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Precalculus and ACT: A Quantitative Study of Five Tennessee High Schools

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Precalculus and ACT:
A Quantitative Study of Five Tennessee High Schools

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by

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ABSTRACT

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The purpose of this study was to determine if students scored significantly higher on the ACT after taking precalculus than they had scored on the ACT prior to taking precalculus. The researcher investigated whether there is an increase, not only in ACT composite scores, but also in ACT math subtest scores after high school students completed a precalculus course. The researcher also investigated differences regarding gender, socio-economic status, and race. Five Tennessee high schools from four counties and five different districts were used in this study. The study involved 208 participants and covered a span of three years. The findings indicated a significant difference in mean ACT composite and mathematics subtest scores for students after completing precalculus. The data were also compared by gender, race, and socioeconomic status for students who completed precalculus. The data indicated a significant difference in ACT composite scores for students completing a precalculus course regardless of gender or socioeconomic status.

DEDICATION

To my parents, Robert and the late Jo McCloud, who were not afforded the opportunity to be college graduates but truly valued the worth of education and pushed me to become whatever I desired, I dedicate this paper. You always made sure that I had opportunities to broaden my world and my experience. Your dedication to my brother and me was selfless and admirable. I am forever grateful!

To my husband, Scott Phipps, who exudes a quiet strength and endless patience toward the kids and me. You were so patient at times when I was stressed trying to get an assignment in or when you had to be the mom and the dad because I was in class. Thank you for being my rock and my calming force. You are truly a gift from God and I cannot thank you enough for all the motivation to help me attain this dream. You are my hero!

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To my students, all that have entered my classroom, who helped form me into the educator that I am today. Thank you for teaching me also.

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INTRODUCTION

Standardized tests have existed for more than a hundred years (Jacobsen, 2017). However, it was with the publication of *A Nation at Risk* in 1983 that standards-based education gained national attention. Finding that students in other nations were developing skills in mathematics and science which exceeded those of students in the United States, the report prompted a push to improve the quality of education for American students (Gardner, 1983). There was a significant push in education to increase the rigor of the standards being taught. This increased attention to standards led to an increase in attention to the testing of those standards. Testing was conducted at all levels of education; elementary, middle, high, and college. It was at the college level, particularly, that a greater push for admissions testing occurred (Linden, 2007). Standardized college admission test instructions require all test takers to take the same test, in the same manner. This allows for comparison of students who should be close to the same educational level. Colleges and universities then use these standard test scores to accept or reject students, as well as to place them in remedial classes (Allen, 2015; Cabrera & Burkum, 2001).

One frequently used standardized test is the ACT, developed in 1959 as the American College Testing test. The ACT measures achievement in the core academic areas: English, math, reading, and science, with an optional test of writing included. The ACT is not an IQ test and does not measure basic intelligence. It contains questions that measure skills and knowledge (ACT, 2008). Zeidner (1991) indicated there is rarely a more anxiety-producing event for a high school student than taking a college admittance test. University admissions officers use it to

judge a student's academic preparedness for college. In addition, the amount of scholarship money a college student receives is often based on an ACT score. This test can be very important to high school juniors and seniors trying to plan their futures (Zeidner, 1991).

The math portion of the ACT includes various amounts of Pre-Algebra (20-25%), Elementary Algebra (15-20%), Intermediate Algebra (15-20%), Coordinate Geometry (15-20%), Plane Geometry (20-25%), and Trigonometry (5-10%) (ACT, 2017b). By recognizing, understanding, and addressing the mathematical components on the ACT, educators can help students improve their ACT scores (ACT, 2008).

In 2004, Tennessee began awarding HOPE scholarships. Funded by the Tennessee education Lottery Scholarship Program, the stated purpose of the program is

> to provide access for Tennesseans to post-secondary education, to improve high school and collegiate academic achievement, to keep more of the best and brightest students in Tennessee, and to provide social and economic benefits to the state of Tennessee. (Tennessee HOPE Scholarship, n.d., p. 1)

Each year, Tennessee students are awarded the HOPE scholarship if they meet certain qualifications including ACT and GPA requirements (Tennessee HOPE Scholarship, n.d.). To qualify for the basic HOPE scholarship, students must either have a 21 on the ACT or maintain a 3.0 high school GPA (Tennessee Student Assistance Award, 2017).

Statement of the Problem

The purpose of the study was to determine if students who take the ACT test, complete a precalculus course, and take the ACT test again score significantly higher after completing precalculus. The researcher investigated whether there is an increase, not only in ACT

composite scores, but also in ACT math subtest scores. The researcher also investigated differences regarding gender, socio-economic status, and race.

Research Questions

1. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus?
2. Is there a significant difference in composite ACT mathematics subtest scores taken before precalculus and ACT mathematics subtest scores taken after precalculus?
3. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for males?
4. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for females?
5. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students receiving free or reduced lunch?
6. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students paying full price for lunch?
7. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for white students?
8. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for non-white students?

Significance of the Study

There were approximately 3.5 million graduating seniors in 2016 (National Center for Educational Statistics, 2017). More than 2 million of these students took the ACT (ACT, 2017b). *Preparing for the ACT* (ACT, 2017c) suggests students take the ACT test during their junior year. Tennessee requires all high school students take Algebra I, Geometry, and Algebra II by their junior year in high school if they are on the traditional path; meanwhile, students on an integrated path would take Integrated I, Integrated II, and Integrated III (Tennessee Department of Education, n.d.). An integrated approach to mathematics blends topics such as algebra, geometry, and statistics for students' first three years of math in high school (Will, 2017). The Glossary of Educational Reform interprets high stakes tests as tests used to make important decisions about students and have consequences for students such as compensation for high test scores (n.d.). With the ACT being such a high stakes test, the researcher will investigate the difference that higher-level mathematics, in particular, precalculus, has on ACT scores. ACT publications indicate that only Algebra I, Geometry, and Algebra II skills are tested on this college admissions test (ACT, 2014; ACT, 2017b, 2017c).

Despite criticisms of the ACT, the test has notable influence on the acceptance of students to colleges and universities. Because of their predictive validity, many admission programs continue to require applicants to submit ACT scores and often award scholarships and acclamation based on test scores. Even before college, other recognitions such as placement in special clubs at high schools, recognition at graduation for high scores, and having names and photos published in local newspapers are important to not only students but also to other stakeholders, including parents, schools, school systems, communities, and states (Peterson, 2016).

Limitations and Delimitations

One limitation to conducting any study is time. Although this study represents a three-year span of ACT test scores data, a larger window of time could possibly provide a clearer picture. Within the time frame of the study, major shifts have occurred in the Tennessee State Standards. These shifts include changes in math standards and an increase in the significance placed on ACT testing by the State of Tennessee. These shifts could have had an impact on the results. However, all the schools in this study are located in Tennessee and have had the same change in standards and increased expectations placed on the ACT.

Another potential limitation is the sample size. Although five high schools were chosen within a specific region in Tennessee, there are 22 high schools in that region. The five schools chosen vary in size, socio-economic status, rural status, and convenience.

The study is delimited by only analyzing the math subtest scores instead of all the subtest scores associated with the ACT test. The questions of the study are focused on whether taking precalculus plays a role in significantly increased test scores for both the ACT composite score and the math subtest. This researcher purposely narrowed the topic to consider only the mathematics subtest and the effect that the completion of a precalculus class had on both the subtest and the composite ACT scores.

Another delimitation is that the researcher purposely choose to study only the students at high schools in Tennessee. Therefore, findings of this study may not be applicable to other states or regions.

Definitions of Terms

The following terms are defined for the purpose of this study.

ACT composite Score: The average of the four scale scores rounded to the nearest whole number (ACT, 2014).

ACT subtests: The four multiple-choice tests – English, Mathematics, Reading, and Science – and an optional Writing test that constitute the ACT Test (ACT, 2014).

Core classes: The set of courses that are considered basic and essential for future class work and graduation in the state of Tennessee. Those courses are as follows: Algebra I, Geometry, Algebra II, English I, English II, English III, English IV, Biology, Physical Science, Chemistry, US History, World History, Economics, US Government, and 2 courses of foreign language. (Tennessee Department of Education, n.d.).

Free/reduced-price meals: A federal program that provides free or reduced-price meals to children based upon their family's income. Effective July 1, 2017, children in a family of four making less than $31,980 are eligible for free meals; those making less than $45,510 qualify for reduced price meals (USDA, 2017).

Integrated mathematics: "An integrated study is one in which children broadly explore knowledge in various subjects related to certain aspects of their environment" (Humphreys, Post, & Ellis, 1981, p. 11).

Merit-based financial aid: Scholarships that may come from the school or from outside sources based on a student's talents or scholarly abilities. A student with extensive assets and income is just as entitled to a merit-based award as a student with limited assets and income ("Need based vs. merit based aid," n.d.).

Standards based: A system of instruction, assessment, grading, and academic reporting that are based on students demonstrating understanding or mastery of the knowledge and skills they are expected to learn as they progress through their education (Concepts, n.d.).

Overview of the Study

In this study, ACT scores were compared for four counties in Tennessee. These four counties include five high schools that will be called Metacognition, Campus, Mastery, Numeracy, and Wisdom high schools. Both Campus High School and Mastery High School are in the same county. Tennessee Rankings Data (2017) ranks these counties by a myriad of data points. The four counties in this study have graduation percentage rates from 83% to 98%. The percentages of children living in poverty range from 26% to 36%. The percentages for the rural counties range from 78.4% to 100%. The percentages of children eligible for free and reduced lunch range from 61% to 67%, and the average income for the four counties used in this study range from $31,800 to $43,800. For a further breakdown of the statistics associated with the counties investigated in this study see Appendix E.

Chapter 1 provides an introduction, statement of the problem, significance of the study, limitations and delimitations, research questions, and the definition of terms used in the study. Chapter 2 contains a review of the related literature. Chapter 3 addresses the research methodology, including data collection and data analysis. Chapter 4 provides an analysis of the data, and Chapter 5 presents a summary of findings and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

Bill Gates once stated, “If you have 50 different plug types, appliances wouldn't be available and would be very expensive. But once an electric outlet becomes standardized, many companies can design appliances, and competition ensues, creating variety and better prices for consumers” (Layton, 2014, p. 1). Likewise, many states test students on a standard set of expectations when a student finishes a set amount of education (“Standardized Tests,” n.d.). There has been much debate about the best method to ascertain students’ abilities and knowledge acquired. Today, colleges commonly use the practice of attaining scores from ACT and SAT tests to predict success in post-secondary education.

Most colleges and universities in the United States, approximately 82%, require students to take the ACT test or the SAT test before entering college (Selingo, 2015). With most colleges and universities requiring these assessments for the students entering higher education, the ACT has become increasingly important to high school students. These test scores are used by the colleges and universities in three ways. First, the ACT scores are used to make college admission decisions. More than 4,400 colleges and universities require a certain score before accepting students (Selingo, 2015). Second, students with higher scores have a greater chance of being admitted to a more prestigious university. Some selective schools will not consider a student with a composite score below 30 on the ACT. Finally, many schools use ACT scores when deciding eligibility for “merit-based financial aid” (U.S. Department of Education, 2016, p. 1). Accordingly, increasing ACT scores is important to high school students and their parents.

A higher ACT score equates to better college opportunities as well as more aid to attend those institutions (Webb, 2006).

Educational tests are used to determine the abilities of students in order to predict future success and chart student progress. Standardized tests are widely used to determine the ability of students for college admission. One such standardized measure is the ACT test formerly known as the American College Testing assessment. This test developed out of a competition in Iowa to highlight academic talent in 1959 (Evans, n.d.). Everett Lindquist, an education professor at the University of Iowa, developed statistical tools and devices to grade the tests automatically for academic competitions in both primary and secondary schools. He later applied those same strategies to produce a test for college admission (Evans, n.d.). The ACT gained in popularity in the 1960s due to a larger number of students attending college (VanScoy, 1997). In 2016, a total 2,090,342 people took the ACT test (ACT, 2016a) while there were approximately 3.5 million students graduating high school that year (National Center for Educational Statistics, 2017). In 2010, Tennessee state law made the ACT assessment mandatory for all high school juniors (Garrison, 2014).

The ACT is designed to measure the academic skills needed to perform college-level work and is based on the general content areas of college and career readiness. The test is used to measure high school course achievement. Allen (2015), a statistician in the Research division at ACT, states "The philosophical basis for the tests are that (a) the tests should measure the academic skills necessary for education and work after high school and (b) the content of the tests should be related to major curriculum areas" (p. 1). The exams are offered six to seven times each year with most students taking them for the first time in the spring of their junior year. They must register online in advance and pay a registration fee of $46 for the ACT test

with no writing test. If students add the writing portion of the test, the cost is $62.50 (ACT, 2017c). Students can take the exam multiple times with colleges typically taking the highest score for admissions. The ACT has four separate subject tests: English, mathematics, reading, and science reasoning lasting for a total of 2 hours and 55 minutes. If a student elects to add the writing test, the total time of the ACT test is 3 hours and 35 minutes. Each subject test has a score range from one to 36, and the exam provides a composite score which is the average of the four subject tests rounded to the nearest whole number. The test is multiple choice and does not penalize for guessing (Evans, n.d.).

There has been much debate among educators on what accurately measures academic performance and predicts college success. The ACT score acts as a tool to compare students from diverse backgrounds and educational opportunities. The exam score functions as a way to compare students on the same scale with present and past students. It can identify students who did not do well in high school but who have high potential while also identifying those who received high grades but who may not be prepared for the rigors of college (Evans, n.d.).

Test Design

The ACT test consists of four multiple-choice parts: English, math, reading comprehension, and science reasoning (ACT, 2017b). The English subtest consists of 75 questions with a time restriction of 45 minutes to complete this subtest. This leaves testing participants 36 seconds per each item on the English subtest. The ACT mathematics subtest contains 60 questions to be completed in 60 minutes. This allows one minute for each question on the mathematics test. The reading comprehension subtest and the science reasoning subtest both have 40 questions with a time allotment of 35 minutes to complete. This allows 52.5

seconds per question on those two subtests (ACT, 2017b). Time is an important component of the ACT test. The test is designed so that the average high school student does not have enough time to complete the test (ACT, 2008).

The national ACT composite average for 2016 was 20.8, and the mathematics subtest average was 20.6. The goal score for Tennessee is a composite score of 21 (Boehnke, 2016). In Tennessee, the 2016 composite average was 19.9 with 1,300 more students reaching the composite score of 21 than the previous year. Another component of the ACT is the College Readiness Benchmarks. The benchmarks are the minimum ACT test scores required for students to have a high probability of success in credit-bearing college courses. In mathematics, College Algebra is the freshman level mathematics course with which the ACT mathematics benchmark is associated. The mathematics benchmark is a score of 22 on the mathematics subtest. Students who meet the mathematics benchmark score on the ACT have a 50% chance of making a B or better and approximately a 75% chance of making a C or better in their College Algebra class (Allen, 2015).

English

The ACT test is divided into four separate tests. The first test taken is the English test. The English test contains 75 items and individuals are given 45 minutes to complete this test. It is designed to measure one's knowledge of grammar and usage, punctuation, and sentence structure. It is also meant to test strategy, organization, and style. The test consists of five passages for test-takers to read and then answer questions regarding grammar, etc. There are three reported scores in the English section. Those are an overall test score on all 75 items; a subscore in usage and mechanics which is 40 items on the test, or 53% of the English subtest;

and rhetorical skills which is 35 questions, or 47% on the English portion of the ACT. Within those two content areas, there are specific skills that are tested. The Usage/Mechanics content area has three sets of skills that are tested. The first of those is Punctuation, which is 10 questions representing 13% of the ACT English subtest. A second skill tested in Usage and Mechanics is Grammar and Usage. This category has 12 questions representing 16% of the ACT English test. The third skill tested in Usage and Mechanics is Sentence Structure. There are 18 questions, or 24% of the English subtest involving sentence structure.

The other content area tested on the ACT English subtest is Rhetorical Skills. Within Rhetorical Skills, there are three skills tested. The first skill mentioned is strategy, which has 12 test questions and is 16% of the ACT English subtest. Another skill tested on the ACT English subtest is Organization. There are 11 questions, or 15% of the ACT English subtest, involving organization. The third and final category tested on the ACT English subtest is Style. There are 11 questions, or 16%, regarding style (ACT, 2014).

Mathematics

The second part of the ACT is the mathematics test, which is a 60 question, 60-minute test designed to assess the skills that a student has acquired in grades 7 through 12. The test is designed to assess knowledge and skills, application, concept mastery and integration of conceptual understanding. The test is divided into six categories: Pre-Algebra, Elementary Algebra, Intermediate Algebra, Coordinate Geometry, Plane Geometry, and Trigonometry. Each question on the ACT mathematics subtest is designed to be completed in one minute. As of 1996, calculators were permitted on the mathematics portion only. A student should use their calculator for computations only to save time (ACT, 2014). The content specification for the

ACT mathematics subtest is broken down into six different areas of mathematics. Each area listed has a specified number of questions and will always be a certain percentage of the mathematics subtest. Pre-Algebra makes up 23% of the mathematics subtest. Fourteen questions on the mathematics subtest are considered Pre-Algebra level questions. This is equivalent to 7th and 8th grade math. Elementary Algebra is attributed to 17% of the test with 10 questions considered elementary algebra questions, which tend to be Algebra I type questions. There are nine questions on the mathematics subtest, which are considered Intermediate Algebra. This would be considered Algebra II type questions. Another content area tested on the mathematics subtest is Coordinate Geometry. Nine questions or 15% of the mathematics subtest is considered Coordinate Geometry. Plane Geometry is also tested. There are 14 questions on the mathematics subtest regarding Plane Geometry, which is approximately 23% of the entire mathematics subtest. The last content specification listed is Trigonometry. There are four questions on the mathematics subtest, or 7%, that are Trigonometry based (ACT, 2014).

Pre-Algebra items are questions regarding operation, decimals, fractions, integers, place value, one variable linear equations, ratio and proportion, scientific notation, percent, and absolute value (ACT, 2014). These skills are in the Tennessee state standards for mathematics in grades six, seven and eight. Elementary algebra items require knowledge of exponents, square roots, functional relationships, and solving quadratic equations. The topics for Elementary Algebra align closely to the Tennessee standards for Algebra I (Tennessee Department of Education [TDOE], 2016). Intermediate algebra questions include using the quadratic formula, rational expressions, radical expressions, matrices, roots of polynomials and complex numbers. These standards align closely with the Tennessee math standards for Algebra II. Coordinate Geometry is 23% of the test and covers points, lines, polynomials, circles, and curves. It also

includes slope, distance, midpoint, parallel and perpendicular lines, as well as conics. Plane Geometry includes properties of circles, triangles, rectangles, parallelograms, and trapezoids. It includes transformations, proofs, and three-dimensional geometry. The standards from Coordinate and Plane Geometry align with the Tennessee state standards in Geometry. Trigonometry is also tested on the math subtest of the ACT. The trigonometry questions require knowledge in trigonometric relationships involving right triangles, graphing and modeling trigonometric functions as well as solving trigonometric equations. The objectives tested within the trigonometry portion tend to align with Algebra II as well as Geometry standards (TDOE, 2016).

Reading

The third test, Reading, has 40 items and takes 35 minutes. This test is designed to measure reading comprehension. Students are to determine the meaning of four sections that are representative of the level that students will be reading during their first year of college. Items in the reading test

> ask students to use referring and reasoning skills to determine main ideas; locate and interpret significant details; understand sequences of events; make comparisons; comprehend cause-effect relationships; determine the meaning of context-dependent works, phrases, and statements; draw generalizations; and analyze the author's or narrator's voice or method. (ACT, 2014, p. 6)

There are four 750-word reading passages on the reading test. Each of the four passages contains one long prose passage or two shorter prose passages. Each of the passages has 10 questions regarding that passage and they are titled Prose Fiction, Social Science, Humanities,

and Natural Science (ACT, 2017c). The reading test does not ask students to recall facts from passages or isolated vocabulary questions but does ask students to focus on complex and supportive skills that a high school reader should possess (ACT, 2014).

There are three scores reported for this test: a score based on all 40 questions, a subscore in Arts/Literature reading skills, and a subscore in Social Studies/Sciences reading skills (ACT, 2014). There are four specific kinds of passages with 10 questions for each ACT reading passage content area (ACT, 2014).

The Literary Narrative passage on the reading subtest of ACT comes from short stories, novels, memoirs, or essays while the prose fiction items are based on excerpts from short stories and novels. The Social Studies passage is based on content areas such as psychology, education, geography, business, anthropology, political science, sociology and history. The humanities passage also comes from memoirs or personal essays on different content areas including radio, television, ethics, film, language, art, dance, architecture, and theatre. The natural sciences passage deals with the sciences content area such as anatomy, biology, technology, zoology, meteorology, and so on (ACT, 2014).

Science

The fourth test given in the general ACT test is the Science Reasoning Test. This, like the reading test, is a 40-item test taking 35 minutes. The content of this test is drawn from biology, chemistry, physics, earth science, and space science. The test measures the analysis, evaluation, reasoning, interpretation, and problem solving skills required for science. There is only one test score reported for this test and it is an overall score based on the entire 40 questions (ACT, 2014).

Students are expected to have a minimum of two years of high school science, typically a biology and a physical science. The test presents six passages of scientific information followed by either six or seven questions regarding each passage. This test requires students to critically examine relationships, recognize and understand basic concepts of the given information, and generalize to "gain new information, draw conclusions, or make predictions" (ACT, 2014, p. 7). The ACT science subtest is designed differently from the other three tests. There are questions over four content areas of science: Biology, Earth/Space Science, Physics, and Chemistry. There are not a certain number of problems associated with those four areas however. Those four areas are divided into three formats: data representation, research summaries, and conflicting viewpoints. The number of items on the science subtest is based on those three different formats. There are 12 questions regarding data representation, which is 30% of the test. There are 20 questions on research summaries, which are 50% of the science subtest, and there are eight questions on conflicting viewpoints, making up the last 20% of the ACT science subtest (ACT, 2014).

Data Representation gives students graphic information that would be found in scientific journals. The test asks students to interpret and predict the information found in tables and graphs. The research summaries ask students to interpret results of one or two different scientific experiments that have been conducted. Lastly, the conflicting viewpoints section requires students to understand, analyze and compare hypotheses or differing viewpoints (ACT, 2014).

Writing

There is an optional writing test taking an additional 30 minutes that is also available. A student would pay an additional $16.50 to take this optional test. This test measures students'

writing skills that would have been in the high school standards. The students are given a writing prompt and two points of view regarding that prompt. The students are then asked to respond to that prompt describing their perspective on the prompt. The score on the writing test does not affect the overall composite score on the ACT test. Students taking the writing portion of the ACT will receive each of the other subtest scores, the composite score, as well as a writing subtest score. Students are also provided comments on the essays they create in the writing portion of the test. Because of the extra grading, those students taking ACT plus writing would expect to get their test back approximately two weeks later than those only taking the multiple choice portions of the test (ACT, 2014).

College and Career Readiness Standards and Benchmarks

ACT developed the College and Career Readiness Standards and the College Readiness Benchmarks. The College and Career readiness benchmarks are defined as "The minimum ACT college readiness assessment scores required for students to have a high probability of success in credit-bearing college courses—English Composition, social sciences courses, College Algebra, or Biology" (ACT, 2013b, p. 1). The College and Career Readiness Standards describe what a student knows based on the score that they made on the ACT. For example, a student scoring in the 16 – 19 range in English should be able to determine the placement of a sentence in a complex paragraph. These standards reflect the skills associated with the scores obtained. "The ACT College Readiness benchmarks are the minimum ACT test scores required for students to have a high probability of success in credit-bearing college courses - English Composition I, social sciences, College Algebra, or Biology" (ACT, 2014, p. 1). Those students meeting the ACT benchmarks have a 50% chance of making a B or better in that course and a 75% chance of

making a C or better in the course. For example, if a student makes the benchmark in mathematics then they would have a 50% chance of making a B or better in their College Algebra course and a 75% chance of making a C or better in College Algebra. Some school systems and states even monitor the school's progress based on the number of students who meet the ACT test benchmarks. Researchers also found that college preparatory classes taken in mathematics and science added to the college-readiness benchmark scores more than the other disciplines (Noble & Schnelker, 2007).

The English Benchmark is associated with English Composition 1 at the college level. The English benchmark is 18. In order for a student to have a 50% chance of making a B or better in their English Composition 1 class, they would need to score at least an 18 on the English ACT subtest. The mathematics benchmark is associated with the College Algebra course. The benchmark score for the mathematics subtest is 22. The reading subtest is associated with the social sciences courses and a score of 22 is required. The science subtest benchmark score is aligned with Biology and requires a benchmark of 23 (ACT, 2014).

The ACT profile report from the graduating class of 2016 reports that of those students taking the standard time ACT test in Tennessee only 20% of the students who tested met all four benchmarks (ACT, 2016). The National ACT profile report for the same graduating class nationally had 27% meeting all the benchmarks (ACT, 2017a).

Nationally, 63% of all students taking the English ACT subtest met the ACT benchmark score. In mathematics, 42% of all students met the ACT mathematics benchmark score. In reading, 37% of those who took the ACT met the ACT reading benchmark and 37% met the benchmark score in science. In Tennessee, reading was the only benchmark score that was above the national percentage. In English, 60% of Tennessee students met the benchmark score.

In mathematics, 31% of students met the benchmark score indicating that they had a 50% chance of making a B or better in College Algebra. In reading, 39% of Tennessee students met the benchmark and in science, 31% of Tennessee students met the benchmark score of 23 (ACT, 2016b).

ACT (2014) indicated that students who met the college readiness benchmarks were much more likely to enroll in college than those who did not meet the benchmarks. In 2016, 83% of students enrolled in college had met the ACT benchmarks in all subjects. In English, 78% of those enrolled in college had met the English benchmark. In mathematics, 81% had met the ACT math benchmark. In reading, 79% had met the benchmark and 82% had met the benchmark in science.

Those students who met the ACT College and Career Readiness Benchmarks were also more likely to make a B or better in their first year college classes and earn a grade point average of 3.0 or higher. Of the students enrolled in college who had met the ACT English benchmark, 51% made a 3.0 or higher. Of the students enrolled in college who had met the ACT mathematics benchmark, 61% made a 3.0 or higher. In reading, 54% of students enrolled in college who had met the reading benchmark made a 3.0 or higher GPA. In science, of the students enrolled in college who had met the ACT science benchmark, 62% were making a GPA of 3.0 or greater. Overall, of the students who had met the benchmarks in all subjects, 67% were making a 3.0 or greater grade point average (p. 133).

Pros of Standardized College Testing

Many educators give credence to the concept of standardized testing for college admittance ("Standardized Tests," n.d.). It is widely perceived that a common standardized test

compares students across the country with their peers to determine what they learned in high school. Furthermore, some educators propose that standardized tests such as the ACT are objective in nature, while classroom grades often appear to be subjective ("Pros and Cons of Standardized Testing," 2013). The rigor for an Algebra I classroom can vary widely making grades not very reliable sometimes. Another positive thing about standardized testing is "standardized tests provide accurate comparisons between subgroups" ("Pros and Cons of Standardized Testing," 2013, p. 1). These subgroups include socio-economic, special needs, race, gender, and provide much data for schools and school systems to develop programs to help those particular students.

Roediger, Putnam, and Smith (2011) list ten benefits of standardized testing. They indicate that testing has both direct and indirect effects that can be very positive for students and enhance their learning. They point out that testing not only identifies gaps in knowledge but also aids in the retrieval of information causing students to better retain what is learned. They also suggest that testing encourages students to study as well as improve students' metacognition. Lastly, they communicate that testing helps students better organize the knowledge and additionally transfer what they have previously learned into new contexts.

High school grades and teacher recommendations are factors used to determine admission status for students who will be successful in their programs. However, those grades and recommendations are often subjective in nature. They relay how the teachers think the students are doing but do not compare them to a set of standard learning benchmarks such as the ACT assessment. Gandy, Minnesota Program Director for Students for Education Reform (SFER), argues that our students are capable of greatness and must take these college entrance exams to show they have mastered the critical skills necessary for success in their future

educational plans. She points out that we stress students with the importance of these tests instead of just gauging their learning (Gandy, 2016).

Periodically, the ACT organization will review the content area of each subtest. They study the curriculum that is being taught across the country through curriculum guides, state standards, and surveys conducted. ACT then uses that information to better align the curriculum taught throughout the country to the test. According to ACT, the specifications of the test are consistent with the coursework being taught in America's high schools (ACT, 2013a).

Cons of Standardized College Testing

Sir Ken Robinson stated in an interview with Trost (2009),

> Now the problem with standardized tests is that it's based on the mistake that we can simply scale up the education of children like you would scale up making carburetors. And we can't, because human beings are very different from motorcars, and they have feelings about what they do and motivations in doing it, or not. (para 28)

Popham (1999) also stated "Educators are experiencing almost relentless pressure to show their effectiveness. Unfortunately, the chief indicator by which most communities judge a school staff's success is student performance on standardized achievement tests" (p. 8). In Tennessee, schools and school systems are being asked to raise ACT scores across the state (Tennessee Department of Education, n.d.). School and district report cards along with teacher evaluation rankings are now linked to the improvement of ACT scores (Tennessee Education Lottery Scholarship Program Annual Report, 2014).

Standardized tests have long been part of American education. Inadequacies in our education system have been linked to teacher quality, poverty levels, and even tenure procedures

("Standardized Tests," n.d.). Many groups both oppose and support standardized college testing. One such group is the National Center for Fair and Open Testing. Fair Test (2007) claims that the ACT test is unfair and biased. Fair Test suggests that ACT scores can be directly related to the income of a family. Children of wealthy families tend to have higher scores than others. This is not the only reason for the differences according to the article. Fair Test continues to say that- even when all of the outside factors are equal, such as background, grades, and socio-economic status- white students still outperformed other student groups. Fair Test suggests that tests could be biased in that they are timed and in a multiple-choice format that favors males or biased language where idiomatic terms are used.

Asian-American students actually do better on the ACT than American students, while white American students continually outperform African-American students. The author indicates there are many students who do not perform well on tests although they understand the content very well. This is not a fair representation or prediction of their performance at the college level ("Pros and Cons of Standardized Testing," 2013). Shanley (2007) reports there is a disproportionate number of students accepted to college from underrepresented minorities and lower socio-economic students when compared to white and Asian students from upper socio-economic backgrounds. Espenshade and Chung (2010) voice that

> The heart of the matter is a strong correlation between standardized admission test scores, parental income and education, and race. An admission process that rewards applicants with high test scores tilts the outcome in favor of students who come from more socioeconomically privileged backgrounds. (p. 8)

Cabrera and Burkum (2001) suggest that the ACT is a "weak predictor" of success in college. They advocate that ACT does not measure many areas of intelligence such as musical

or artistic ability and motivation. They also indicate that work habits cannot be determined from a standardized test given on one day in a school career.

Scholarships

In November of 2002, Tennessee passed a law allowing a state lottery in Tennessee. Tennessee had voted on this several times in the past with the bill failing each time until 2002. The purpose of the lottery was to generate money to fund college scholarships. In Fall of 2004, Tennessee began awarding college scholarships for students meeting certain criteria. There were five different scholarships: HOPE, Merit, Need-based, Wilder-Naifeh Technical Skills, and HOPE access grant. Three of those five scholarships had ACT requirements attached to the award. All three of those were either an ACT component or a GPA component (Tennessee Student Assistance, n.d.). In the 2005-2006 school year, there were 40,000 students receiving approximately $100 million in lottery scholarships. By the 2013-2014 school year, there were over 100,000 Tennessee students receiving approximately $303 million in lottery scholarship aid (Tennessee Education Lottery Scholarship Program Annual Report, 2014). The table in Appendix A shows the different types of Tennessee Lottery scholarships, amount of possible award, and the requirements to attain the scholarships.

The HOPE scholarship is given to students who score a 21 on the ACT or have a 3.0 GPA. The amount of the award is $1,500 for a two-year college and $3,000 for a four-year college or university. The Merit scholarship is awarded to students with a 29 ACT composite score or a 3.75 GPA. This award adds $1,000 to the HOPE scholarship. A third lottery scholarship is the Need-Based scholarship. Students receive this scholarship when they meet the HOPE requirements and have an income less than $36,000 a year. The Wilder-Naifeh Technical

Skills Scholarship is awarded for $1,250 to students enrolled at Tennessee Technology Centers who have not received the HOPE Scholarship. Lastly, the HOPE Access Grant is awarded to students making an 18 on the ACT and maintaining a 2.75 GPA with an income less than $36,000. The award for this grant is $1,250 for a two-year college and $2,000 for a four-year college (Tennessee Student Assistance, n.d.). More detailed information regarding HOPE scholarships can be found in Appendix A.

Retesting

From 2009 to 2015, there was a 4% increase, from 41% to 45%, in the proportion of students who took the ACT for at least the second time. Students who retake the ACT are trying to improve their scores most of the time. "Of the 2015 graduates who retested, 57% improved their composite score on the second testing. However, 22% saw the composite score decrease on the second test" (Harmston & Crouse, 2016, p. 1). Generally, students who retested multiple times tended to do better, although there is a ceiling in the number of tests taken to improve one's score. Retesting at least once is associated with increases in average composite scores when comparing first and second tests. However, it is crucial to question why these gains occur. In fact, according to Harmstrom and Crouse (2016), there are multiple factors that influence these gains.

Scholes and Lain (1997) examined the effects of test preparation procedures when students retest. They eliminated students who tested under special circumstances as well as students with invalid or missing data. They also eliminated students who had already completed some form of test preparation before their first test. They found that the mean gain score for students not engaging in any test preparation was 0.6. They also found that those students

engaging in test preparation in the form of practice tests, workbooks, and completed a test preparatory course was 0.8. There was a 0.2 difference between the scores of those who prepared for the second test and those who did not have preparation. Their results showed that short-term test preparation showed very small effects on the ACT composite score increases. The larger effects on composite ACT scores tended to be the course work taken in high school.

Preparation strategies do play a role in the increase in average ACT composite scores. The effect of test preparation activities on ACT composite scores vary depending on the strategy. According to the ACT (2014) Technical Manual, the strategy that has the least effect on increasing ACT composite scores is the use of workbooks designed to assist ACT test takers. There was a 1.2 percent increase in composite scores utilizing this strategy. The strategy of attending workshops and/or using computer software showed an increase of 1.5 points on the composite ACT score. These two preparation strategies are considered short term strategies and do not increase the composite scores as much as long-term strategies (ACT, 2014).

Long-term strategies show larger composite ACT score increases (ACT, 2014). Studies show a positive correlation between the courses taken by a student in certain subject areas and their performance on standardized tests (Kellaghan &Airasian, 1982; Sawyer, 1989). There is also a positive correlation between number of courses a student takes in certain subjects and that student's standardized test scores (Laing et al., n.d.; Wang & Pennington, n.d.). Students taking the recommended core curriculum showed a 2.3 point increase on their ACT composite score. Core curriculum is defined here as four or more years of high school English and three years each of high school mathematics, social studies, and natural sciences. High school students who added a physics course to that curriculum showed a 2.4 point increase on the ACT composite score. Students adding an advanced math course had a 4 point increase in average ACT

composite scores. Adding an additional upper level math course increased their ACT composite score by 5.3 points. Lastly, the research shows that adding calculus to their curriculum increased average ACT composite scores by 5.8 points (ACT, 2014).

Harmstron and Crouse (2016) go on to indicate that the percentage of students increasing their score upon retesting is higher when their initial score is low, compared to gains made by students whose initial score is high. Those students who tested as sophomores saw an average composite score increase of 2.7 with their last test while students testing as juniors only saw a 1.1 point increase from first to last test. Students taking their first and last tests as seniors only saw a 0.6 point increase on their average.

Increasing the average ACT composite score tends to have more to do with high school coursework than with test preparation activities. The results of these studies suggest that course work has a much larger role in ACT test composite increases than short-term test preparation activities. "Approximately 95% of all students have a 70% to 80% chance of maintaining or increasing their score on retesting" (ACT, 2014, p. 90).

Changes in Test Scores

All the questions on the test are multiple choice and the test is designed for the average person to not be able to complete it in the time frame given. The test is graded on a scale of 1 to 36 (ACT, 2017b). The national composite average for 2016 was 20.8 while the composite average for Tennessee was 19.9 (ACT, 2017a). The national average ACT composite scores for the last ten years have changed very little, ranging from 20.8 to 21.2. The national average ACT composite scores for 2007 to 2016 are as follows: 21.2, 21.1, 21.1, 21.0, 21.1, 21.1, 20.9, 21.0, 21.0, and 20.8 (ACT, n.d.c). Tennessee consistently scored lower than the national average from

the years 2007 to 2016. Tennessee average ACT composite scores for the last ten years are as follows: 20.7, 20.7, 20.6, 19.6, 19.5, 19.7, 19.5, 19.8, 19.8, and 19.9 (ACT, n.d.c; ACT Newsroom, n.d.).

In 2010, Tennessee's average composite score decreased by 1.0 points. This was also the first year that all Tennessee juniors were required to take the ACT test statewide. According to the ACT Profile Report -2009 (ACT, n.d.a), 52,052 students from the graduating class of 2009 took the ACT in Tennessee. In 2010, there were 66,552, which is a 27.9% increase in the number of students in Tennessee taking the ACT Exam (ACT, n.d.b). The difference in students taking the ACT in Tennessee from 2009 to 2010 was 14,500 students.

Racial, Ethnic, and Gender Group Differences

Numerous studies show that white students have an advantage over minority students and that minority students achieve lower academically signifying that race plays a major role in students' education (Battle & Lewis, 2002; Crosnoe, Johnson, & Elder, 2004; Seyfried, 1998). Equity issues concern many educators. Researchers have compiled ACT score data with respect to race and ethnicity. ACT compiles a report each year (ACT, 2016a) containing data on ethnic groups as well as subtest data and benchmark data. The national ACT composite scores for racial and ethnic groups for the years 2014 – 2016 are listed in the table in Appendix B. These numbers indicate differences based on race/ethnicity.

The average ACT composite score for all students in the United State for the years 2014 – 2016 were 21.0, 21.0, and 20.8 respectively. Asian students outscored all the groups with mean scores of 23.5, 23.9, and 24.0. White students in the United States scored above the average every year with mean scores of 22.3, 22.4, and 22.2. The lowest scoring race/ethnicity

group was the Black/African American group with mean scores of 17.0, 17.1, and 17.0 respectively for the years 2014 – 2016 (ACT, 2017a). A more complete list of percent and average composite scores by race and ethnicity for years 2014-2016 can be found in Appendix B.

From 2015 to 2016, every subgroup decreased by at least 0.2 of a point, excluding the Asian group which increased by one tenth of a point. Across the three-year comparison for race/ethnic groups, the black/African American group scored the lowest composite score every year. Consistently, the American Indian/Alaska Native group scored the next lowest each year. The group scoring the highest for each of the three years was the Asian group. Each year, this group scored more than a full point above the second place group, which was the white group. According to the ACT Profile Report – State (ACT, 2016b), the same trends were found for Tennessee. The highest average ACT scoring group was Asians followed by whites, those of two or more races, those with no response, Hispanic/Latino, Native Hawaiian/Island Pacific, American Indian/Alaskan Native, and Black/African American (ACT, 2016b). Twenty years ago, Sherri Seyfried (1998) showed in her work that African-American students scored significantly lower on SAT tests for the 1991- 1992 school year.

Many colleges and universities proclaim their high ACT scores for incoming freshmen. Many still only admit students with the highest ACT or SAT scores, although now there is a decrease in the importance of these college admissions tests in many colleges and universities. Many schools have decreased the amount of importance placed on these tests or completely discarded them. Some colleges and universities are starting to place more emphasis on high school grades and less on a test given during one day of their high school career (Peterson, 2016; Sacks, 2000; Shanley, 2007).

There is some difference in ACT composite scores between the genders. In Tennessee in 2016, there was a 0.3-point difference between males and females, with females scoring better than males. On average, Tennessee males taking the ACT scored 19.9 composite and females scored 20.2 composite. Tennessee females taking the ACT test outscored males in English and reading. Tennessee females' average English subtest score was 20.3 while males scored 19.2. On the reading subtest, females outscored males by 0.8 point - 20.8 to 20.0. Tennessee males taking the ACT outscored females on the math and science subtests. Tennessee males scored an average of 19.6 on the math subtest while females scored 19.1. On the science test, males outscored females by 0.1 point – 20.1 to 20.0.

At the national level, males outscored females by 0.6 point. Nationally, females scored 0.8 points better on the English subtest than the males - 20.6 to 19.8. Males' average scores were better nationally on the math and reading subtests. The national average ACT composite for males was 21.0 while the national female average was 20.3, a difference of 0.7 points. Males also outscored females nationally on the reading test by 0.5 points, 21.1 to 20.6, respectively. Nationally, males and females both scored an average of 20.9 composite on the science subtest of the ACT (ACT, 2016b).

There seems to be a difference in the performance of students on the ACT test in different populations. Although according to the Technical Manual produced by ACT, Inc., the greatest differences in performance are based on race/ethnicity. There was a seven-point difference between the Asian group and the Black/African American group on ACT composite scores in 2016. There was also a 3.5 difference between the scores of white ACT takers and Hispanic/Latino ACT takers in 2016.

Academic Preparation

In 1990s, interest in ACT test preparation has increased dramatically. Many parents, teachers, and students are convinced test preparation strategies are important and should be utilized for higher ACT scores. Research on this has been mixed. For example, Kulik, Kulik, and Bangert (1984) concluded that students could raise scores by taking practice tests. Becker (1990), however found that much test preparation was ineffective and non-beneficial to the student. Scholes and Lain (1997) suggest that test preparation strategies designed to help students become familiar with the test or test-taking strategies to perform better may be useful. However, short-term test preparation programs to review concepts previously learned seem not to be as effective.

Testing preparation programs have become big business for standardized testing platforms. There are specific testing preparation programs that are being implemented to increase ACT scores for high school students. Many of the preparation programs implemented have been done so to help with the following areas:

- Helping to familiarize students with the layout of the test
- Helping students with general testing strategies such as eating a good breakfast or getting a good night's sleep
- Helping students with specific strategies for the ACT test such as making students aware they will not be penalized for guessing on the ACT
- And helping students with specific drills in content areas such as review of unit circle trigonometry

These test preparation programs can be given individually, in a small group setting, or even in a large class. They can also be taught in person or online. These test preparation programs can

include workbooks, computer software, practice tests, classroom curriculum, and a multitude of other resources. The cost of these test preparations vary widely but can cost as much as hundreds of dollars. They could be purchased by the school system to help the entire student body or by an individual to help them achieve a higher score (US Department of Education, 2016).

McMann (1993) conducted a research study to determine whether ACT scores would improve if general test taking strategies and ACT practice problems were embedded into students' high school algebra classes. The study was done in southeastern Michigan in one high school involving eight different sections of algebra classes using sophomores and juniors. The course lasted 10 weeks and compared students who did not receive the algebra classes embedded with test taking strategies with those students who did receive those classes. The results showed a "statistically significant positive effect" on those students who had embedded test-taking strategies in their math classes. There was a statistically significant difference between the two different algebra classes (U.S. Department of Education, 2016).

ACT acknowledges that test scores are related to educational plans. Those students who tend to be more academically ambitious generally score higher on the ACT. These students tend to prepare more for the test as well as to take a more rigorous course path in high school. ACT reported that their research showed that students taking more English and mathematics score higher on the ACT itself. Most readily available information regarding ACT, including their own practice booklets given to high school students, suggests that one only needs Algebra I, Geometry, and Algebra II to do well on their exam. The ACT Company affirms that all of their test questions are covered in those three classes (ACT, 2014). Even the state of Tennessee gives the ACT test to students when they complete Algebra II or Integrated III at the end of their junior

year. However, students who took a fourth English and a fourth mathematics course scored higher on the test. This may attest to the idea that ACT is a curriculum-based test or that those taking more advanced math and English classes would score higher on any test. Because the ACT test is oriented to the general curriculum of high school, a student's performance on the test should be related to the amount of courses and the rigor of the courses taken in high school (ACT, 2014). "ACT's recommended college preparatory core curriculum is defined as at least four years of English and at least three years each of mathematics, social science, and natural sciences" (ACT, 2014, p. 67).

Findings reported by ACT (2014) indicated that high school grade point average, the courses taken in high school and the high school attended were all strongly associated with higher ACT scores. There were considerable mean differences in the scores of those who had taken and those who had not taken upper level rigorous coursework in their high school. The researcher studied academic preparation for the time span of 2009 – 2013. Students completing the core curriculum scored the following composite ACT score, respectively: 22.0, 22.0, 21.9, 21.8, 21.7. Those students who did not complete the core curriculum had the following scores from 2009-2013, respectively: 19.1, 18.9, 19.0, 19.1, 18.7. Core curriculum is defined here as four or more years of high school English and three or more years each of high school mathematics, social studies, and natural sciences. Each of the ACT subtest scores showed similar patterns regarding core curriculum completed. There was a 3.3-point difference in the mean of English scores between the students completing the core curriculum or more and those not completing the core curriculum. Likewise, there was a 3.1-point difference between the two groups in reading. Mathematics subtest scores showed a 2.9-point difference between the two groups, while science subtest scores showed a difference of 2.7 points (ACT, 2014). A more

detailed display of ACT composite and subtest scores by academic preparation is listed in Appendix C.

The results indicate that most students who take upper level classes, such as trigonometry, calculus, chemistry, or physics, can expect to score significantly higher ACT scores than those students who do not take those courses. These results indicate that, in general, students taking the core curriculum or more can expect to score significantly higher on the ACT than those not taking the core curriculum. High School course work is positively associated with increased ACT scores. Taking a foreign language increased the ACT English score by 1.1 points. Taking an advanced math class such as trigonometry or calculus increased the ACT math score by 1.0 to 1.5 points over the five-year period. Taking either physics or chemistry increased the ACT science score by 0.5 points (ACT, 2014).

The average ACT score as broken down by grade point averages for the school year of 2012-2013 shows a positive correlation between high school GPAs and ACT composite scores. There is also a positive correlation between high school GPAs and each of the subtest scores for ACT. When looking at ACT composite scores, students with a 1.99 or below GPA had a mean ACT composite score of 15.3. Students with a 2.00-2.49 GPA increased the mean ACT composite to 16.5. Students with GPAs of 2.50-2.99 had a mean composite ACT score of 18.1. The next student GPA range of 3.00-3.49 yielded a mean composite ACT score of 20.3 while a 3.50-4.00 high school GPA range showed a mean ACT composite score of 24.5. This same correlation is also evident when looking at each of the four ACT subtests: English, mathematics, reading, and science (ACT, 2014).

There are significant differences in ACT scores for students based on grade point averages. Students with a GPA between 3.5 and 4.0 will score an average 3.8 points higher on a

composite score than a student with a GPA range of 3.0 to 3.49 according to the ACT Technical Manual (2014). A typical student with a high school GPA of 3.0 will score 3.8 points higher on their ACT composite than a student who has a 2.0 GPA. The relationship between GPA and ACT scores appear undeniable (ACT, 2014). For more detailed information about GPAs and mean ACT scores consult Appendix D.

Research shows that taking more rigorous, college preparatory courses is associated with higher ACT composite scores. Likewise, taking higher-level mathematics college preparatory courses not only produces higher average ACT composite scores but also higher mathematics subscores (Noble, Davenport, & Pommerich, 2006). Noble and Schnekler (2007) indicate that a significant effect exists for composite ACT scores based on the high school attended. They found that composite ACT scores varied widely based on the high school attended. This could be due to a variety of reasons including the importance placed on the test.

Socioeconomic Status and ACT Scores

"Socioeconomic status (SES) encompasses not just income but also educational attainment, financial security, and subjective perceptions of social status and social class" ("Education and Socioeconomic Status," n.d., p. 1). Battle and Lewis (2002) express that income is very closely linked to a person's education. Most people would agree that poor children are not born with less intelligence. However, studies consistently show that low-income students score more poorly than high-income students do on standardized tests (Hays, 2015). Students from higher SES families begin high school on average five years ahead of their peers from a lower SES (Reardon, Greenberg, Kalogrides, Shores, & Valentino, 2013). The recent downturn in the economy places more students within the poverty threshold identified by the

U.S. Census Bureau (2015). The official poverty rate in 13.5%, which is 43.1 million people living in poverty in the United States. In 2015, the poverty rate for children was 19.7%. That is almost one in five children considered to be living in poverty in the United States in 2015 (Proctor, Semega, & Kollar, 2016).

"A family is counted as poor if its pretax money income is below its poverty threshold. Money income does not include noncash benefits such as public housing, Medicaid, employer-provided health insurance and food stamps" (U.S. Bureau of the Census, 2009, p. 55). The 2016 Poverty Guidelines for the 48 contiguous states and the District of Columbia indicate that a one-person household is considered to be in poverty if they make below $12,060 per year. Two people living in a household or as a family are considered to be in poverty if they make a combined total below $16,240 per year. A family of four in 2016 was considered to be in poverty if they made a combined total of less than $24,600. For each additional person in the family or household, one would add an additional $4,180 ("Poverty Guidelines," 2017).

Poverty has significant effects on student participation, treatment of students, and student achievement in schools. It makes sense that children in poverty do not do well in school (Jensen, 2009). Statistics indicate that they are far more

> likely to fall behind their classmates in school, to be assigned to lower tracks in education, to be retained in grade, to be labeled as "problem" students, to be absent, truant, and to drop out of school altogether, and – over time – to earn lower scores in standardized tests of knowledge and achievement. (Biddle, 2001, p. 6)

Morgan, Farkas, Hillemeier, and Maczuga (2009) indicate that children from higher SES groups develop academic skills faster than do children from lower SES groups. They go on to point out that low SES in childhood is related to meager cognitive development, reduced language ability,

less memory skills, a smaller degree of social processing, and poorer health than their higher SES counterparts.

Research shows that teachers generally have lower expectations for children of poverty academically, socially, and emotionally (Biddle, 2001; Jensen, 2009). Biddle (2001) indicates that teachers assume students of poverty are unwilling to do their work and do not want to learn in general. He also indicates that teachers believe if they push these students, then they will resist or drop out of school. Teachers who have this philosophy tend to use instructional practices that focus on lecture while students are passive. Homework is done in class. In these classrooms, students are not engaged, not challenged, and are exposed to less. Students also seem to have the opinion that no one cares (Biddle, 2001).

Nationally, the medium income in the United States was $56,516. The poverty rate in the United States has increased a full percentage point since 2007 (Proctor et al., 2016). According to the Federal Poverty Guidelines (2015),

> The Federal Poverty Line (FPL) is the set minimum amount of gross income that a family needs for food, clothing, transportation, shelter and other necessities. In the United States, this level is determined by the Department of Health and Human Services (HHS). The Federal Poverty Line varies according to household size, and the number is adjusted for inflation and reported annually in the form of poverty level guidelines. (p. 1)

Poverty Data (n.d.) ranked Tennessee as the 41st poorest state in the nation with 16.7% of the population falling below the poverty line. In 2016, there was 16% (*n* = 1,077,900) of the population in Tennessee living in poverty; 23.8% of those were children. Of those living in poverty in Tennessee in 2016, 31% (*n* = 334,149) were Latino, which was the largest category of

poverty. African Americans in Tennessee had the second largest percentage living in poverty, 25% (*n* = 269,475). Nineteen percent (*n* = 204,801) of those in poverty were Native Americans in Tennessee in 2016. The White population made up 15% (*n* = 161,685) of people living in poverty in Tennessee and 10% (*n* = 107,790) of those in poverty were Asian Americans (Tennessee Report, 2016).

Diemer and Blustein (2007) reported that racial, ethnic, and socioeconomic barriers hinder students' academic development. It is much harder for those from low-income families or minorities to attain careers that are more advanced. There seem to be more barriers to those career options. Likewise, Ali, McWhirter, and Chronister (2005) showed that lower SES students generally had less self-efficacy regarding careers and educational aspirations.

In 1966, the United States Department of Education studied over 4,000 schools and identified that socioeconomic status was the more powerful predictor of success for students. The report indicates that our education system penalizes low-income students based on the disparity between the two groups (Coleman, 1966). Hattie (2012), a highly regarded researcher in education, ranked 150 influences on achievement in education based on multiple research studies. His ranking of SES was at number 45 with an effect size of 0.52. This means that the effect of SES on student achievement is 0.52 standard deviations above those students not considered low SES.

Williams (2015) stated

> For students who grow up in an impoverished household, stresses and other distractions make success all the more challenging. Transience, lack of resources at home, lack of parental engagement – all diminish a student's chances for success, and in many cases are a direct impact of poverty on a household. (para. 3)

Hiatt (2012) mentioned in her research, "Students of schools with greater free and reduced lunch rates do not score as well on ACT composite tests and tend to have higher dropout rates" (p. 8).

Jensen (2009) studied brain research extensively and suggests that the acute stress resulting from living in poverty actually affects the brain and learning. It affects performance on standardized tests such as the ACT. Although some stress is healthy, chronic stress, also known as distress, is toxic. Low socioeconomic status (SES) students, in general, are not only exposed to more stress, but the intensity and duration of this stress is higher than for their middle class counterparts. They also have fewer coping skills. This prolonged exposure to stress impairs cognition, memory, and creativity. Payne (2013), an educator who has done extensive research on poverty, indicates that students living in poverty come to school with less background knowledge and less family support, which present challenges to students. Those students are so concerned with survival and just making it through the day that they cannot concentrate and put forth their energy on something that is so far removed from them such as the ACT test (Payne, 2013).

Orlich and Gifford (n.d.) found an extremely high correlation between incomes of parents and college entrance exams. He compared scores of students in Washington State who were on free or reduced lunch to the scores of students in a more affluent area. The students from more affluent parents outscored the students on free or reduced by as much as 60 percent. Orlich also stated in his report:

> Given the widespread use of tests to sort and/or classify students, the socioeconomic, social class and ethnicity status of students needs to be analyzed for apparent test bias by the educational community, policy-makers and those who work in the social justice arena. (p. 14)

Rampell (2009) shows that as family income increases, there is a corresponding increase of SAT scores in each of the following areas: critical reading, math, and writing. There is a positive correlation between family income and SAT scores. For each $20,000 increase in family income, there is a significant increase in SAT scores in each of the three areas. There is a very strong positive correlation between these SAT test scores and family income. The R^2 is 0.95, showing a significant difference. The table displayed in Appendix F also shows an approximately 12-point jump or more for every income category increase. Generally, students do better on standardized tests when they have more economic resources. Those students tend to have better teachers, more access to tutoring, more educated parents that can assist them, and more opportunity for life experiences (Rampell, 2009). Reardon (2016) states, "socioeconomic context is a powerful force shaping educational opportunities and success" (p. 13). He goes on to say that "poverty is not destiny; inequality is not inevitable" (p. 13).

Chapter Summary

Standardized tests and college admittance tests have been part of American education for years. They were introduced into education because of inadequacies in our education system linked to teacher quality, poverty levels, and grading differences. With most colleges and universities in the United States requiring students to take either the ACT or the SAT before entering college, ACT scores have become increasingly important to high school students and their parents. Students are often selected or denied college admittance based on ACT scores, and scholarship money is frequently tied to college admission test scores. The ACT is designed to be an indicator of high school achievement and a predictor of success in freshman level college

courses. The ACT College Readiness Benchmarks are the minimum scores required for students to have a high probability of success in their college freshman year courses.

The ACT is broken into four main parts: English, mathematics, reading, and science. There is also an optional writing component to the test. There are 215 questions on the ACT test with an allotment of 2 hours and 55 minutes to take the four parts of the test. The state of Tennessee requires all juniors to take the ACT test and has a state goal score of 21 by the year 2020.

Many factors play a role in ACT scores such as socioeconomic status, gender, race, high school GPA, and courses taken in high school. Each of these affect ACT scores at some level. Findings reported by ACT (2014) indicated that high school grade point average; courses taken in high school and high school attendance were all strongly associated with higher ACT scores. Increasing the average ACT composite score tends to have more to do with high school coursework than with test preparation activities.

CHAPTER 3

RESEARCH METHODOLOGY

African-American folklorist and novelist Zora Neale Hurston (2010) stated, "Research is formalized curiosity. It is poking and prying with a purpose" (p. 174). Her statement, in effect, defines quantitative research as a method to gather data in numerical form that can be ranked, categorized, or measured to find solutions to problems. Quantitative research is conclusive in its purpose. It tries to quantify a problem and come to a solution. The results, however, are extendable to larger populations. The purpose of the study was to determine if students who take the ACT test, complete a precalculus course, and take the ACT test again score significantly higher after completing precalculus. The researcher wishes to ascertain whether precalculus is conducive to students scoring higher on the ACT. This quantitative study investigates whether there is a significant difference in ACT math subtest scores and ACT composite scores before and after students have taken and completed precalculus. The researcher sought to understand if completing precalculus made a significant difference in student ACT scores. To determine the difference, the researcher gathered data from five high schools to compare ACT scores based on precalculus completion.

Students are told by the ACT Company that pre-calculus is not tested on the ACT (ACT, 2014) and that all questions are derived from Algebra I, Geometry, and Algebra II. The goal of this research is to discover whether precalculus has a significant difference on ACT composite scores and ACT mathematics subtest scores. The researcher is also interested in discovering if gender, socio-economic status, and race make a significant difference in ACT composite and mathematics subtest scores.

Creswell (2002) has given a concise definition of quantitative research as a type of research that explains an anomaly by collecting numerical data that are analyzed using statistics. The role of this researcher is to collect the ACT scores that have already been achieved by students at five high schools. The researcher will collect, analyze, and then report findings.

Research Questions

Research questions should "explain specifically what your study will attempt to learn or understand" (Maxwell, 2005, p. 67). The research questions related to the researcher's goals explored the effect of taking precalculus on ACT scores while also exploring possible connections of gender, socio-economic status, and race. The following research questions were specifically addressed:

1. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus?

   H_o1: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus.
2. Is there a significant difference in ACT mathematics subtest scores taken before precalculus and ACT mathematics subtest scores taken after precalculus?

   H_o2: There is not a significant difference in ACT mathematics subtest scores taken before precalculus and ACT mathematics subtest scores taken after precalculus.
3. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for males?

   H_o3: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for males.

4. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for females?

   H_o4: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for females.

5. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students receiving free or reduced lunch?

   H_o5: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students receiving free or reduced lunch.

6. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students paying full price for lunch?

   H_o6: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students paying full price for lunch.

7. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for white students?

   H_o7: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for white students.

8. Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for non-white students?

   H_o7: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for non-white students.

Sample

There were 208 total participants in this research study. There were 105 female participants while 103 were male. Of the total participants, 68 were considered socio-economically disadvantaged as determined by the state. The families of these students receive some form of aid from the government. Of the 208 students, 201 were white, three were African-American, two were Latino, one was Asian, and one was Pacific Islander. All the students in the study were between the ages of 15 and 19. Five Tennessee public high schools were used in this study. To protect anonymity, these schools have been given pseudonyms: Campus High School, Mastery High School, Metacognition High School, Numeracy High School, and Wisdom High School.

Campus High School is a public, rural school founded in 1926 and ranked by the State of Tennessee in 2016 as a Level 5 school (TDOE, n.d.). According to the 2015 United States Census Bureau, the town where Campus High School is located has a population of 1,940 (U.S. Census Bureau, 2015). Campus is a Title I school and according to the state report card, has a total population of 584 students with 97.9 % of the population being white, 1.1% being African-American, and 0.5% being Asian. The free and/or reduced lunch was sixty-nine percent in 2016, and the composite ACT of Campus High School was 19.8, close to the state average of 19.9 (TDOE, 2017).

Mastery High School is located in a rural county and was established in the Fall of 1919. There are 575 people who live in the city that houses Mastery High School (U.S. Census Bureau, 2015), but there are 296 students at the school (TDOE, 2017). Enrollment includes students from other small communities around the area. This is a rural area with little industry and only a few businesses. The State of Tennessee Report Card shows that 42.6% of students at this school

are economically disadvantaged. White students make up 97.6% of the student population and no other populations are shown. In 2016, the average composite ACT score at Mastery High School was 17.9, or 2 points below the state average (TDOE, 2017).

Metacognition High School is located in a small town in Tennessee with a reported population of 4,661 in 2015 (U.S. Census Bureau, 2015) and has an enrollment of 828 students in the high school (TDOE, 2017). Of these students, 87.8% are white, 9.8% are Hispanic or Latino, and 1.8% is African American as reported on the Tennessee State Report Card. The report card also shows that 31.2% are considered economically disadvantaged. Due to several group homes in the area, the school has a high mobility rate. The composite average ACT at Metacognition High School is 18.8, or 1.1 points below the state average (TDOE, 2017).

Numeracy High School, established in 1909, serves the residents of a somewhat larger county in Tennessee. The population of the town where Numeracy High School is located is 4,052 (U.S. Census Bureau, 2015). The high school has 919 pupils (TDOE, 2017). Of those 919 students, 97.4% are white, and 1.3 % is African American. The report card also shows that 30.4% of students are economically disadvantaged. The composite average ACT at Numeracy High School is 19.7, or 0.2 points below the Tennessee state average (TDOE, 2017).

Wisdom High School, established in 1909, serves 1,191 students (TDOE, 2017). The population of the town in which Wisdom is located is 5,075 people (U.S. Census Bureau, 2015) and it is closer to a larger city than the four other schools used in this study. Of the 1,191 students, 94.8% are white, 3% are African American, and 1.5% is Hispanic. The state report card shows 33.4% of students are considered economically disadvantaged. The composite average ACT at Wisdom High School is 18.6 (TDOE, 2017), or 1.3 points below the state average.

Instrumentation

This research is a causal-comparative/quasi-experimental study that investigates the effects of precalculus on ACT test composite and mathematics subtest scores. Reliability is the accuracy of the instrument the researcher will be using. ACT tests and scores have been tested and evaluated many times over the years. Statistics show that ACT scores are accurate and will give a reliable measure. The median scale score for reliability according to ACT (2014) is 0.91. The concern of this study is the area of validity. Among conditions affecting the score someone receives on the ACT are health, temperature of the room, hunger, sleep, life experiences, and ACT preparation classes. Validity is the extent to which the instrument measures what it is supposed to measure. "Key Facts on Validity" states, "ACT takes pride in our reputation for the validity of the tests we produce" (Validity, 2014, p. 2). This same article states "ACT adheres to professionally established guidelines to ensure that the ACT assessments meet the standards for construct-related, criterion-related, and content-related evidence – so that users can trust the results" (Validity, 2014, p.2). To ensure validity, this researcher conducted numerous tests and measures. The data was ratio data. Independent *t*-tests were conducted on the data in multiple ways. The independent *t*-tests measured not only the differences in having taken precalculus and then taking the ACT again, but also it measured the differences in race, gender, and socio-economically disadvantaged status. The researcher kept a 0.05 level of significance. Data collected from the study of the five high schools could be generalized to and representative of other rural areas in the United States.

There is always potential for inconsistencies or errors when giving standardized tests such as the ACT. A student could take the test in one test center and make a better grade than when taking the test in a different test center. The testing proctors follow the same script and the

testing scenarios should be quite similar. However, there may be different scores. This could come from many different areas such as testing distractions or health of the test taker.

The Web Center for Social Research Methods defines *reliability* as the repeatability of measures, having to do with the quality of measurement. (Web Center for Social Research Methods, n.d.). "Reliability coefficients estimate the consistency of test scores" (ACT, 2014, p. 51). The median scale score reliability and average standard error of measurement (SEM) for the 2011 – 2012 test administrations for the composite test are 0.96 median scale score reliability and 0.93 for the average standard error of measurement. Each subtest is also broken down. On the English subtest, the median scale score reliability is 0.92 and the SEM is 1.66. On the mathematics subtest, the median scale score reliability is 0.88 and the SEM is 1.95. On the reading subtest, the median scale score reliability is 0.91 and the SEM is 1.43 and on the science subtest, the median scale score reliability is 0.83 and the SEM is 1.95 (ACT, 2014).

Data Collection

The researcher must anticipate any ethical issues that may arise during the research process and prepare for those issues accordingly (Creswell, 2009). In addition, ethics should be considered for both the data collection process and procedures while equally ensuring ethical practices in the writing and reporting phases of the research (Creswell, 2012). Each one of the five directors of schools gave consent to the access of the data. There are no interviews or recordings with this project. The researcher gathered data from students' permanent records with no identification marks that could identify the students. The researcher also attended the Collaborative Institutional Training Initiative (CITI) training and completed the Institutional Review Board (IRB) process.

The researcher contacted the directors of schools for five Tennessee high schools. The researcher collected ACT scores of students who had taken the ACT, completed precalculus, and then retook the ACT. If a student took the ACT more than once before completing precalculus, the most recent ACT score was recorded. If a student took the ACT more than once after precalculus, the test score immediately following the precalculus class was used. The scores gathered were from the school years 2014-2015 through 2016-2017, covering a three-year span. This pre-existing data, recorded on each student's permanent record, was obtained from the records department or guidance offices at each high school. Principals and guidance counselors pulled student records based on precalculus rosters to indicate students that met the criteria for the study. The principals and guidance counselors provided the data associated with the qualifying students. That data contained ACT scores, ACT mathematics subtest scores, SES information, race, and gender. The researcher obtained this data encompassing three years' worth of scores. The statistics used were already on permanent records and included class schedules showing which students had taken pre-calculus and when the class was taken. This data was supplied to the researcher by the principals and guidance counselors of each of the schools.

Data Analysis

The ACT scores were put into Excel files and then imported into the Statistical Package for the Social Sciences (SPSS). The researcher used a paired samples *t*-test to analyze the data and determine whether there was a significant difference between the means of a group taking the ACT before completing precalculus and after completing precalculus. The researcher further

compared the combined test data. This data was unseparated by schools, to determine if there was a significant difference in ACT scores after completing a precalculus class.

The variables in this study investigated associations with ACT composite scores over a period of three years. The general population was also compared to the subgroups by race, gender, and socio-economic status for ACT composite scores. Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making (Creswell, 2012). The researcher also analyzed the variables of gender, socio-economic status, and race against the general population of each school as well as the combined population of five schools. The data was thoroughly crosschecked by an outside party to prevent errors in the data. All data were analyzed at the .05 level of significance.

Chapter Summary

There were seven research questions involved in the study. The researcher explored whether or not completing a precalculus course significantly improved ACT composite and mathematics subtest scores. The researcher also compared the variables of gender, race, and SES status of participants. There were 208 participants from five high schools in five different Tennessee school districts. Paired-samples t tests were conducted on the data with a 0.05 level of significance using the Statistical Package for the Social Sciences (SPSS). The variables in the study investigated associations with ACT composite and mathematics subtest scores over a period of three years.

CHAPTER 4

FINDINGS

The purpose of this study was to determine if there was a significant difference in the mean ACT scores of students taking the ACT, completing precalculus, and then taking the ACT again. ACT composite scores were analyzed as well as ACT mathematics subtest scores to investigate significant differences in the means of those having completed precalculus. In addition, the study analyzed correlations among gender, race, and those receiving free and reduced lunch (those participants eligible for and participating in the National Free or Reduced Price School Lunch Program).

There were 208 student participants from five high schools. These participants were enrolled in four counties in five different districts. The study spanned school years 2014-2015 through 2016-2017, thus giving a span of three years of data. Of the 208 student records analyzed, 68 participated in the free or reduced lunch program; 103 were male while 105 were female; and 201 were white, three were African American, two Hispanic, one Asian, and one Pacific Islander. Table 1 shows the gender, race, school year from which data were collected, and free or reduced distinctions taken by school in percentages and number of participants. The table in Appendix G shows the race, gender, year from which the data were collected, and the free or reduced distinctions of the five participating high schools of this study.

Five schools participated in the study, with the number of participants from each school ranging from 15 to 62, and each school used either a traditional or an integrated math approach. The traditional path utilizes the Algebra I, Geometry, and Algebra II courses and the integrated math path incorporates Integrated I, Integrated II, and Integrated III. The standards for both paths are similar in nature; however, they are taught in different ways and at different times. The

schools in the study are split in the approach they used in their mathematics programs, three using traditional mathematics pathways and two schools using integrated mathematics. The individual students' scores were used to produce a mean and *t* value for their first ACT scores and then their second ACT scores after taking precalculus.

Research Question 1

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus?

H_o1: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus.

A paired-samples *t* test was conducted to determine whether there was a significant difference between ACT composite scores prior to taking precalculus and ACT composite scores after taking precalculus. There was a significant difference in the ACT composite scores before and after completing precalculus when comparing the participants of all five high schools, $t(207) = -7.426$, $p = .001$. Therefore, Null Hypothesis 1 was rejected. The ACT composite - prior to taking precalculus - ($M = 22.81$, $SD = 3.52$) was significantly lower than the ACT composite score after completing precalculus ($M = 23.75$, $SD = 3.79$). The 95% confidence interval for the difference in means was -1.19 to -.69. The η^2 index was .12, which indicated a medium to large effect size. Students who had taken precalculus scored significantly higher on the ACT composite test than those students who had not taken precalculus. Figure 1 depicts the combined ACT composite scores of the participants at the five schools in the study.

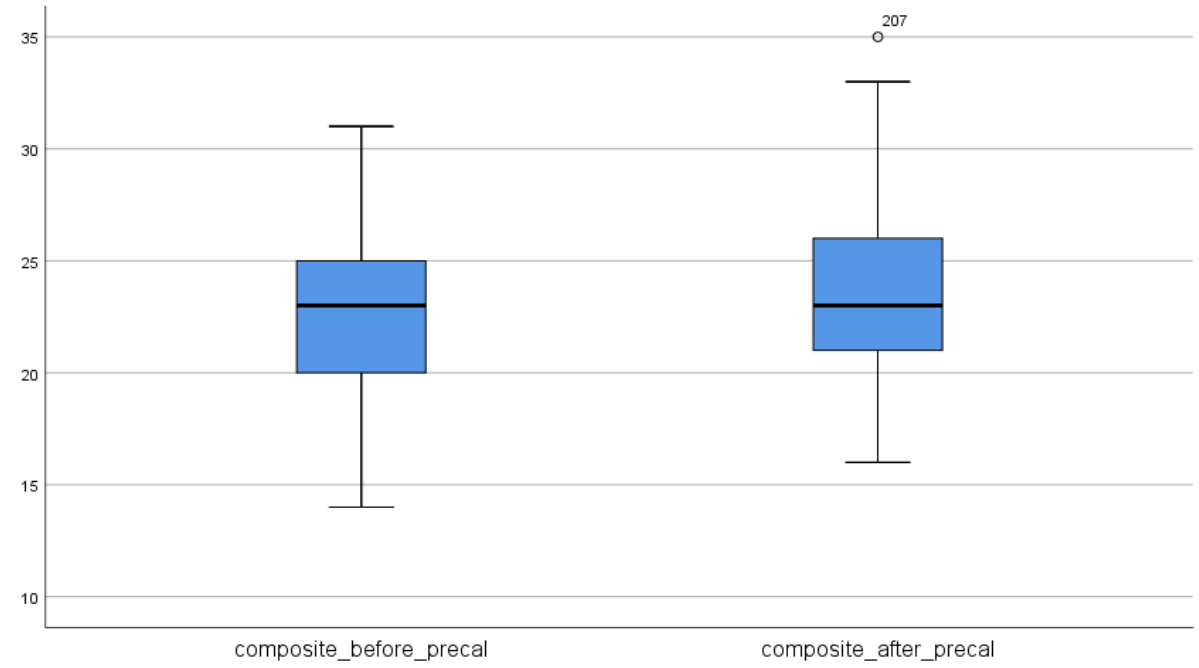

Figure 1. ACT composite scores of all participants in the study

Research Question 2

Is there a significant difference in ACT mathematics subtest scores taken before precalculus and ACT mathematics subtest scores taken after precalculus?

H_o2: There is not a significant difference in ACT mathematics subtest scores taken before precalculus and ACT mathematics subtest scores taken after precalculus.

A paired-samples *t* test was conducted to determine whether there was a significant difference between ACT mathematics subtest scores prior to taking precalculus and ACT mathematics subtest scores after completing precalculus. There was a significant difference in ACT mathematics subtest scores before and after taking precalculus when comparing the participants of all five high schools, $t(207) = -5.344$, $p = .001$. Therefore, Null Hypothesis 2 was rejected. The ACT mathematics subtest mean score - prior to taking precalculus - ($M = 22.15$,

SD = 3.52) was significantly lower than the ACT mathematics subtest mean score after completing precalculus (*M* = 23.04, *SD* = 3.58). The 95% confidence interval for the difference in means was -1.22 to -.56. The η^2 index was .06, which indicated a medium effect size. The mean of students' ACT mathematics subtest scores was significantly higher after taking precalculus. Figure 2 depicts the combined ACT mathematics subtest scores of the participants of the five schools in the study.

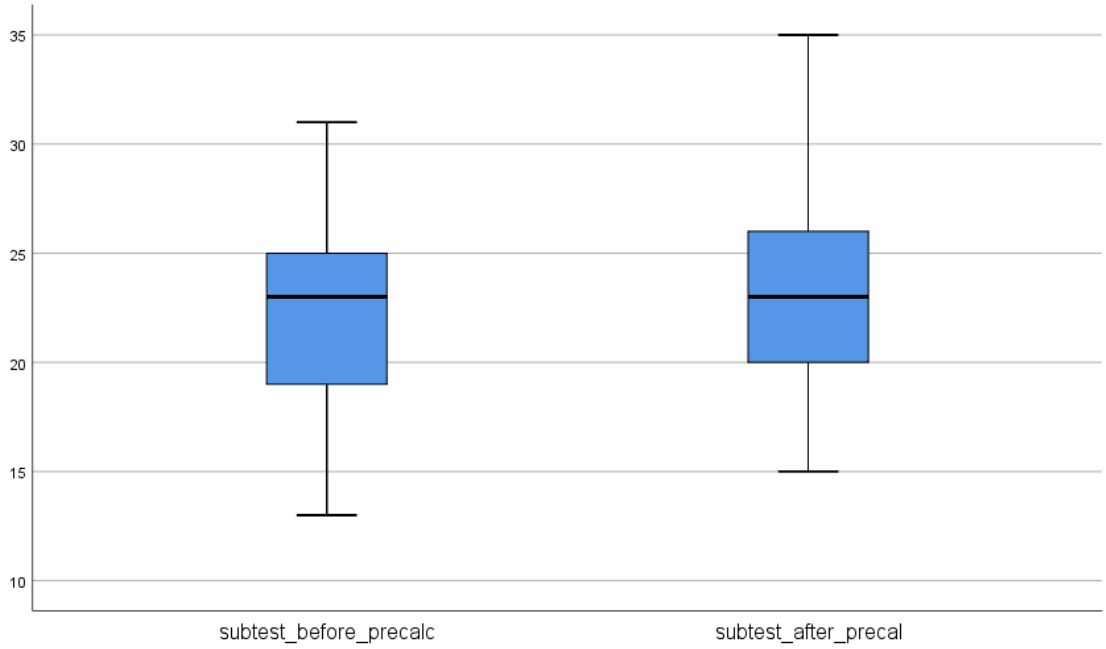

Figure 2. ACT mathematics subtest scores of participants in the study

Research Question 3

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for males?

H_o3: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for males.

A paired-samples *t* test was conducted to determine whether there was a significant difference between ACT composite scores prior to taking precalculus and ACT composite scores after taking precalculus for all the participants involved in the study who were male. When comparing males, the test was significant, $t(102) = -4.502$, $p = .001$. Therefore, Null Hypothesis 3was rejected when comparing males. The ACT composite score - prior to taking precalculus for males - ($M = 23.30$, $SD = 3.83$) was significantly lower than the ACT composite score after completing precalculus ($M = 24.18$, $SD = 4.04$). The 95% confidence interval for the difference in means was -1.27 to -.49. The η^2 index was .09, which indicated a medium to large effect size. For male students in the sample, there was a significant difference in the mean ACT composite scores after taking precalculus. Figure 3 depicts the combined ACT composite scores of the male participants from the five schools in the study.

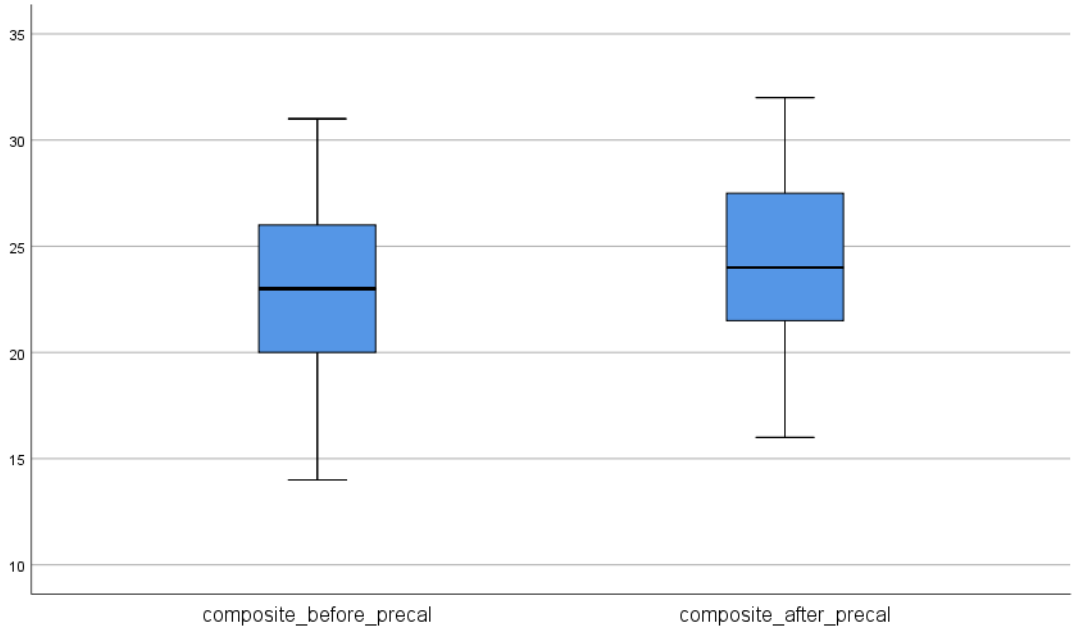

Figure 3. ACT Composite scores of male participants in the study

Research Question 4

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for females?

H_o4: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for females.

A paired-samples *t* test was conducted to determine whether there was a significant difference between ACT composite scores prior to taking precalculus and ACT composite scores after taking precalculus for all the participants involved in the study who were female. When comparing females, the test was significant, $t(104) = -6.158$, $p = .001$. Therefore, Null Hypothesis 4 was rejected when comparing females. The ACT composite score - prior to taking precalculus for females - ($M = 22.33$, $SD = 3.13$) was significantly lower than the ACT composite score after completing precalculus ($M = 23.33$, $SD = 3.50$). The 95% confidence interval for the difference in means was -1.32 to -.68. The η^2 index was .15, which indicated a large effect size. For female students in the sample, there was a significant difference in the mean ACT composite scores after taking precalculus. Figure 4 depicts the combined ACT composite scores of the female participants from the five schools in the study.

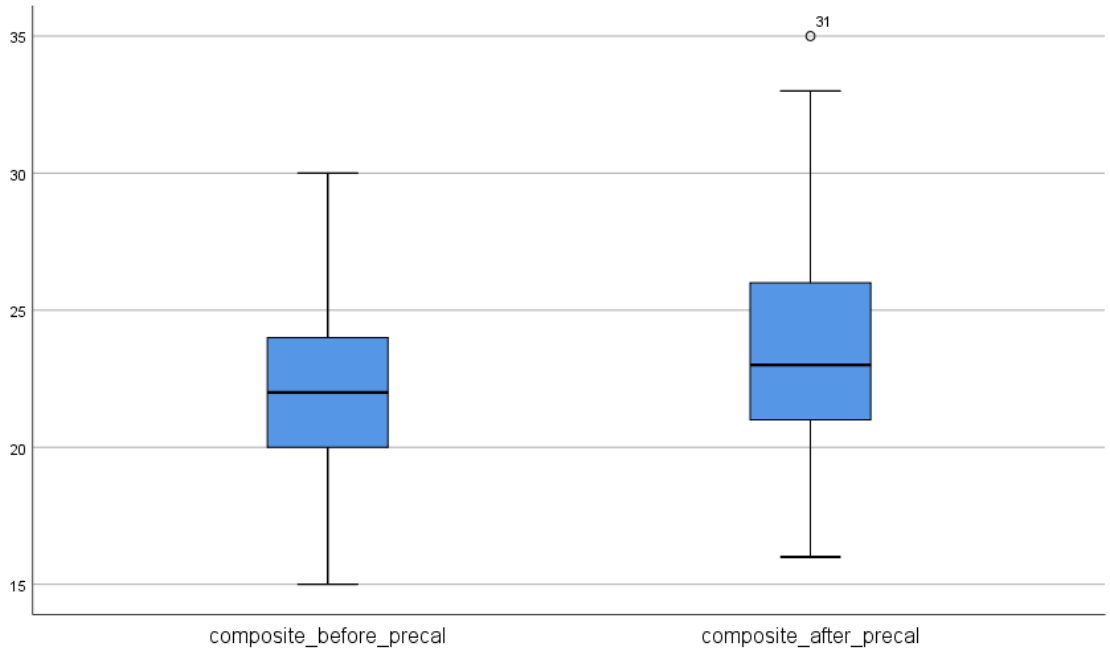

Figure 4. ACT composite scores of female participants in the study

Research Question 5

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students receiving free or reduced lunch?

H_o5: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students receiving free or reduced lunch.

For the purposes of this study, there were two groups of participants: those eating regular priced lunch and those utilizing the free or reduced lunch program through the United States government's National School Lunch Program.

When comparing participants utilizing free and reduced lunch, the test was significant, $t(62) = -3.265$, $p = .002$. Therefore, Null Hypothesis 5 was rejected. The ACT composite score - prior to taking precalculus for free or reduced lunch - ($M = 22.33$, $SD = 3.13$) was significantly lower than the ACT composite score after completing precalculus ($M = 23.25$, $SD = 3.70$). The

95% confidence interval for the difference in means was -1.20 to -.29. The η^2 index was .15, which indicated a large effect size. For students receiving free or reduced lunch, ACT composite scores were significantly higher after taking precalculus. Figure 5 depicts the combined ACT composite scores of participants receiving free or reduced lunch at the five schools in the study.

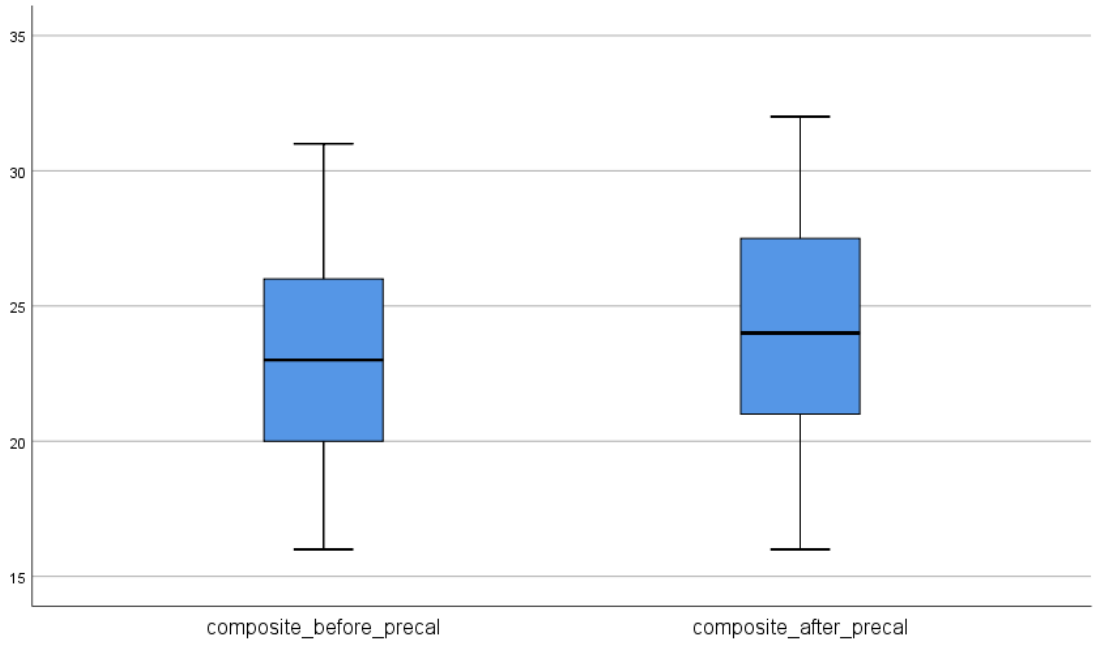

Figure 5. ACT composite scores of participants in the study receiving free or reduced lunch

Research Question 6

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students paying full price for lunch?

H_o6: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for students paying full price for lunch.

A paired-samples *t* test was conducted to determine whether there was a significant difference between ACT composite scores prior to taking precalculus and ACT composite scores after completing precalculus based on socioeconomic status. When comparing participants

paying regular price for lunch, the test was significant, $t(144) = -6.736$, $p = .001$. Therefore, Null Hypothesis 6 was rejected. The ACT composite score - prior to taking precalculus for participants paying regular lunch prices - ($M = 22.62$, $SD = 3.43$) was significantly lower than the ACT composite score after completing precalculus ($M = 23.65$, $SD = 3.73$). The 95% confidence interval for the difference in means was -1.33 to -.73. The η^2 index was .46, which indicated a large effect size. For students paying regular price for lunch, ACT composite scores were significantly higher after taking precalculus. Figure 6 depicts the combined ACT composite scores of participants paying regular price for lunch from the five schools in the study.

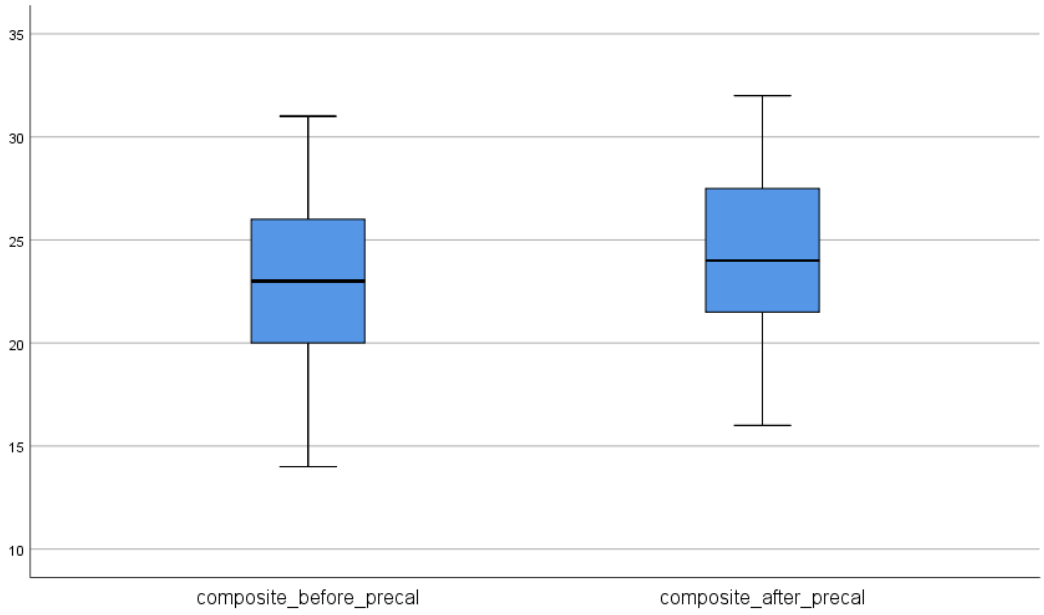

Figure 6. ACT composite scores of participants paying regular price for lunch in the study

Research Question 7

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for white students?

H_o7: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for white students.

Participants of this study were categorized by five distinct categories for race: White/Caucasian, African American, Hispanic/Latino, Asian, and Pacific Islander. Out of the total 208 participants in the study, 201 were White/Caucasian; three were African American; two were Hispanic/Latino; one was Asian; and one was Pacific Islander. There was not enough nonwhite participants to compare ACT scores. The White population of this study was 97% while the African American population represented 1.4%, the Hispanic/Latino population represented 1%, the Asian and Island Pacific population represented 0.4% each. Therefore, it is impossible to investigate if there was a significant difference in the composite ACT scores of students who have taken precalculus based on race.

Research Question 8

Is there a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for non-white students?

H_o8: There is not a significant difference in composite ACT scores taken before precalculus and composite ACT scores taken after precalculus for non-white students.

There was not enough nonwhite participants to compare the data. The White population of this study was 97% while the African American population represented 1.4%, the Hispanic/Latino population represented 1%, the Asian and Island Pacific population represented 0.4% each. Therefore, it is impossible to investigate if there was a significant difference in the composite ACT scores of students who have taken precalculus based on race.

Chapter Summary

The purpose of this study was to determine if there was a significant difference in the mean ACT scores of students taking the ACT test, completing precalculus, and then taking the ACT test again. ACT composite scores and ACT mathematics subtest scores were analyzed to investigate significant differences in the means of those having completed precalculus. The findings indicated that there was a significant difference in students' mean ACT composite and mathematics subtest scores after completing precalculus. The findings further indicated that males, females, students who paid regular price for lunch, and students receiving free or reduced lunch all increased ACT scores after completing a precalculus course. There was not enough data to explore significant differences based on race.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains a summary of the findings, conclusions, applications for practice, and recommendations for future research. The purpose of the study was to determine if students who take the ACT test, complete a precalculus course, and take the ACT test again score significantly higher after completing precalculus. Factors of race, gender, and socioeconomic status in regards to ACT scores of students completing precalculus were included in this study. It is hoped that results of this study could be helpful to educators who are trying to guide students towards the best path for attaining higher ACT scores. The study was conducted using ACT scores from five rural Tennessee high schools in five different districts and based on three years of data.

Summary of Findings

The statistical analysis reported in this study was based on seven research questions and seven null hypotheses presented in Chapters 1 and 3. The first six research questions were analyzed using paired-samples *t* tests, while the remaining research question could not be analyzed. The total number of participants in this study was 208 high school students from five different high schools over a three-year period. The level of significance used for the statistical tests was .05. The findings, for the entire group studied, indicated that there was a significant difference in ACT composite scores and in ACT mathematics subtest scores for students who took the ACT, completed a precalculus course, then took the ACT again.

The gender of the participants did not seem to play a role in ACT scores. The five schools in the study showed a significant difference in scores after students took precalculus. The findings indicated that it did not matter whether a participant was male or female, there was still a significant difference in ACT scores. Socioeconomic status (SES), as well as race, did not appear to play a major role in ACT score increases after a participant-completed precalculus.

Although the ACT has been important for many years, in recent years, it has become increasingly important to Tennessee students. In 2004, Tennessee began awarding lottery scholarships to students based on ACT scores. The state, by attaching money to ACT, made the test even more important for many Tennessee students. Not only students, but also schools and systems, are graded on ACT scores, further increasing the importance of the ACT to many educators and administrators.

Conclusions

The purpose of this study was to determine if there were a significant difference in composite and mathematics subtest ACT scores for those having completed precalculus. Specifically, the study was an analysis of high school students who took the ACT, then completed precalculus, and then retook the ACT. The following conclusions were made based on the findings of this study:

1. The findings indicated a significant difference in ACT composite scores of students who had taken the ACT, completed a precalculus course, and then taken the ACT again. The participants' overall scores significantly increased after the precalculus course was taken.

2. The findings indicated a significant difference in ACT mathematics subtest scores of students who had taken the ACT, completed a precalculus course, and then taken the ACT again. Overall, the participants' mathematics subtest scores significantly increased after the course was taken.
3. There was a significant relationship between ACT composite scores of students who had taken precalculus based on gender. This finding indicated that regardless of gender, there should be a significant increase in ACT composite scores after taking precalculus. There was a significant difference in ACT composite scores for the entire group of participants, both male and female, after completing a precalculus course.
4. The findings indicated a significant difference in the means of ACT composite scores of participants who had taken the ACT, completed a precalculus course, and then taken the ACT again based on socioeconomic status. SES was divided into two groups: those paying full price for lunch and those participants who received free or reduced lunch through the government lunch program. ACT composite scores for the total 208 participants significantly increased after the precalculus course was taken regardless of SES.
5. The study simply did not have large enough numbers of diverse races to perform analysis of the data. When considering the entire population of the study, there were only seven students of the 208 who were considered a race other than White/Caucasian. Specifically, three were African Americans, two Hispanic/Latinos, one Asian, and one Pacific Islander. The numbers for the races other than

White/Caucasian were simply too small to be statistically significant. This is true for the participants analyzed as a whole as well as the schools analyzed individually.

The results obtained in this study are consistent with the findings of ACT. The research published by ACT indicates a significant difference between ACT composite scores for students completing precalculus and an even higher difference between those completing a calculus course. The ACT Technical Manual states "ACT research has shown that taking rigorous, college-preparatory mathematics courses is associated with higher ACT Mathematics and Composite scores" (ACT, 2014, p. 70). The ACT Technical Manual further indicates that typical high school students taking upper level mathematics courses such as trigonometry and calculus, can expect to make a "meaningfully higher" ACT score (ACT, 2014, p.45).

Recommendations for Practice

With the understanding that there is a significant difference in ACT composite and mathematics subtest scores for those students having taken and completed precalculus, educators and administrators should encourage students to take precalculus as a way to increase ACT scores. Research also suggests (ACT, 2014) that even higher-level mathematics courses make a significant difference in composite and mathematics subtest scores. As a result, administrators and educators should encourage students to not only take precalculus but also higher-level mathematics courses such as Calculus and Dual Enrollment College Algebra.

Because of the important role ACT plays in college admissions, scholarships, and Tennessee school report cards, school leaders should make good decisions for students. School administration should read and critique related research with a critical eye in order to be better informed regarding ACT test preparation and strategies.

Recommendations for Further Research

The results of this study have raised more questions for the researcher. Although the findings of this study are supported in literature, additional questions raised should be explored with additional research.

- Investigate the difference in ACT scores of students taking even higher-level mathematics courses such as calculus or dual credit college algebra.
- Investigate statistical differences in ACT composite scores between students who earn As in precalculus and students who earn Cs in precalculus.
- Examine if there is a significant difference in ACT composite scores after students take higher-level science courses.
- Conduct a larger study that considers race, gender, SES and differences in ACT composite scores in relation to higher-level courses.
- Investigate the precalculus teacher-effect on increased ACT composite scores.
- Examine student perceptions of the ACT, ACT preparation courses, higher-level courses, GPA, and the effect of reading on ACT scores.
- Examine the effect of advanced science courses on ACT science reasoning subtest scores.
- Conduct a case study of a student in a single high school using the variables of this study to explore other influences on increased ACT scores.

Summary

Since 2010, in the state of Tennessee, the ACT has become increasingly important to schools, school systems, and communities. The Tennessee State Department of Education has tied ACT results to school and district accountability. At the same time, lottery scholarships

based on ACT scores have become more financially important to students. These two variables have led to the importance of increased test scores. The results of this study indicate a significant increase in both ACT composite and ACT mathematics subtest scores for students who complete a course in precaluclus.

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APPENDICES

Appendix A

Student Requirements for Tennessee Lottery Scholarships

Scholarship	Requirements	Amount
HOPE	21 on ACT or 3.0 GPA	$1,500 for 2-year college $3,000 for 4-year college
Merit	29 on ACT or 3.75 GPA	$1,000 added to HOPE
Need-Based	Meet HOPE requirement and Income less than $36,000	$1,000 added to HOPE
Wilder-Naifeh Technical Skills	Enrolled at TN Technology Center – have not received HOPE	$1,250
HOPE Access Grant	18 on ACT and 2.75 GPA Income less than $36,000	$1,250 for 2 year college $2,000 for 4 year college

(Tennessee Student Assistance, n.d.)

Appendix B

Percent and Average Composite Score by Race/ Ethnicity for Year 2014 - 2016

	2014			2015			2016		
	N	%	*M*	*N*	%	*M*	*N*	%	*M*
All Students	1,845,787	100	21.0	1,924,436	100	21.0	2,090,342	100	20.8
Black/African American	241,678	13	17.0	252,566	13	17.1	272,363	13	17.0
American Indian/Alaska Native	14,263	1	18.0	14,711	1	17.9	16,183	1	17.7
White	1,038,435	56	22.3	1,057,803	55	22.4	1,119,398	54	22.2
Hispanic/Latino	281,216	15	18.8	299,920	16	18.9	337,280	16	18.7
Asian	80,370	4	23.5	87,499	5	23.9	93,493	4	24.0
Native Hawaiian/Pacific Islander	5,676	0	18.6	6,090	0	18.8	6,797	0	18.6
Two or More Races	70,013	4	21.2	76,066	4	21.2	85,494	4	21.0
Prefer not to respond/No response	114,136	6	20.7	129,781	7	20.6	159,334	8	20.1

(ACT, 2017a)

Appendix C

Average ACT Scores by Academic Preparation, 2009 - 2013

Academic Preparation			**ACT Score**				
	Year	***N***	**English**	**Math**	**Reading**	**Science**	**Composite**
Core Curriculum* or More Completed	2008-09	1,039,502	21.7	21.9	22.3	21.7	22.0
	2009-10	1,118,639	21.6	21.9	22.2	21.7	22.0
	2010-11	1,202,164	21.5	21.8	22.0	21.6	21.9
	2011-12	1,259,744	21.3	21.8	22.0	21.6	21.8
	2012-13	1,322,739	21.2	21.7	22.0	21.5	21.7
Core Curriculum* NOT completed	2008-09	391,458	18.3	18.9	19.4	19.2	19.1
	2009-10	397,685	18.1	18.9	19.2	19.0	18.9
	2010-11	366,518	18.3	19.0	19.3	19.0	19.0
	2011-12	355,849	18.3	19.1	19.4	19.1	19.1
	2012-13	396,592	17.8	18.9	19.0	18.8	18.7

* Core curriculum is defined here as four or more years of high school English, and three or more years each of high school mathematics, social studies, and natural sciences (ACT, 2014, p. 69).

Appendix D

Average ACT Scores by High School GPA Ranges, 2012 - 2013

Group	*N*	ACT Score									
		English		**Math**		**Reading**		**Science**		**Composite**	
		M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
All Students	1,799,243	20.2	6.5	20.9	5.3	21.1	6.3	20.7	5.3	20.9	5.4
HS GPA:											
3.50-4.00	626,008	24.4	5.8	24.4	5.0	24.8	5.8	23.9	4.8	24.5	4.8
3.00-3.49	433,214	19.6	5.4	20.2	4.3	20.6	5.4	20.3	4.5	20.3	4.3
2.50-2.99	257,138	17.0	5.0	18.1	3.6	18.3	5.0	18.3	4.3	18.1	3.8
2.00-2.49	146,003	15.2	4.7	16.8	3.0	16.6	4.7	16.9	4.2	16.5	3.5
1.99-below	65,943	13.7	4.4	16.0	2.5	15.3	4.4	15.7	3.9	15.3	3.2

(Technical Manual, 2014, p. 69).

Appendix E

County Demographics

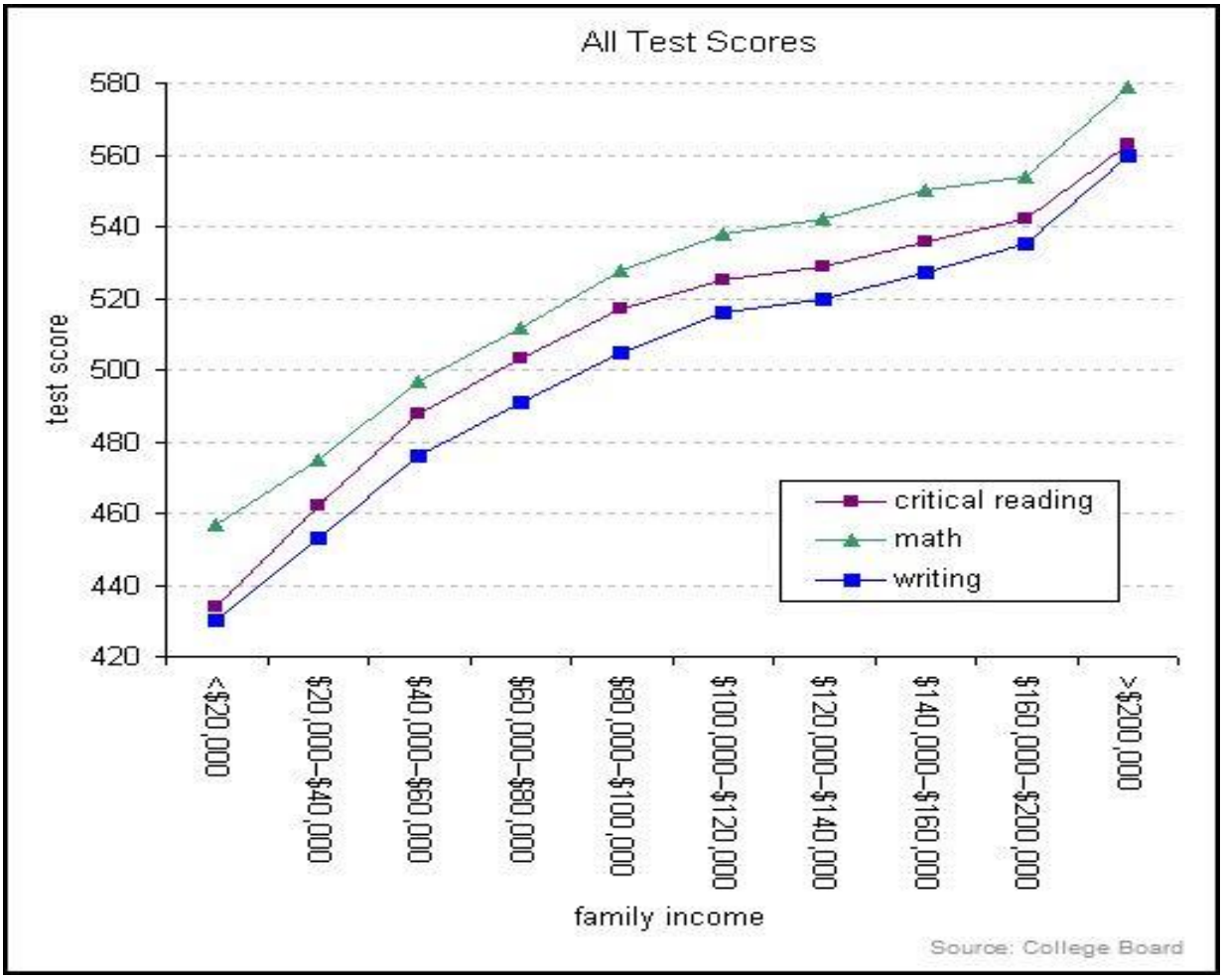
Counties	Metacognition	Campus & Mastery*	Numeracy	Wisdom
% of population < 18 years old	22%	21.6%	22.1%	22.1%
Graduation Rate %	98%	83%	91%	94%
% of Children in Poverty	31%	36%	26%	28%
% of Unemployment	7%	7.4%	7.3%	6.2%
% Rural	78.4%	100%	84.2%	78.2%
Children Eligible for free or reduced lunch	61%	67%	62%	65%
% Adults with some College	38%	34%	41%	47%
Median Household Income	$43,800	$31,800	$36,300	$38,600

(County Health Rankings, 2017)

*Both Campus High School and Mastery High School are in the same county.

Appendix F

Overall SAT Scores in Critical Reading, Math, and Writing as Compared to Family Income



Source: (Rampell, 2009)

Appendix G

Gender, Race, Year from which Data was Collected, and Free/Reduced Distinctions of Participating High Schools

	Campus		Mastery		Metacognition		Numeracy		Wisdom	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Gender										
Male	9	60	12	38	21	55	20	32	41	67
Female	6	40	20	62	17	45	42	68	20	33
Race										
White	15	100	32	100	35	92	62	100	57	93
Black	0	0	0	0	0	0	0	0	3	5
Hispanic	0	0	0	0	2	5	0	0	0	0
Asian	0	0	0	0	1	3	0	0	0	0
Is. Pacific	0	0	0	0	0	0	0	0	1	2
Year										
2014-2015	0	0	9	28	10	26	31	50	8	13
2015-2016	1	7	15	47	19	50	1	2	21	35
2016-2017	14	93	8	25	9	24	30	48	32	52
Lunch										
Free/Reduced	15	100	10	31	12	32	10	16	16	26
Regular Price	0	0	22	69	26	68	52	84	45	74

VITA

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	Place of Birth: Pontiac, Michigan
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Education:	Public Schools, Fentress County, Tennessee
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	M.S. Curriculum and Instruction, Tennessee Technological University, Cookeville, Tennessee, 1995
	Ed.S. Administration and Supervision, Tennessee Technological University, Cookeville, Tennessee, 1998
	Ed.D. Educational Leadership, East Tennessee State University, Johnson City, Tennessee, 2018
Professional Experience:	Teacher, Alvin C. York Institute: Jamestown, Tennessee 1992-Present
	Administrator, Alvin C. York Institute: Jamestown, Tennessee 2007-Present
	Master Teacher Pimser Partnership, University of Kentucky, Lexington, Kentucky, 2008-2013
	Reward Schools Ambassador, State Department of Education, Nashville, Tennessee, 2012 – 2014
Presentations:	Bradley, C., Cady, J., & Phipps, M. (December 2014). *Teaching students living in poverty*. Educator workshop presented at Title 1 Regional Conference, Gatlinburg, TN.
	Phipps, M., & England, T. (August 2015). *Standards based grading.* Invited talk presented to administration of Morgan County School System, Wartburg, TN.