, they appeared to search considerably more deeply into why their answer was correct or incorrect, resulting in the students more often generating conceptually more sophisticated solutions (Granott & Parziale, 2002).

Repetitive problem solving. Schneider and Artelt (2010) described Pressley's opinion (Pressley, 1986) that "mathematic strategies" is not only a broad, general term, but that it is actually very similar in meaning to the metacognitive relevant term "procedural knowledge." Because of the similarity in meaning of these two terms, mathematical algorithms and problem-solving routines can be considered to be strategies or relative to metacognition procedural knowledge. Schneider and Artelt listed Pressley's proposed principles of teaching mathematics: 1) explicit teaching; 2) teaching specific strategy knowledge; 3) a need for students to acquire general knowledge; 4) the enrichment of the student's knowledge base; and 5) the need to practice each component separately before attempts are made to coordinate the components needed to solve a mathematical problem. Of particular interest for this study is Pressley's suggestion that students enrich their knowledge base in an effort to improve their strategies to solve mathematics problems. Schneider and Artelt wrote that Pressley described one procedure to enrich students' knowledge, and thereby their procedural knowledge, by repeatedly practicing mathematical operations.

Writing problem-solving processes. Pugalee (2004) found that students who wrote about their problem-solving processes produced the correct solution at a statistically higher rate than those students who used the think-aloud metacognitive process. He found that students who wrote descriptions of their processes produced more orientation and execution statements than students who only verbalized their responses, as traditionally found in the think-aloud process (Pugalee, 2004). Pugalee also demonstrated that writing can be a tool for supporting a metacognitive framework and that physically writing about one's problem-solving processes is more effective than verbally describing the process as found in the metacognitive strategy, the think-aloud process.

One method suggested to assist students in providing written descriptions of their problem-solving processes is for them to write the answers to a series of self-posed questions. Mevarech and Amrany (2008) suggested that students should answer at least one of each of the following four types of questions, including a: 1) comprehensive question; 2) connection question; 3) strategy-related question; 4) reflection question. Table 8 provides sample questions for each of the four question types.

Table 8

Types and Samples of Metacognitive Questions

Question type	Sample question
Comprehension question	What was the problem all about?
Connection question	What are the similarities and differences between the current problem and problems you have solved before?

Strategy question	What strategies are appropriate for solving the problem?
Reflection question	Does the solution make sense?
Reflection question	Can I solve the problem differently?
Reflection question	Did I consider all relevant information?

(Mevarech & Amrany, 2008, p. 151).

Mevarech and Amrany (2008) reported that members of their experimental group, the students who underwent metacognitive training to utilize this type of question, experienced “significant” differences between them and the control group in relation to their individual mathematics achievement and their regulation of cognition. In addition, the researchers found that students in their experimental group were able to transfer their knowledge to new situations, including testing time limitations and stress associated with taking a high-stakes examination, better than students in the control group. To help students incorporate their suggested questions, the researchers recommended printing these metacognitive-relevant questions on their study worksheets and that students physically write out their answers to the questions (Mevarech & Amrany, 2008).

Summary

The SAT and ACT examinations are the most common college entrance examinations used in the college admission process in the United States. Both examinations have been utilized as part of the college admission process for decades. While there has been some movement away from using either the SAT or ACT examinations in the college admission process, it seems that these examinations will continue to play an integral role in the admissions process for the foreseeable future. Due to the vital role these examinations play in the college admissions process, many students and their parents willingly pay for examination preparatory programs, which can cost anywhere from $20 to thousands of dollars. While there are many types of college examination preparatory programs available to students, research on score improvement shows the limited positive results of such programs (Briggs, 2009). Students and their parents, however, continue to use college entrance examination preparatory programs in an effort to boost entrance examination scores. In doing so, the college entrance examination preparatory business has grown into a multibillion-dollar industry.

The fuel to help build this multibillion-dollar college preparatory industry is principally parental and student awareness that even a slight increase in college entrance examination scores can play a disproportionate role in the college admissions process. For example, more than a third of colleges and universities that participated in a study on the college entrance examinations agreed that an increase of 20 points on the SAT-M test, or an increase of 10 points on the SAT-CR test would “significantly improve student’s likelihood of admission” (Briggs, 2009, p. 19). With such a relatively small increase in points making it more likely that a student is admitted into a college, it is little wonder students and parents alike pursue college entrance examination preparatory programs with such vigor that they cumulatively spend billions of dollars a year on what seems to be a limited measure of success in raising entrance examination scores. As important as college entrance examinations are for students gaining admission to the college of their choice, it is worthwhile to develop a different method of construct of college entrance examination preparatory programs.

Perhaps using a different methodology to approach college entrance examination preparatory programs should be considered–specifically, the training of students to improve their metacognitive skills and strategies. Metacognition is defined as “one’s knowledge concerning one’s own cognitive processes and products” (Flavell, 1976, p. 232). Individuals gain knowledge on how they learn as they develop from childhood through adulthood. Direct instruction over metacognitive skills and knowledge has been shown to improve individual learning (Waters & Schneider, 2010). Erickson and Heit (2013) argued that metacognition plays a crucial role in gauging one’s own knowledge, specifically in the area of mathematics. If a college examination preparatory program can be used to enhance a student’s metacognitive skills and associated strategies of planning, monitoring, and self-regulation effectively, then it may well increase a student’s college entrance mathematics sub-test examination scores. This hypothesis is similar to Eker’s (2014) contention that academic achievement can be improved routinely when students utilize their metacognition skills and strategies.

Improving a test-taker’s metacognitive skills and strategies can invoke the person’s metacognitive knowledge, procedural knowledge, and conditional knowledge. Implementing a strategy of improving one’s metacognitive reflection and regulation that occurs in problem solving can occur by teaching metacognitive skills and strategies (Waters & Schneider, 2010). John Flavell, considered by most to be the father of the concept of metacognition, contended that a person’s metacognitive ability improves with practice, so one way to become better at invoking one’s metacognition is to practice using it (Stillman & Mevarech, 2010).

In conclusion, the following statistics bring into focus the untenable situation many Georgia high school graduates face: 1) only 38% of 2014 high school graduates from Georgia met ACT, Inc.’s benchmark for college readiness for mathematics; and 2) the average Georgia high school student’s ACT mathematics sub-test score is 17, and is the lowest score of the four subject areas tested by the ACT examination. Knowing this, the situation of many Georgia high school graduates is tenuous as to whether or not they will be accepted to their first choice of colleges. The life-long income of Georgia high school graduates could be severely and negatively affected if they are not able to get into a top-tier university in Georgia. Taken together, these facts seemingly call into question the future of many Georgia high school students. This being the case, it seems reasonable to expect parents of Georgia high school students to continue seeking different forms of assistance to help increase their children's college entrance examination scores. As noted above, though, the value of most college entrance examination preparatory programs is questionable at best.

However, research shows that teaching metacognitive strategies and skills can improve mathematics achievement (Erickson & Heit, 2015; Panaoura & Philippou, 2007; Schraw, 1998). It seems reasonable to suggest that high school teachers can play an important role in helping students understand their own metacognition and cognition (Schraw, 1998). For example, teachers can take time to discuss with their students the importance of metacognitive knowledge and regulation. One way teachers can do this is to make an effort to model their own metacognition for students (Schraw, 1998). Another way students can improve their metacognition is by utilizing the metacognitive process of calculating multiple sets of mathematics problems. Furthermore, using the metacognitive strategy of directed journaling of answering metacognitive-relevant questions can potentially increase mathematics achievement (Callahan & Garofalo, 1987; Mevarech & Amrany, 2008; Panaoura & Philippou, 2007; Pugalee, 2004; Schneider & Artelt, 2010). By combining these two specific metacognitive skills, students will hopefully be able to generate feedback about the state of their knowledge of calculating solutions to selected mathematical problems and their level of preparedness to be successful in their mathematics achievement (Butler et al., 2008).

CHAPTER THREE: METHOD

The purpose of this study was to determine the effects of participants' utilization of two specific metacognitive strategies in impacting their ACT mathematics sub-test examination scores. There were two groups of participants in this study: an experimental group that completed the study's treatment during the prescribed time frame, and a control group that did not undergo the study's treatment. The experimental group received seven weekly workbooks that contained worksheets consisting of 25 similarly worded mathematics problems found in the ACT study guide. Included on the worksheets were six metacognitive-relevant questions that participants had to answer when they finished calculating each day's worksheets. The experimental group completed a daily worksheet made up of a series of five sets of six similarly worded selected mathematics questions found in the ACT study guide. In addition, members of the experimental group answered a set of six provided metacognitive-relevant questions, 5 days a week. The members of the experimental group completed these two assignments each week for the duration of the 7 weeks of the treatment. The second group, the control group, did not receive any treatment during the course of this study.

Design

This quasi-experimental quantitative study used a non-equivalent post-test only control design. Participants were conveniently assigned to either the experimental group or the control group. The experimental group started the study's treatment on October 26, 2015, and completed the treatment on December 11, 2015. Participants in both the experimental and control groups took the regularly scheduled ACT examination on December 12, 2015, which served as the study's post-test.

This study was a quasi-experimental design instead of a true experimental design primarily due to the fact the participants were not randomly assigned to either one of the two participant groups. Instead, participants were conveniently assigned to one of the two groups created for this study by their respective high school counselors. The purpose of this type of research design is to assess any changes to participant ACT mathematics sub-test scores that may have taken place after the research treatment was completed by participants in the experimental group.

Research Question and Hypotheses

This study determined whether or not using two specific metacognitive skills increased students' scores on their ACT mathematics sub-test.

RQ1: What effect did calculating five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answering a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks have on the participants' ACT mathematics sub-test scores?

H_1: Students who calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks would score significantly higher on the ACT mathematics sub-test that served as the study's post-test instrument than students who did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

Null Hypothesis

Alternatively, the following null hypothesis is provided:

H_{O1}: Students who took the ACT examination as the study's post-test and calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks did not score significantly higher on the ACT mathematics sub-test than students who took the ACT examination as the study's post-test but did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

Participants

This study used a convenience sample. The participant population groups were made up of current high school juniors or seniors who attended two different Christian schools located in the metropolitan Atlanta, Georgia area. Since the student populations at the Christian schools were typically made up of members of both sexes, different races, and other demographic considerations, it seemed reasonable to suggest that there was limited, if any, undue demographic influence on the study.

Potential participants were introduced to the research design and the study's treatment procedure by the researcher, who was a guest lecturer at a class meeting with the junior and senior class at each of the schools. After the meeting, students in attendance were surveyed to determine their level of interest in volunteering to participate in this study. Students who chose to participate in the study were assigned to one of two study groups, the experimental group or the control group. Those students who desired to undergo the study were assigned to either group by their respective high school counselors. To ensure student confidentiality, no student names were recorded on any data collection forms. Instead, each participant was assigned a unique participant number. Each unique participant number was used to record the participants' ACT examination mathematics sub-test scores. Only the researcher had access to the record of which participant number was assigned to which participant. Parents of students under the age of 18 signed an informed consent form approved by the Liberty University Institutional Review Board. Students under the age of 18 also signed a Student Assent Form, also approved by the Liberty University Institutional Review Board.

Participants in the experimental group began the study's treatment regime on October 26, 2015. During the ensuing 7-week interval between the start of the treatment process and the nationally scheduled ACT examination given on December 12, 2015, members of the experimental group completed the study's treatment regime. The control group took the ACT examination scheduled on December 12, 2015 (The ACT National Test Dates in the U.S., U.S. Territories, and Canada, www.actstudent.org/regist/dates.html). For members of both the experimental group and the control group, this examination served as the study's post-test.

Setting

The setting for this study was two metropolitan Atlanta, Georgia, Christian high schools. Both schools are located in the western metropolitan Atlanta area. Each of the schools has between 250 and 350 students. Among their students, each school has a junior class and a senior class ranging between 15 and 50 students each. Both schools are accredited by ACSI and AdvancED. The study's treatment was explained to the participants of both schools at a gathering of the students at each high school.

Participants assigned to either the experimental group or control group took the ACT examination on December 12, 2015, and upon receipt of their respective scores from ACT, Inc., provided the researcher with their ACT examination mathematics sub-test scores. Each participant's examination score was recorded in a spreadsheet that had each student's assigned study participant number. The spreadsheet was password protected, with only the researcher having knowledge of the password that could be used to retrieve the participants' ACT mathematics sub-test examination scores.

Whereas the members of the control group were not provided the study treatment, members of the experimental group were provided all treatment instructions and the first week's study workbooks on October 26, 2015. For the 7 weeks from the start of the study's treatment until the ACT examination on December 12, 2015, participants completed study worksheets at a rate of five worksheets a day. Each worksheet was made up of six similarly worded questions from selected mathematics sample questions found in the ACT study guide. In addition, members of the experimental group answered a set of six provided metacognitive-relevant questions that were printed on each of the daily worksheets. This treatment was completed daily by each member of the experimental group for 5 days a week and totaled 25 worksheets each week for 7 weeks. The majority of the experimental group's treatment took place at each participant's home. Beginning with the second Monday of the study, participants returned their completed workbook to the researcher for review. The researcher reviewed each of the participants' workbooks each Monday to make certain each participant completed all worksheets and answered all of the metacognitive relevant questions assigned for the preceding week. Once the researcher confirmed that each participant had completed the weekly assignments, the researcher returned the workbook to the participant to make it available for use as a study guide.

At the conclusion of this study, participants turned in all seven of their workbooks to the researcher.

Instrumentation

The ACT examination is one of the two gold standard college admissions examinations used by colleges and universities in the United States to assist admissions officials in making a determination whether or not to admit an applicant to their institution. The second such gold standard college admissions examination is the SAT examination. The ACT examination served as the instrument used to produce the data that was utilized for this study.

ACT, Inc., has described the ACT program as a comprehensive system of data collection, processing, and reporting that has been designed to help high school students develop post high school educational plans and to help colleges and universities meet the needs of their students. The ACT examination is comprised of the following four multiple-choice tests of educational achievement: English, mathematics, reading, and science. A writing test is optionally available at the time a student takes the ACT examination.

The ACT examination is an achievement test that is designed to indicate what students are ready to learn in college by measuring what the student currently knows and can do. The curriculum-based test assesses student mastery of both college readiness standards and most state learning standards (ACT Technical Manual, 2007). The ACT examination was designed to reflect general content areas found in both high school and college instructional programs. The test questions require students to integrate the knowledge and skills they have learned within major curriculum areas contained within the test (ACT Technical Manual, 2007). The ACT examination is designed to accurately reflect educational goals that are accepted and judged to be important by most educators. Additionally, the ACT examination also gives educational considerations a greater level of importance than statistical and empirical techniques might otherwise provide (ACT Technical Manual, 2007).

The ACT mathematics sub-test is a 60-item, 60-minute examination designed to assess the mathematical skills that high school students typically would have attained by the beginning of their senior year. The ACT mathematics sub-test examination is made up of multiple-choice questions that require the test taker to use mathematical skills to solve practical mathematical problems. The six content areas in the ACT mathematics test include pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry (ACT Technical Manual, 2007).

Table 9 shows the percentage of mathematics problems from each content area in the ACT mathematics sub-test.

Table 9

Types of Mathematics Problems on the ACT Mathematics Sub-test

Problem types	Percentage of Sub-test	Number of items
Pre-algebra	23	14
Elementary algebra	17	10
Intermediate algebra	15	9
Coordinate geometry	15	9
Plane geometry	23	14
Trigonometry	7	4
Total	100	60

(ACT Technical Manual, 2007, p. 10).

The ACT mathematics test raw scores (number of correct answers) are converted to a scale of 1 to 36. A composite score is an average of all four sections of the ACT examination (English, mathematics, reading, and science). The minimum composite score is 1; the maximum composite score is 36. In addition, seven sub-scores are calculated; two for English, three for mathematics, and two for reading. The raw scores of the sub-score items are converted to a scale ranging from 1 to 18. The sub-scores are derived independently from one another and do not necessarily add up to the test score in that area of the examination (ACT Technical Manual, 2007).

ACT, Inc., claims that ACT scores are valid predictors of overall first-year college student GPA (ACT Technical Manual, 2007). ACT scores are often used in the college admissions process to help make admissions and course placement decisions for first-year college students (ACT Technical Manual, 2007). The ACT Technical Manual (2007) listed four common uses for ACT examination results. These four common uses are making college admissions decisions, making college placement decisions, evaluation of the effectiveness of high school college-prep programs, and evaluating students' probable success in the first year of college. Each use of the ACT examination has been studied and has been judged by researchers to have clearly met the threshold of proper validity for the ACT (ACT Technical Manual, 2007). Reliability coefficients are commonly described as estimates of consistency of test scores and typically range from 0 to 1, with the values near 1 indicating greater consistency and those near 0 indicating little to no consistency (ACT Technical Manual, 2007).

Table 10 provides the Scale Score Reliability based on the results of six national ACT examinations administered in 2005-2006 (ACT Technical Manual, 2007).

Table 10

Scale Score Reliability of ACT Examination; 2005-2006

Test/Sub-test	Scale score reliability		
	Median	Minimum	Maximum
Mathematics	.91	.89	.91
Pre-algebra/Elementary algebra	.82	.81	.83
Intermediate algebra/Coordinate geometry	.72	.70	.75
Plane geometry/Trigonometry	.74	.69	.78

Procedures

Approval from the Liberty University Institutional Review Board (IRB) was obtained to conduct this research study. Upon receipt of IRB approval, permission from the respective high schools was obtained in order to implement the research procedures. After receiving permission to begin the study from the appropriate official at both schools, the researcher met with members of each high school's junior and senior classes in the school's cafeteria or sanctuary. The researcher showed a PowerPoint presentation that provided a full description of the proposed study, including projected time requirements based on which of the study's two groups a participant was assigned to. The researcher provided each student with his appropriate contact information to be used if needed. The researcher provided a consent form for each student who wished to participate in the study, for the student or his or her parents to sign if they approved of the student's participation in the research study.

The participants were assigned their respective groups when they returned their signed permission slips. Upon receipt of their December 12, 2015, ACT examination scores, participants provided the researcher a copy of their ACT examination score sheet in order to record the participants' ACT mathematics sub-test score into the correct group spreadsheet by student number. These records were free of any personal identifying marks.

As noted above, members of the experimental group received their first treatment workbook on October 26, 2015. The length of this study was 7 weeks. In reviewing Kramarski and Zoldan's (2008) research study and the research studies of Hudesman et al. (2013), on the effects of metacognition on mathematics achievement, cited in the Literature Review, it was calculated that their studies averaged 30 sessions of treatment intervention, with a minimum of 24 sessions and a maximum of 36 sessions. The following table provides the average number of sessions used in three research studies cited above.

Table 11

Number of Treatment Sessions

Research study	Frequency	Number of sessions
Kramarski	3 times a week for 12 weeks	36 sessions
Hudesman	4 times a week for 6 weeks	24 sessions
Hudesman	Twice a week for 15 weeks	30 sessions

(Kramarski & Zoldan, 2008, p. 142; Hudesman et al., 2013, p. 4).

Table 11 shows that these separate studies had an average of 30 sessions each, during which their respective research treatment was utilized by the study's participants. Using the average of 30 sessions of treatment intervention of these research studies and evaluating the published dates when the ACT examinations would be given, it was determined to use the ACT examination on the date of December 12, 2015, as the study's post-test examination. Participants in the experimental group used 7 weeks between October 26, 2015, and the December 12, 2015

ACT examination to complete the study's treatment. Members of the experimental group completed five sets of six mathematics problems worded similarly to those found in the ACT, Inc., study guide, and answered six metacognitive relevant question each day for 5 days a week. Since participants in the experimental group answered five sets of six similarly worded mathematics problems and answered six metacognitive relevant questions 5 days a week, they completed 35 treatment sessions during the course of the 7-week duration of this study. Following this schedule provided participants almost the same number of treatment sessions as the studies by Kramarski (2008) and Hudesman (2013).

Beginning on Monday, October 26, 2015, the researcher handed out the first of seven weekly workbooks that served as the study's treatment to study participants in the experimental group. Contained in the weekly workbook were five daily worksheets containing six questions worded similarly to those found in the ACT, Inc., study guide. Also contained on each daily worksheet was a series of six metacognitive-relevant questions that participants in the experimental group were asked to answer. Students were provided an answer key found at the back of the weekly workbook so that they were able to check the accuracy of their answers as they completed each day's work.

Each successive Monday, the researcher met with each member of the experimental group to provide the participants with that week's workbook. At that same time, the researcher conducted a review of the prior week's workbook to check for completeness and answer any questions the participants may have had about the reviewed workbook. When the reviewer was finished with the review of the participants' completed workbooks, they were returned to the participants to be used as study material as they continued their preparation for taking the ACT examination scheduled on December 12, 2015.

At the conclusion of the treatment process, participants of both the experimental group and the control group took the regularly scheduled December 12, 2015, ACT examination. Upon receipt of these ACT examination scores in January 2016, participants provided the researcher their ACT examination mathematics sub-test score sheets. The researcher recorded the participants' scores in the correct group spreadsheet under each participant number (no names), so as to protect the privacy of the participants.

Data Analysis

A quantitative analysis of this study's collected data was used because of the nature of the data. Inasmuch as the study data were based on the numerical scores of the participants on their ACT mathematics sub-tests, the data were analyzed by means of mathematically based methods (Yilmaz, 2013). To that end, the ACT mathematics sub-test scores from the December 12, 2015, examination were provided to the researcher by all participants in the experimental group and the control group. Using a Microsoft Excel spreadsheet that was free of participant identification, these examination scores were recorded in the spreadsheet by study participant number. An independent sample *t* test analysis was used to determine the difference of the two groups, comparing the singular variable of the ACT mathematics sub-test scores (MacFarland, 2013). The decision to use an independent sample *t* test analysis was made based on the recommendation of Campbell and Stanley (1963), who indicated that the preferred type of analysis to be used with a post-test only control group design is the independent sample *t* test analysis design. For the purpose of this study, this analysis design was used to help assess the possible increase in the participants' ACT mathematics sub-test scores that may have occurred from completing the study's treatment.

CHAPTER FOUR: FINDINGS

The purpose of this study was to determine if using two specific metacognitive skills, 1) repetitive questions worded similarly to the problems contained on the ACT mathematics sub-test, and 2) a form of directed journaling by answering a series of metacognitive-relevant questions, increased participants' ACT mathematics sub-test scores. This quasi-experimental quantitative study used a post-test only control group design to assess any ACT mathematics sub-test score improvement experienced by male and female participants, with the experimental group using two metacognitive strategies prior to taking the ACT mathematics sub-test examination. The Statistical Program for the Social Sciences (SPSS) computer program was used to conduct an independent sample *t* test analysis to examine post-test differences in ACT mathematics sub-test scores for the post-test only control and experimental groups.

This chapter was organized in order of frequency and percentages for the experimental and control group participants, descriptive statistics, and the difference in scores between control and experimental group participants.

Descriptive Statistics

Table 12 shows the breakdown of participants between the experimental group and the control group.

Table 12

Frequency and Percentages for the Post-Test Only Experimental and Control Groups

Group	*N*	%
Experimental group	23	60.5
Control/Post-test only group	15	39.5

Total	38	100.0

The descriptive statistics for the ACT mathematics sub-test scores appear in Table 13. The average post-test ACT mathematics sub-test scores was 19.86 (*SD* = 4.56) and the post-test scores ranged from 14.00 to 32.00.

Table 13

Means and Standard Deviations for the Post-Test ACT Math Sub-Test Scores

Variable	N	Min	Max	*M*	*SD*
Post-test ACT mathematics sub-test score	38	14.00	32.00	19.86	4.56

Test of the Hypothesis

This study was proposed to determine if using two specific metacognitive skills can increase students' scores on their ACT mathematics sub-test.

RQ1: What effect did calculating five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answering a set of six provided metacognitive relevant questions 5 days a week for 7 weeks have on the participants' ACT mathematics sub-test scores?

H_1: Students who calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks would score significantly higher on the ACT mathematics sub-test that served as the study's post-test instrument than students who did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

H_{O1}: Students who took the ACT examination as the study's post-test and calculated five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answered a set of six provided metacognitive relevant questions 5 days a week for 7 consecutive weeks did not score significantly higher on the ACT mathematics sub-test than students who took the ACT examination as the study's post-test but did not calculate five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answer a set of six provided metacognitive relevant questions 5 days a week for 7 weeks on the participants' ACT mathematics sub-test that served as the study's post-test instrument.

Analysis of Group Differences

An independent sample *t* test analysis was used to compare the mean ACT mathematics sub-test scores for the post-test only control and experimental groups (see Table 14). The post-test only experimental group had a mean pretest ACT mathematics sub-test score of 19.21 (*SD* = 3.97). The post-test only control group had a mean pretest ACT mathematics sub-test score of 20.86 (*SD* = 5.34). The mean difference of 1.64 (CI = 1.41, 4.78) in the mean post-test ACT mathematics sub-test scores was not statistically significant ($t(36) = -1.09$, $p > .05$) and as such, the null hypothesis was accepted.

Table 14

T Test for Independent Samples Comparing the Mean Post-Test ACT Math Sub-Test Scores for the Post-Test Only Experimental and Control Groups

Variable	Group	*N*	*M*	*SD*	*t*	*p*

Post-test ACT math sub-test score	Experimental	23	19.21	3.97	-1.09	.28
	Control	15	20.86	5.34		

Levene's test of equality of error variances for this analysis was statistically significant (F = 2.68, p = .11), indicating this assumption was not violated.

Summary

This chapter presented data to determine the effectiveness of using two specific metacognitive strategies on ACT mathematics sub-test scores used in this study. Of the 38 students who participated in the study, there were 60.5% participants in the experimental group and 39.5% participants in the control group. SPSS was used to conduct a post-test only control group analysis to assess any ACT mathematics sub-test score improvement experienced by male and female participants using two specific metacognitive strategies prior to taking the ACT mathematics sub-test examination. Analysis of group scores for the hypothesis did not show statistically significant differences at the .05 level. Additionally, a Levene's test of equality of error variances for this analysis was statistically significant, indicating this assumption was not violated.

CHAPTER FIVE: DISCUSSION

The purpose of this chapter is to review the findings of this study and discuss them. The chapter is divided into the following sections: statement of the problem, summary of results, discussion of the results, implications, limitations, and recommendations for further research.

Statement of the Problem

More than 3 million students have graduated from high school in the United States each year for the past several years, and more than 1.6 million students took the SAT examination and 1.8 million students took the ACT college entrance examination in the most recently reported annual testing period (National Center for Education Statistics, 2013; National ACT Profile, 2014). The results of college entrance examinations commonly play a vital role in the college admission process, scholarship award determinations, and other college cost-abatement program decisions. To help improve their SAT or ACT examination scores, many students participate in a wide variety of college entrance examination preparatory programs (Wiener, 2000). The total amount of money spent on such programs in the United States amounts to several billion dollars a year (Buchmann et al., 2010). How well college entrance examination preparatory programs help increase student SAT or ACT examination scores, however, is questionable (The Task Force on Standardized College Admission Testing, 2002).

The problem is this: many high school graduates hoping to attend college often need to increase their college entrance examination scores. To help students increase their college entrance examination scores, students and their parents are collectively paying billions of dollars a year for college entrance examination preparatory programs. The results of many of these programs, as to whether they help students achieve higher SAT or ACT examination scores, are questionable.

Summary of Research Results

The purpose of this study was to determine if using two specific metacognitive skills, 1) repetitive questions worded similarly to the problems contained on the ACT mathematics sub-test, and 2) a form of directed journaling by answering a series of metacognitive-relevant questions, will increase participants' ACT mathematics sub-test scores. This quasi-experimental quantitative study used a post-test only control group design to analyze any ACT mathematics sub-test score improvement experienced by participants using these two metacognitive strategies prior to taking the ACT mathematics sub-test examination.

Research Question 1 asked what effect that calculating five sets of six similarly worded questions of selected mathematics sample questions found in the ACT study guide and answering a set of six provided metacognitive-relevant questions 5 days a week for 7 weeks had on the participants' ACT mathematics sub-test scores. The results of the independent sample *t* test analysis used to assess possible post-test differences between comparison groups demonstrated that there were no significant statistical differences between the study's experimental group's post-test ACT mathematics sub-test scores and the study's control group post-test ACT mathematics sub-test scores.

Implications

The lack of statistical significance between the results of the experimental group that used two selected metacognitive strategies to help students improve their ACT mathematics sub-test scores and the study's control group seemed to call into question the level to which there is tangible value to the proposition of high school students using a metacognitive-enhancing college entrance examination preparatory program. Other research has been conducted over many years designed to study the efficacy of other types of college entrance examination programs. Many such studies have shown various college examination preparatory programs are, at best, minimally successful in helping students increase their SAT or ACT examination scores (Briggs, 2009; Powers, 1993). While the independent sample *t* test analysis used to analyze the current study's data showed there was not a statistical significance between the two study groups' ACT mathematics sub-test scores, several students in both of the study's groups did experience an increase in their ACT mathematics sub-test scores, with the highest point increase experienced by members of the experimental group. Whether or not the realized ACT mathematics sub-test score increase was in direct response to the experimental groups' utilization of the study's treatment, each member of the experimental group whose ACT mathematics sub-test scores did go up expressed a belief that their increased scores were attributable to their completing the study's treatment.

Limitations

Several limitations were encountered with this study. Perhaps the most impactful limitation was the small number of participants in the study's experimental and control groups. While the number of participants in the study met the minimal total sample size for an independent sample *t* test analysis (with a large effect size and an alpha of .05) as proposed by Stephen Olejnik (Gall, Gall, & Borg, 2007), the ACT mathematics sub-test scores of only a few participants could show the study's results not to be statistically significant when, in fact, the results of many of the participants increased.

While this study did not evaluate or otherwise take into account the demographic makeup of the experimental and control groups, there is common belief by many that the test taker's sex, race, socioeconomic status, and other participant demographics often impact a student's ACT or SAT examination scores. Several peer-reviewed journal articles have described how students from low-income families, on average, have low SAT scores (Berg, 2010; Walpole, 2007). Hyde, Fennema, and Lamon (1990) described how achievement tests, such as the ACT and SAT exams, cause differences in scores favoring males, with females scoring lower on college entrance examinations (Altermatt & Esther, 2004). Similarly, Alon (2010) reported "persistent racial gaps in student" ACT and SAT scores (p. 463). Peterson (2009) indicated research has shown that African American, Native American, and Latino students have lower mean scores on college entrance examinations than do White students. So while participant demographics were not part of this study's research criteria, it seems reasonable to suggest participant demographics could have caused some limitations to the study.

Finally, it should be noted that in a previous study conducted to measure the efficacy of utilizing a metacognitive enhancement program designed to help improve participant SAT examination scores, the program was actively facilitated by a high school teacher within a school's usual classroom periods (Urbina-Lilback, 2003). However, this current study was conducted in such a way that each participant was responsible for completing assigned tasks in the timeframe allowed by the study's instructions. The self-paced, self-directed methodology used in this study could have been a limitation if any of the study's participants had failed to complete their scheduled tasks in the timeframe allotted by the study's instructions. Even though each participant's workbook was reviewed each week by the researcher, there was no way of knowing with all certainty that each participant completed the assigned tasks personally.

Recommendations for Future Research

This study focused on the effectiveness of utilizing two specific metacognitive strategies to improve ACT mathematics sub-test scores. Based on the results and limitations of this study, additional research should be conducted on the efficacy of utilizing metacognitive training to improve student ACT mathematics test scores. While the sample size of this study met the standards recommended by Olejnik (Gall et al., 2007), the study should be replicated with a larger sample size and with participants randomly assigned to either the experimental or control group. By being randomly assigned to either group, participants with differing mathematics ability and skill would more likely be more evenly distributed between the two study groups.

In addition, attention to the participants' sex, race, socioeconomic status, and other demographic descriptors should be considered for further research. Such research could demonstrate whether or not training in one or more specific metacognitive strategies can be affected based on students' sex, race, socioeconomic status, and other demographic descriptors. If this were demonstrated then specific metacognitive strategy could be possibly be employed to improve ACT test scores based on the student's sex, race, and socioeconomic status.

Conclusion

The results of this study indicate that the effects of using two specific metacognitive strategies did not raise ACT mathematics sub-test scores in a statistically significant way. However, future consideration should be given to the following factors: the sample size of the experimental group and control group; what, if any, impact a participant's sex, race, socioeconomic status, or other demographic descriptors may have on the two types of metacognitive skills used in such a potential future study; and whether or not the metacognitive skills being utilized in such a study are more likely to be more fully understood and utilized if taught by a teacher or instructor. While the two comparison groups' post-test analysis failed to show a statistical significance between groups, many of the students who undertook the study's treatment did realize an increase in their ACT mathematics sub-test scores. With this in mind, further research should be conducted in an attempt to determine whether or not there are other metacognitive skills that could be used to improve participants' ACT mathematics sub-test scores.

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APPENDEX A – IRB APPLICATION

IRB Application #________   _____________

1. APPLICATION INSTRUCTIONS:

a. Complete each section of this form.
b. Email it and any accompanying materials (i.e., recruitment letters, consent forms, instruments, and permission letters) to irb@liberty.edu.
c. **Please note; we can only accept our forms in Microsoft Word format; we cannot adequately review applications and supporting documents submitted as PDFs, Google docs, or in html format. *See signature pages and permission letter exceptions below in item f.**
d. Please submit one signed copy of the fourth page of the protocol form, which is the Investigator's Agreement.
e. If you intend to use LU students, staff, or faculty as participants or LU students, staff, or faculty data in your study, you will need to have the appropriate department chair/dean sign page two below.
f. ***Signed pages 2 and 4, proprietary documents, and permission letters can be submitted by email (attached, scanned document or PDF) to irb@liberty.edu; by fax to 434-522-0506; or by mail, and campus mail, 1971 University Blvd. Lynchburg, VA 24515; or hand delivery to 701 Thomas Road Campus, Carter Building, Rm. 134.**
g. Electronic signatures are acceptable for pages 2 and 4 if a time and date stamp is included. If you choose to sign electronically, be careful not to convert the entire IRB application to a PDF.
h. Please be sure to use the grey form fields to complete this document; **do not remove any information/sections or change the format of the application**. Use the tab key to move from one form field to the next.
i. **Applications with the following problems will be returned immediately for revisions: 1) Grammar/spelling/punctuation errors, 2) A lack of professionalism (lack of consistency /clarity) on the application itself or any supporting documents, or 3) Incomplete applications. Failure to minimize these errors will delay the review and approval process.**

2. BASIC PROTOCOL INFORMATION:

Study/Thesis/Dissertation Title: **The effects of using selected metacognitive strategies on ACT mathematics sub-test scores**

Principal Investigator(s) (PI) (Who is planning to conduct the research?): **Jeffrey W. LeMay**

Professional Title (i.e., student, teacher, principal, professor, etc.): **Student**

School/Department (i.e., School of Education, LUCOM, etc.): **Education**

Personal Mailing Address: **3617 Homewood Drive Powder Springs, GA. 30127**

Telephone: [redacted] LU Email: [redacted]

Check all that apply: ☐ Faculty ☒ Graduate Student ☐ Undergraduate Student ☐ Staff

This research is for: ☐ Class Project ☐ Master's Thesis ☒ Doctoral Dissertation ☐ Faculty Research

☐ Other (describe):

If applicable, have you defended and passed your dissertation proposal? ☒ Yes ☐ No

If no, what is your defense date?

Co-Researcher(s): N/A

School/Department(s):

Telephone(s): LU/Other Email(s):

Faculty Advisor/Chair/Mentor: David Holder, PhD

School/Department: **Education**

Telephone: [redacted] LU Email: [redacted]

Non-key Personnel (i.e., reader, assistant, etc.): Steven McDonald, EdD

School/Department: **Education**

Telephone: [redacted] LU Email: [redacted]

Consultants (required for School of Education EdD candidates): David Holder, PhD

School/Department: **Education**

Telephone: [redacted] LU Email: [redacted]

Liberty University Participants:

Do you intend to use LU students, staff, or faculty as participants or LU student, staff, or faculty data in your study? If yes, please list the department and/or classes you hope to enlist, and the number of participants/data sets you would like to enroll/use. If you do not intend to use LU participants in your study, please select "no" and proceed to the section titled "Funding Source."

☒ No ☐ Yes Number of participants/data sets

Department Class(es)/Year

In order to process your request to use LU participants, we must ensure that you have contacted the appropriate department and gained permission to collect data/include their students. Please obtain the original signature of the department chair in order to verify this.

Name of Department Chair/Dean

Signature of **Department Chair/Dean** Date

Funding Source: If research is funded, please provide the following:

Grant Name (or name of the funding source):

Funding Period (month/year): Grant Number:

Anticipated start and completion dates for collecting and analyzing data: Anticipated Start Date: November, 2015 Anticipated End Date: February, 2016

Completion of required CITI research ethics training course(s):

Course Name(s) (School of Education, Psychology/Counseling, etc.) Date

3. OTHER STUDY MATERIALS AND CONSIDERATIONS:

Use of voice, video, digital, or image recordings?	☐ Yes ☒ No
Participant compensation?	☐ Yes ☒ No
Advertising for participants?	☒ Yes ☐ No
More than minimal psychological stress?	☐ Yes ☒ No
Confidential material (questionnaires, surveys, interviews, test scores, photos, etc.)?	☒ Yes ☐ No
Extra costs to the participants (tests, hospitalization, etc.)?	☐ Yes ☒ No
The inclusion of pregnant women?	☐ Yes ☒ No
More than minimal risk? *	☐ Yes ☒ No
Alcohol consumption?	☐ Yes ☒ No
Waiver of Informed Consent?	☐ Yes ☒ No
The use of protected health information obtained from healthcare practitioners or institutions?	☐ Yes ☒ No

VO2 Max Exercise?	☐ Yes ☒ No
The use of blood?	☐ Yes ☒ No
Total amount of blood	
Blood draws over time period (days)	
The use of rDNA or Biohazardous materials?	☐ Yes ☒ No
The use of human tissue or cell lines?	☐ Yes ☒ No
The use of other fluids that could mask the presence of blood (including urine and feces)?	☐ Yes ☒ No
The use of an **Investigational New Drug (IND) or an Approved Drug for an Unapproved Use?**	☐ Yes ☒ No Drug name, IND number, and company:
The use of an **Investigational Medical Device or an Approved Medical Device for an Unapproved Use?**	☐ Yes ☒ No Device name, IDE number, and company:
The use of **Radiation or Radioisotopes?**	☐ Yes ☒ No

**Minimal risk is defined as "the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests." [45 CFR 46.102(i)]*

4. ***INVESTIGATOR AGREEMENT & SIGNATURE PAGE** (Stand-alone signature pages are available at http://www.liberty.edu/academics/graduate/irb/index.cfm?PID=20088)**:**

BY SIGNING THIS DOCUMENT, THE INVESTIGATOR AGREES:

1. **That no participants will be recruited or entered under the protocol until the PI has received the final approval or exemption email from the chair of the Institutional Review Board.**
2. That no participants will be recruited or entered under the protocol until all key personnel for the project have been properly educated on the protocol for the study.
3. That any modifications of the protocol or consent form will not be initiated without prior written approval, by email, from the IRB and the faculty advisor, except when necessary to eliminate immediate hazards to the participants.

4. The PI agrees to carry out the protocol as stated in the approved application: all participants will be recruited and consented as stated in the protocol approved or exempted by the IRB. If written consent is required, all participants will be consented by signing a copy of the approved consent form.
5. That any unanticipated problems involving risks to participants or others participating in the approved protocol, which must be in accordance with the Liberty Way (and/or the Honor Code) and the Confidentiality Statement, will be promptly reported in writing to the IRB.
6. That the IRB office will be notified within 30 days of a change in the PI for the study.
7. That the IRB office will be notified within 30 days of the completion of this study.
8. That the PI will inform the IRB and complete all necessary reports should he/she terminate University association.
9. To maintain records and keep informed consent documents for **three years** after completion of the project, even if the PI terminates association with the University.
10. That he/she has access to copies of 45 CFR 46 and the Belmont Report.

Jeffrey W. LeMay

Principal Investigator (Printed) Principal Investigator (Signature) Date October 12, 2015

FOR STUDENT PROPOSALS ONLY

BY SIGNING THIS DOCUMENT, THE FACULTY ADVISOR AGREES:

1. To assume responsibility for the oversight of the student's current investigation as outlined in the approved IRB application.
2. To work with the investigator and the Institutional Review Board, as needed, in maintaining compliance with this agreement.
3. To monitor email contact between the Institutional Review Board and principle investigator. Faculty advisors are cced on all IRB emails to PIs.
4. That the principal investigator is qualified to perform this study.
5. **That by signing this document you verify you have carefully read this application and approve of the procedures described herein, and also verify that the application complies with all instructions listed above**. If you have any questions, please contact our office (irb@liberty.edu).

David Holder, PhD

Faculty Advisor (Printed) Faculty Advisor (Original Signature) Date

***The Institutional Review Board reserves the right to terminate this study at any time if, in its opinion, (1) the risks of further experimentation are prohibitive, or (2) the above agreement is breached.**

5. **PURPOSE:**
   a. **Purpose of the Research**: Write an original, brief, non-technical description of the <u>purpose</u> of your project. Include in your description your research hypothesis or question, a narrative that explains the major constructs of your study, and how the data will advance your research hypothesis or question. This section should be easy to read for someone not familiar with your academic discipline.

      The purpose of this research study is to determine if using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

6. **PARTICIPANT INCLUSION/EXCLUSION CRITERIA:**
   a. **Population:** From or about whom will the data be collected? Address each area in non-scientific language. Enter N/A where appropriate.
      i. **Provide the inclusion criteria for the participant population—gender, age range, ethnic background, health status, occupation, employer, and any other applicable information—and provide a rationale for targeting this population.** If you are related to any or all of your participants, please explain.

         Inclusion criteria for the participant population is either male or female high school students in their junior or senior year in high school. There is not ethic background, health status, occupation, or employer inclusion criteria for inclusion for the participant population of this study. The rationale of targeting high school juniors or seniors for this study is based on the perceived likelihood that participants will want to take an ACT examination as part of their college application process and by doing so would almost certainly desire to make the highest score they possible can when taking this examination.

      ii. **Who will be excluded from your study (e.g., persons under 18 years of age):**

         Students not at least a junior in high school.

iii. **Explain the rationale for the involvement of any special population** (e.g., children, specific focus on ethnic populations, mentally disabled, lower socio-economic status, prisoners).

The rationale of using high school juniors and seniors as participants of this study lies principally due to their need to take a college entrance examination while in high school in order to gain admission to most colleges or universities in the United States.

iv. **Provide the maximum number of participants you plan to enroll from all participant populations and justify the sample size.** You will not be approved to enroll a number greater than the number you list. If, at a later time, it becomes apparent you need to increase your sample size, you will need to submit a change in protocol form and await emailed approval of your requested change before recruiting additional participants. **50**

v. **For NIH, federal, or state-funded protocols only**: Researchers sometimes believe their particular project is not appropriate for certain types of participants. These may include, for example: women, minorities, and children. If you believe your project should not include one or more of these groups, please provide your justification for their exclusion. Your justification will be reviewed according to the applicable NIH, federal, or state guidelines.

b. Types of Participants: Only check the boxes for those participants who will be the ***focus*** of your study. You do not need to check the boxes for individuals who may be coincidental to your study.

- ☒ Normal Volunteers (Age 18-65)
- ☒ Minors (under age 18)
- ☐ Over age 65
- ☐ University Students
- ☐ Active-Duty Military Personnel
- ☐ Discharged/Retired Military Personnel
- ☐ Inpatients
- ☐ Outpatients
- ☐ Patient Controls
- ☐ Pregnant Women
- ☐ Fetuses
- ☐ Cognitively Disabled
- ☐ Physically Disabled
- ☐ Participants Incapable of Giving Consent
- ☐ Prisoners or Institutional Individuals
- ☐ A specific racial or ethnic population
- ☐ Other Potentially Elevated Risk Populations
- ☐ Participants related to the researcher(s)

7. RECRUITMENT OF PARTICIPANTS:

a. Contacting Participants: Describe in detail ***how*** you will contact participants regarding this study.

Researcher contact would-be participants during a presentation of all facets of the study to would-be participants at high schools who have given their permission to seek participants for the study from their respective institutions. This presentation will be generally held during a meeting of prospective participants at each individual school.

***Please submit as separate Word documents to irb@liberty.edu with this application one copy of all letters, emails, flyers, advertisements, or social media posts you plan to use to recruit participants for your study. If you will contact participants verbally, please provide a script that outlines what you plan to say to potential participants.**

b. **Location of Recruitment**: Describe the location, setting, and timing of recruitment.

The location of recruitment will be at Christian high schools located in the metropolitan Atlanta, GA. area. The setting of the recruitment will be during a presentation conducted at each of the Christian high schools and should take place in the August/September, 2015 time frame.

c. **Screening Procedures:** Describe any screening procedures you will use when recruiting your participant population (i.e., screening survey, database query, etc.).

Screening procedures for participants will be a screening survey that affirms would-be participants are either high school juniors or seniors.

d. **Relationships:** Does the researcher have a position of grading or professional authority over the participants (e.g., the researcher is the participants' teacher or principal)? If a position of authority exists, what safeguards are in place to reduce the likelihood of compromising the integrity of the research (e.g., addressing the conflicts in the consent process and/or emphasizing the pre-existing relationship will not be impacted by participation in the research, etc.)?

The researcher will have no professional authority over the participants.

8. RESEARCH PROCEDURES:

a. ***Description of the Research:** Write an original, non-technical, step-by-step (1, 2, 3, 4 . . .) description of what your participants will be required to do during your study and data collection process, **including information about how long each procedure should take**.

1. A meeting between the researcher and the head of schools of three Christian high schools located in metropolitan Atlanta, GA. will be held during which the researcher will present the rationale of the pending research. Approval to conduct the research at the Christian high schools will be sought at the time of this meeting.

2. Approval from the Liberty University IRB Board to conduct the research will be applied for. Upon receipt of the Liberty University IRB approval to conduct the research, a meeting between the researcher and would-be participants at each of the three Christian high schools will take place.

3. At the time of the presentation, the research will provide an overview of the research, including: it's purpose, significance, and procedures. During the

presentation, the researcher will provide a letter of recruitment to those students in attendance, parental consent forms for student participation, and child consent forms to be signed and returned to reseacher before the collection of any data used in the research study.

*__Please submit as separate Word documents to irb@liberty.edu with this application one copy of all instruments, surveys, interview questions or outlines, observation checklists, etc.__

b. **Location of the Study:** Please describe the location in which the study will be conducted. Be specific; include city, state, school/district, clinic, etc.

There will be two locations in which this study will be conducted. One location is [redacted] **Students will usually complete their treatment worksheets at their own homes.**

9. **DATA ANALYSIS:**
   a. **Estimated number of participants to be enrolled or data sets collected: 50**
   b. **Analysis Method(s):** Describe ***how*** the data will be analyzed and what will be done with the data and the resulting analysis, including any plans for future publication or presentation.

   Data will be analyzed using *t* tests and possibly ANOVAs.

10. **PARENTAL/GUARDIAN CONSENT:**
    a. **Does your study require parental/guardian consent?** (If your intended participants are under 18, parental/guardian consent is required in most cases.)
       i. ☒ Yes
       ii. ☐ No
    b. **Does your study entail greater than minimal risk without potential for participant benefit?**
       i. ☐ Yes (If so, consent of both parents is required.)
       ii. ☒ No

11. **ASSENT FROM CHILDREN:**
    a. **Is assent required for your study?** Assent is required unless the child is not capable (age, psychological state, sedation), or the research holds out the prospect of direct benefit that is only available within the context of the research. If the parental consent process (full or part) is waived (see #14 below), assent may be also. See our website for this information.
       i. ☒ Yes
       ii. ☐ No

12. PROCESS OF OBTAINING INFORMED CONSENT:

a. **Consent Procedures:** Describe in detail ***how and when*** you will obtain consent from participants and/or parents/guardians and, if applicable, child assent.

A recruitment letter will be provided to would-be participants during a meeting held at each respective high school location provided above. In addition, a parental consent will be provided to each potential would-be participant to have their parents read and approve of their child's participation in the researc study.

13. *DECEPTION:

a. **Are there any aspects of the study kept secret from the participants (e.g. the full purpose of the study)?**
   i. ☒ No
   ii. ☐ Yes
      1. If yes, describe the deception involved and the debrief procedures. Attach a post-experiment debriefing statement and consent form offering participants the option of having the data destroyed:

b. **Is any deception used in the study procedures?**
   i. ☒ No
   ii. ☐ Yes
      1. If yes, describe the deception involved and the planned debriefing procedures.

***Attach a post-experiment debriefing statement and consent form offering participants the option of having the data destroyed. A debriefing template is available on our website.**

14. WAIVER OR MODIFICATION FOR REQUIRED ELEMENTS IN INFORMED CONSENT PROCESS:

a. A waiver or modification of some or all of the required elements of informed consent is sometimes used in research involving *deception, the use of archival data, and other minimal risk studies*. If requesting a waiver or modification of consent, please address the following:
   i. Does the research pose no more than minimal risk to participants (i.e., no more risk than the risk involved in everyday activities)? **No** ***and***
   ii. Will the waiver have no adverse effects on participants' rights and welfare? **No** ***and***
   iii. Would the research be impracticable without the waiver?
      1. ☐ Yes
         a. Please explain.
      2. ☒ No
   iv. ***and*** Will participant debriefing occur (i.e., Will the true purpose and/or deceptive procedures used in the study be reported to participants at a later date?)?
      1. ☐ Yes
      2. ☒ No

15. WAIVER OF SIGNED INFORMED CONSENT DOCUMENT:

a. A waiver of signed consent is sometimes used in anonymous surveys or research involving secondary data. This does not eliminate the need for a consent document, but it does eliminate the need for a signature(s). If you are requesting a waiver of signed consent, please address the following (yes or no):

i. Would the signed consent form be the only record linking the participant and the research? **Yes *and***

ii. Does a breach of confidentiality constitute the principal risk to participants? **Yes *or***

iii. Does the research pose no more than minimal risk to participants (i.e., no more risk than everyday activities)? **No *and***

iv. Does the research exclude any activities that would require signed consent in a non-research context? **No**

v. Will you provide the participants with a written statement about the research (i.e., an information sheet that contains all the elements of the consent form but without the signature lines)? **Yes**

16. CHECKLIST OF INFORMED CONSENT/ASSENT:

a. **Attach a copy of all informed consent/assent documents.** Informed consent/assent template(s) are available at http://www.liberty.edu/index.cfm?PID=20088, and additional information concerning consent is located at http://www.liberty.edu/index.cfm?PID=12837.

17. PARTICIPANT PRIVACY AND CONFIDENTIALITY:

a. **Privacy:** Privacy refers to persons and their interest in controlling access to their information. Describe what steps you will take to protect the privacy of your participants (e.g., If you plan to interview participants, will you conduct your interviews in a setting where others cannot easily overhear?).

Participants will provide the researcher the mathematics portion of their ACT examination score reports. The ACT examination on December 12, 2015 will serve as the study's post-test. The scores from the participant's sub-test will be recorded in a password protected Microsoft Excel spreadsheet, after which the participant's score reports will be returned to the appropriate participant.

b. **Confidentiality**: Confidentiality refers to agreements with the participant about how data are to be handled.

i. How will you keep your data secure (i.e., password protection, locked filing cabinet, etc.)?

The Excel spreadsheet used to record data will be on the researcher's laptop and password protected. There will be two files used during this research. One file will contain the names of participants and a corresponding number that will be assigned to each particular participant. In doing this, the file that contains the ACT math sub-test scores will be devoid of any participant names.

ii. Who will have access to the data? **The primary investigator.**

iii. *Will you destroy the data once the three-year retention period required by the federal regulations expires?
   1. ☒ Yes
      a. How will the data be destroyed? **The Excel files will be delted from the laptop's hard drive.**
   2. ☐ No

***Please note that all research-related data must be stored for a minimum of three years after the end date of the study, as required by federal regulations.**

c. Is all or part of the data archival (i.e., previously collected for another purpose)?

i. ☐ Yes ("No" response is included below. Please skip to c.ii if your response is "No.")
   1. **Is the archival data publicly accessible?**
      a. ☐ Yes
         i. Please provide the location of the publicly accessible data (website, etc.).
      b. ☐ No
         i. *Please describe how you will obtain access to this data.

   2. **Will you receive the data stripped of identifying information, including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc.?**
      a. ☐ Yes
         i. Please describe who will link and/or strip the data. Please note that this person should have regular access to the data and he or she should be a neutral third party not involved in the study.
      b. ☐ No
         i. If no, please describe what data will remain identifiable and why this information will not be removed.
   3. **Can the names of the participants be deduced from the data set?**
      a. ☐ Yes
         i. Please describe.
      b. ☐ No
         i. Initial the following: I will not attempt to deduce the identity of the participants in this study:
   4. **Please provide the list of data fields you intend to use for your analysis and/or provide the original instruments used in the study.**

***If the archival data is not publically available, please submit proof of permission to access the data (i.e., school district research officer letter or email). If you will receive the data stripped of identifiers, this should be stated in the letter or email.**

ii. ☒ No (Please complete the following questions concerning non-archival data.)

d. **If you are using non-archival data, is the non-archival data you will collect anonymous?** (i.e., Data do not contain identifying information including names, postal addresses, telephone numbers, email addresses, social security numbers, medical record numbers, birth dates, etc. and *cannot be linked to identifying information by use of pseudonyms, codes, or other means*.) If you are audio or video recording or photographing participants, your data is **not** considered anonymous.

   i. ☒ Yes

      1. Describe the process you will use to collect the data to ensure that it is anonymous. **All data will be recorded on PI laptop using a Microsoft Word Excel spreadsheet. The spreadsheet will us a numeric identifier for each participant. This numeric identifier will be known only by the PI and will be recorded on the same laptop computer. All Excel spreadsheets used to record data for this study will be password protected. Only the PI will know the password used to gain access to any research Excel spreadsheets.**

   ii. ☐ No

      1. Can the names of the participants be deduced from the non-archival data?

         a. ☐ Yes

            i. Please describe:

         b. ☒ No

            i. If you agree to the following, please type your initials. I will not attempt to deduce the identity of the participants in the study:

            JWL

      2. Please describe the process you will use to collect the data and to ensure the confidentiality of the participants (i.e., You may know who participated, but participant identities will not be disclosed.). If you plan to maintain a list or codebook linking pseudonyms or codes to participant identities, include this information and verify that the list or codebook will be kept secure and separate from the data by stating where it will be kept and who will have access to the data and list or codebook. **Data collected during this study will be keep confidential. PI will record each paticipant's name and a numeric code that will correspond to the participants name. Only the PI will have access to this information as it will be contained in a password protecte Microsoft Excel spreadsheet. Whenever any data is recorded, the data will be recorded by the participant numeric code only, not by participant name.**

   iii. ☐ N/A (Non-archival data will not be utilized.)

***If you plan to use participant data such as photos, recordings, videos, drawings, etc. for presentations beyond data analysis for the research study (e.g., classroom presentations, library archive, or conference presentations), you will need to provide a materials release form to the participant.**

e. **Media Use:**

   i. Will your participants be audio recorded? ☐ Yes ☒ No

ii. Will your participants be video recorded? ☐ Yes ☒ No

iii. Will your participants be photographed? ☐ Yes ☒ No

1. *If you answered *yes* to any of the above, and a participant withdraws from your study, how will you withdraw their recording or photograph?

***Please add the heading *How to Withdraw from the Study* on the informed consent document and include a description of the removal procedures.**

iv. Will your participants be audio recorded, video recorded, or photographed without their knowledge?

1. ☐ Yes
   a. *Describe the deception and the debriefing procedures.

***Attach a post-experiment debriefing statement and a post-deception consent form, offering participants the option of having their tape/photograph destroyed.**

2. ☒ No

18. PARTICIPANT COMPENSATION:

a. *Describe any compensation participants will receive. Participants will have their ACT examinations paid for by the PI.

*** Research compensation exceeding $600 per participant within a one-year period is considered income and will need to be filed on the participants' income tax returns. If your study is grant funded, Liberty Universities' Business Office policies might affect how you compensate participants. Please contact the IRB for information on who to contact for guidance on this matter.**

19. PARTICIPANT RISKS AND BENEFITS:

a. Risks:

i. Describe the risks to participants and steps that will be taken to minimize those risks. Risks can be physical, psychological, economic, social, or legal. If the only potential risk is a breach in confidentiality if the data is lost or stolen, please state this fact here. **There is a potential risk of a breach in confidentiality if the research data is lost or stolen.**

ii. Will alternative procedures or treatments that might be advantageous to the participants be made available?

1. ☐ Yes
   a. Please describe the alternative procedures.
2. ☒ No

iii. Describe provisions for ensuring necessary medical or professional intervention in the event of adverse effects to participants. Examples include the proximity of the research location to medical facilities and your ability to provide counseling referrals in the event of emotional distress. **N/A**

b. Benefits:

i. Describe the possible direct benefits to the participants. If participants are not expected to receive direct benefits, please state so. Participants should not expect to receive a direct benefit from completing a survey or participating in an interview.

Participants may experience the direct benefit of achieving a higher ACT mathematics sub-test score by participating in this research study.

ii. Describe the possible benefits to society.

If ACT mathematics sub-test scores are realized from the treatments used in this study, it could be that society could benefit from using similar study practices to achieve higher ACT mathematics sub-test scores.

c. Investigator's evaluation of the risk-benefit ratio: Please explain why you believe this study is worth doing even with any identified risks.

Any negative risks associated with this study are very low; however, if it can be demonstrated that improving high school student's metacognitive skills can help improve their ACT mathematics sub-test scores, the benefits could include the acceptance to more selective colleges or universities and the potential for more or higher scholarship awards.

APPENDIX B – SCHOOL PARTICIPATION REQUEST LETTER - [redacted]

August 10, 2015

[redacted]

Dear [redacted]:

As a graduate student in the Education Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree. The title of my research project is The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores. The purpose of this study is to determine if using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test, and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

I am writing to request your permission to conduct my research at [redacted] and invite high school juniors and seniors at [redacted] to participate in my study. Participants will be asked to calculate daily, 6 repetitive mathematics problems of 5 different questions that are similarly worded to mathematics problems contained on the ACT mathematics sub-test. Participants will also be asked to answer 6 metacognitive relevant questions in addition to calculating these mathematics questions.

Participants will receive their first workbook associated with this study on October 26, 2015 at your school. Each subsequent Monday, participants will be provided a new weekly workbook of problems to complete during the ensuing week. Participants will be required to take the ACT examination on December 12, 2015. This examination will serve as the study's post-test. Participant score reports from the ACT examination will be provided to me for recording into a password protected Excel spreadsheet. Data collected in the spreadsheet will be devoid of any student personal identification. An analysis of all data will be conducted and reported as part of this study.

Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

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

Sincerely,

Jeffrey W. LeMay, Ed.S.

APPENDIX C – SCHOOL PARTICIPATION APPROVAL LETTER - [redacted]

[redacted]

October 21, 2015

Jeffrey W. LeMay
[redacted]

Dear Mr. LeMay,

You are approved to conduct your research study entitled *The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-Test Scores,* at [redacted], utilizing our students who meet the requirements to be study participants.

Please keep any participation in your study voluntary for our students. We would request that the anonymity of student participants be preserved in any reporting of your study's results.

Sincerely,

[redacted]

Headmaster

[redacted]

APPENDIX D – SCHOOL PARTICIPATION REQUEST LETTER - [redacted]

August 10, 2015

[redacted]
Headmaster
[redacted]

Dear [redacted]:

As a graduate student in the Education Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree. The title of my research project is The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores. The purpose of this study is to determine if using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test, and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

I am writing to request your permission to conduct my research at [redacted] and invite high school juniors and seniors at [redacted] to participate in my study. Participants will be asked to calculate daily, 6 repetitive mathematics problems of 5 different questions that are similarly worded to mathematics problems contained on the ACT mathematics sub-test. Participants will also be asked to answer 6 metacognitive relevant questions in addition to calculating these mathematics questions.

Participants will receive their first workbook associated with this study on October 26, 2015 at your school. Each subsequent Monday, participants will be provided a new weekly workbook of problems to complete during the ensuing week. Participants will be required to take the ACT examination on December 12, 2015. This examination will serve as the study's post-test. Participant score reports from the ACT examination will be provided to me for recording into a password protected Excel spreadsheet. Data collected in the spreadsheet will be devoid of any student personal identification. An analysis of all data will be conducted and reported as part of this study.

Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

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

Sincerely,

Jeffrey W. LeMay, Ed.S.

APPENDIX E – SCHOOL PARTICIPATION APPROVAL LETTER - [redacted]

[redacted]

October 21, 2015

Jeffrey W. LeMay
[redacted]

Dear Mr. LeMay,

You are approved to conduct your research study entitled *The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-Test Scores,* at [redacted] utilizing our students who meet the requirements to be study participants.

Please keep any participation in your study voluntary for our students. We would request that the anonymity of student participants be preserved in any reporting of your study's results.

[redacted]
Headmaster

[redacted]

APPENDIX F – PARENTAL RECRUITMENT LETTER

Date: October 15, 2015

Parent of [redacted] student

Dear Sir/Madam:

As a graduate student in the Education Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree. The purpose of my research is to determine if using two specific metacognitive skills: repetitive questions similarly worded as the problems contained on the ACT mathematics sub-test; and using a form of directed journaling of metacognitive relevant questions, will increase ACT mathematics sub-test scores.

If you are willing to allow your child to participate in this research study, they will be asked to calculate a set of 5 repetitive problems of 6 mathematics questions each weekday for the duration of the study (30 problems a day). In addition, your child will be asked to answer a set of 6 metacognitive relevant questions each day. It should take about 20-30 minutes a day for your child to complete this entire process. Your child's participation is completely voluntary.

On Monday, October 26, 2015, students in the study's experimental group will receive a workbook they will be asked to complete during the following week and return to me the following Monday, November 2, 2015. After turning in their completed workbook, your child will receive another workbook they will be asked to complete the following week and return to me on Monday, November 9, 2015. This routine will be followed each week until your child takes the ACT examination on December 12, 2015. If there is an occasion in which your student cannot pick up or return their weekly workbook as scheduled, please let me know and I will make arrangements for an alternative date to pick up or return their weekly workbook. Upon receipt of the ACT examination score reports, your student will provide their mathematics sub-test scores to me for recording.

To participate, your child must return the accompanying Parental Consent form to his or her high school on Monday, October 23, 2015. The consent document contains additional information about my research, but you do not need to sign and return it.

If you consent to allow your child to participate in this study I will pay for any costs associated with the ACT examination your child must take on December 12, 2015.

Thank you for your consideration and your child's interest in participating in this research study.

Sincerely,

Jeffrey W. LeMay, Ed.S.

APPENDIX G – PARENT/GUARDIAN CONSENT FORM - EXPERIMENTAL

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

PARENT/GUARDIAN CONSENT FORM

THE EFFECTS OF USING SELECTED METACOGNATIVE STRATEGIES ON ACT MATHMATICS SUB-TEST SCORES

Jeffrey W. LeMay
Liberty University
School of Education

Your child is invited to be in a research study of The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores. He or she was selected as a possible participant because of their current classification as a high school junior or senior. I ask that you read this form and ask any questions you may have before agreeing to allow him or her to be in the study.

Jeffrey W. LeMay, a doctoral candidate/in the School of Education at Liberty University, is conducting this study.

Background Information:

The purpose of this study is to determine if using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

Procedures:

If you agree to allow your student to be in this study, I would ask him or her to do the following things:

1. Beginning on Monday, October 26, 2015, members of the study's experimental group will be provided a weekly workbook that is comprised of daily worksheets of similarly worded mathematics problems found on the ACT examination. In addition, participants in the experimental groups will also have a set of 6 questions at the end of each worksheet. A new workbook will be provided your student each ensuing week of the entirety of the 7 weeks of the research study.
3. Take the ACT examination on December 12, 2015. In order to do this properly, your student must register at the ACT web site. The deadline for registration for this examination is November 6, 2015.
4. Your student will provide me with his or her ACT mathematics sub-test score for recording in a password protected Excel spreadsheet. For confidentiality purposes, this spreadsheet is available only to me, the study's Principle Investigator. In addition, your student will provide me with a copy of his or her Test Information Release results generated from the December 12, 2015 examination upon its receipt.
5. Your child should work on the appropriate daily worksheet each day of the school week. I would expect this to take between 20 and 30 minutes a day.

Risks and Benefits of being in the Study:

The risks involved in this study include the breach of security and confidentiality of your student's ACT mathematics sub-test score. This risk will be mitigated by using a password protected Excel spreadsheet to record their test scores. In addition, the spreadsheet will not have personal identification markings (name) of any students as scores will be recorded by participant number only.

The benefits to participation are the potential increase of your student's ACT mathematics sub-test score. In addition, your student will gain insight on how to improve their metacognitive skills that can be used within other educational disciplines such as reading comprehension.

Compensation:

Your child will not receive any direct compensation; however, I will pay for the costs associated for any ACT examinations they take as part of this study. In order to qualify for this, your student must complete all assigned workbooks in the time frame provided with each workbook. I will pay for your student's December 12, 2015 ACT examination ($39.50).

Confidentiality:

The records of this study will be kept private in a password protected Excel spreadsheet. The primary researcher will be the only person with knowledge of the password used to gain access to the data recorded in the spreadsheet. If any sort of report is published, the report will not include any information that will make it possible to identify a participant. As per federal guidelines, the data generated by this research study will be disposed of by deleting any and all files containing any data three years after the study is concluded.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University nor his or her current high school. If you decide to allow your child to participate, he or she is free to not answer any question or withdraw at any time without affecting those relationships.

How to Withdraw from the Study:

If your child chooses to withdraw from the study, you or he/she should contact the researcher at the email address/phone number [redacted]. Should your child choose to withdraw, data collected from him or her will be destroyed immediately and will not be included in this study.

Contacts and Questions:

The researcher conducting this study is Jeffrey W. LeMay. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at [redacted]. You may also contact the research's faculty advisor, [redacted] at [redacted]

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Carter 134, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information to keep for your records.

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

Statement of Consent:

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

(NOTE: DO NOT AGREE TO ALLOW YOUR CHILD/STUDENT TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

☐ The researcher has my permission to record my child's ACT mathematics sub-test score as part of his participation in this study.

Signature of minor: ______________________________________ Date: ______________

Signature of parent or guardian: ____________________________ Date: ______________

Signature of Investigator: _________________________________ Date: ______________

APPENDIX H – PARENT/GUARDIAN CONSENT FORM - CONTROL

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

PARENT/GUARDIAN CONSENT FORM

THE EFFECTS OF USING SELECTED METACOGNATIVE STRATEGIES ON ACT MATHMATICS SUB-TEST SCORES

Jeffrey W. LeMay
Liberty University
School of Education

Your child is invited to be in a research study of The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores. He or she was selected as a possible participant because of their current classification as a high school junior or senior. I ask that you read this form and ask any questions you may have before agreeing to allow him or her to be in the study.

Jeffrey W. LeMay, a doctoral candidate/in the School of Education at Liberty University, is conducting this study.

Background Information:

The purpose of this study is to determine if using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

Procedures:

If you agree to allow your student to be in this study, I would ask him or her to do the following things:

1. Take the regularly scheduled ACT examination on December 12, 2015.
2. Upon receipt of your student's ACT examination scores, your student and I will meet at Cumberland Christian Academy for the purpose of recording your student's ACT mathematics sub-test scores in a password protected Excel spreadsheet. This particular spreadsheet is free of any student names. Instead, a pre-assigned study participant number will be used to record your student's ACT mathematics sub-test scores. In an effort to afford a high level of student privacy, your student's name and study participant number will be recorded in a separate password protected Excel spreadsheet than the spreadsheet where their scores are recorded. I will be the only person with knowledge of the passwords for these two Excel spreadsheets.
3. After your student's ACT mathematics sub-test scores are recorded, their participation in the study is complete.

Risks and Benefits of being in the Study:

The risks involved in this study include the breach of security and confidentiality of your student's ACT mathematics sub-test score. This risk will be mitigated by using a password protected Excel spreadsheet to record their test scores on. In addition, the spreadsheet will not have personal identification markings (name) of any students as scores will be recorded by participant number only.

Participants in the control group will not receive any direct benefits from participating in this study.

Compensation:

Your child will not receive any direct compensation; however, I will pay for the costs associated for any ACT examinations they take as part of this study that is scheduled to take place on December 12, 2015 ACT examination ($39.50).

Confidentiality:

The records of this study will be kept private in a password protected Excel spreadsheet. The primary researcher will be the only person with knowledge of the password used to gain access to the data recorded in the spreadsheet. If any sort of report is published, the report will not include any information that will make it possible to identify a participant. As per federal guidelines, the data generated by this research study will be disposed of by deleting any and all files containing any data three years after the study is concluded.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University nor his or her current high school. If you decide to allow your child to participate, he or she is free to not answer any question or withdraw at any time without affecting those relationships.

How to Withdraw from the Study:

If your child chooses to withdraw from the study, you or he/she should contact the researcher at the email address/phone number [redacted] Should your child choose to withdraw, data collected from him or her will be destroyed immediately and will not be included in this study.

Contacts and Questions:

The researcher conducting this study is Jeffrey W. LeMay. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at [redacted]. You may also contact the research's faculty advisor, [redacted]

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Carter 134, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information to keep for your records.

Statement of Consent:

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

(NOTE: DO NOT AGREE TO ALLOW YOUR CHILD/STUDENT TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

☐ The researcher has my permission to record my child's ACT mathematics sub-test score as part of his participation in this study.

Signature of minor: ____ Date: _____________

Signature of parent or guardian: _______________________________ Date: _____________

Signature of Investigator: ___________________________________ Date: _____________

APPENDIX I – ASSENT OF CHILD TO PARTICIPATE IN A RESEARCH STUDY – EXPERIMENTAL GROUP

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

Assent of Child to Participate in a Research Study

What is the name of the study and who is doing the study? The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores by Jeffrey W. LeMay.

Why are we doing this study?
We are interested in studying whether or not training and using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

Why are we asking you to be in this study?
You are being asked to be in this research study because you are a high school junior or senior and you are contemplating attending college in your future.

If you agree, what will happen?
If you are in this study, on Monday, October 26, 2015, you will be provided a weekly workbook you will be required to complete during the following week. On each subsequent week, you will be provided with another weekly workbook that you will be required to complete during each respective week. You will be required to take the ACT examination on December 12, 2015 and upon receipt of the score report from this examination, you will provide me with your mathematics sub-test score and any other official score reports ordered for the December 12, 2015 examination.

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

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

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

______________________________ ______________

Jeffrey W. LeMay
[redacted]

Advisor:
[redacted]

Liberty University Institutional Review Board,
1971 University Blvd, Carter 134, Lynchburg, VA 24515
or email at irb@liberty.edu.

APPENDIX J – ASSENT OF CHILD TO PARTICIPATE IN A RESEARCH STUDY – CONTROL GROUP

The Liberty University
Institutional Review Board
has approved this study for use
from 10/24/15 to --

Assent of Child to Participate in a Research Study

What is the name of the study and who is doing the study? The Effects of Using Selected Metacognitive Strategies on ACT Mathematics Sub-test Scores by Jeffrey W. LeMay.

Why are we doing this study?
We are interested in studying whether or not training and using two specific metacognitive skills: repetitive questions similarly worded to the problems contained on the ACT mathematics sub-test and if using a form of directed journaling of metacognitive relevant questions will increase participants' ACT mathematics sub-test score.

Why are we asking you to be in this study?
You are being asked to be in this research study because you are a high school junior or senior and you are contemplating attending college in your future.

If you agree, what will happen?
If you agree to be part of this study, you will be asked to take the ACT examination scheduled on December 12, 2015. When you receive your ACT examination results from this test, you and I will meet at your school at which time I will record your ACT examination mathematics sub-test scores. I will record your scores in a password protected Excel spreadsheet. This particular spreadsheet does not list your name, instead your scores will be recorded next to your study participant number. I will have a separate password protected Excel spreadsheet that will correlate your name and your study participant number. I am using two separate files to keep the data collected during this research as private as I can. When I report any data generated by my research, I will not use your name, or any other participant's name in my reporting.

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

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

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

_______________________________ _____________

Jeffrey W. LeMay — Advisor:

[redacted] [redacted]

Liberty University Institutional Review Board,
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