

THE RELATIONSHIP BETWEEN MIDDLE GRADES COGNITIVE ABILITIES TEST AND
HIGH SCHOOL ADVANCED PLACEMENT EXAM SCORES

by

Kathy Marie Daniel

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Advanced Placement (AP) is a College Board program that offers a college-level curriculum to high school students. AP has expanded dramatically in recent years, and with noted program benefits accruing to successful participants, the issue of equity has become a concern. When identified early, students who have potential to be successful in AP courses could obtain the preparation necessary to excel academically in courses that have an impact on college admissions and outcomes. The purpose of this correlational study was to determine if a relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores. The setting for the study was a rural northeast Georgia school district. Utilizing archived data, a special kind of Pearson correlation, a point biserial correlation, and a logistics regression analysis were conducted. All null hypotheses were rejected indicating that a statistically significant positive relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam scores. Moreover, the relationship is a predictive one. Based on study results, more informed curriculum decisions could be made for students beginning in the middle school years. Recommendations for further study include consideration of additional variables that might influence AP exam success such as gender, socioeconomic factors, giftedness, and motivation.

Keywords: Cognitive Abilities Test, Advanced Placement Exams, gifted, college performance

Dedication

I would like to dedicate this dissertation to my parents, Lewis and Helen Daniel, who wholeheartedly believed that education is a great equalizer. As low-income textile workers, neither of whom attended college, they demonstrated an unwavering dedication as they made countless sacrifices in order to provide the funds to send both my sister and me to the University of Georgia, each of us obtaining masters degrees, without the use of financial aid.

My mother's belief in both education and a strong work ethic has influenced me throughout my 30-year career as an educator; however, more importantly, her strong belief in God's strength has influenced every aspect of my life. Whenever I face life's trials, the memory of my mother's favorite saying, "this too shall pass," gives me the determination I need to persevere.

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List of Abbreviations

Advanced Placement (AP)

American College Test (ACT)

Cognitive Abilities Test (CogAT)

Culturally, Linguistically, and Ethnically Diverse (CLED)

Educational Testing Service (ETS)

Grade Point Average (GPA)

Helping Outstanding Pupils Educationally (HOPE)

Institutional Review Board (IRB)

International Baccalaureate (IB)

National Association for College Admissions Counseling (NACAC)

National Association for Gifted Children (NAGC)

Preliminary Scholastic Aptitude Test (PSAT)

Scholastic Aptitude Test (SAT)

Socioeconomic status (SES)

CHAPTER ONE: INTRODUCTION

The Advanced Placement (AP) program is an educational alternative that offers high ability students an opportunity to earn college credit while still in high school. Since the program's inception in the 1950s, it has grown to impact millions of students each year (College Board 2011c). The growing popularity of the program has generated a call for further research regarding various issues relating to AP; these problems include topics such as student characteristics, enrollment criteria, program benefits, equity, predictors of success and other factors relating to function of AP in our educational system (Klugman, 2005; Kyburg, Hertberg-Davis, & Callahan, 2007; McBee, 2006; Peters & Mann, 2009; Yoon & Gentry, 2009). The perceived benefits of the AP program in recent years have led to a greater interest in the program from a more diverse group of students who are not necessarily gifted but who want to pursue higher education. These students are more nontraditional than those who typically are found in an advanced academic setting, based on previous AP enrollment patterns. Thus an important concern has become the continued inequity in the AP program, which has been acknowledged by the institution that administers the AP program, the College Board (College Board, 2010; Wakelyn, 2009). One barrier to entry for nontraditional students is the use of AP as a gifted program delivery model in high schools (Hertberg-Davis & Callahan, 2008; Peters & Mann, 2009). If students do not meet eligibility requirements for being gifted identified, they are often not encouraged to take AP courses which are reserved for the gifted population. Standardized achievement and intelligence tests administered in early grades often serve as the basis for gifted identification programs and thus end up being an exclusionary element for the AP program. Examining the relationship between elements of the identification process and AP exam scores is an important springboard to discovering student characteristics indicative of future academic

success in AP courses. Identifying methods to determine potentially successful AP students while they are still in middle grades could aid in better preparation for nontraditional students to meet the challenge of a more rigorous curriculum and create greater equity in the AP program. Findings of this study could serve as a foundation for qualitative research leading to the development of more appropriate identification methods to predict potential academic achievement.

Background

The importance of education has long been a tradition in our nation, beginning in the colonial period (Kennedy, Cohen, & Bailey, 2006). Over time, the importance of obtaining an education has only become more imperative, with the desire for a post secondary degree steadily increasing. The National Center for Educational Statistics noted that between 2000 and 2009 college matriculation across the nation increased by 34% from 13.2 million in 2000 to approximately 17.6 million in 2009 with a projected increase to 19.6 million by 2020 (Taliaferro & DeCuir-Gunby, 2008). Ensuring that everyone has an equal opportunity for a higher education has also become a critical issue. “Because education is perceived to be the great equalizer, the school environment must promote equity to realize equal opportunity as an outcome” (Taliaferro & DeCuir-Gunby, 2008, p. 160).

In 1900 to encourage higher education, the College Board Entrance Examination Organization was formed with the intent of simplifying the admissions process for both colleges and students (College Board, 2011d). Current emphasis on higher education is noted at the national level where governmental policies are enacted that directly impact students, teachers, and other educational stakeholders. In the 2010 Reauthorization of the Elementary and Secondary Education Act, President Obama stated, “We will set a clear goal: Every student

should graduate from high school ready for college and a career, regardless of their income, race, ethnic or language background, or disability status” (U.S. Department of Education, 2010, p. 3). In recent years, the advantages of a college education have become even more important (Danzier & Ratner, 2010). In 1973, males with a college education earned 33% more in entry level positions than those with a high school diploma or less. By 2007, the difference had risen to 79%. Similar findings were true for females as well, with a college education in 1973 yielding 52% more income and in 2007 yielding 92% more income (Danzier & Ratner, 2010). Because the education of our citizens impacts our society and economy, groups and organizations are often interested in sponsoring research concerning educational topics in the United States. The insurance company, Metropolitan Life, has sponsored educational research for 27 years in an effort to better utilize their grant funds. In the 2010 survey “Preparing Students for College and Careers,” 64% of the Fortune 1000 executives polled indicated their belief that the preparation for college and career requires the same readiness. Information from student surveys in the study indicated that the two subgroups of low-income and learning-challenged students placed the same importance on a college education but had lower aspirations and more concern about being adequately prepared for college (Metropolitan Life, 2010).

Methods of encouraging high school students to pursue higher education differ by state. In Georgia, where the current study took place, a new type of scholarship program was created in 1993. The Helping Outstanding Pupils Educationally (HOPE) scholarship was established to help students who have demonstrated academic ability to further their education by attending one of Georgia’s colleges, universities, or technical schools. The Georgia lottery funded program has awarded billions of dollars to millions of students as enrollment in Georgia colleges and universities has increased (GACollege411, 2010). Since the inception of the program in 1993,

recipient numbers have risen from 42,796 utilizing \$21.4 million in 1993 to 256,477 utilizing \$748.1 million in 2010–11 (GAcollege411, 2011).

Currently, one of the most popular opportunities for high school students to experience college-level work is offered through the AP program. Beginning in 1955, the College Board furthered its commitment to higher education by acquiring the administration of the AP program as part of its goal to expand post secondary education access to high school seniors. Created by the Fund for the Advancement of Education, the AP program's purpose was to encourage students to complete college-level work while still in high school. Harvard, Princeton, and Yale, three of the nation's most prestigious colleges, were a part of the initial study which culminated in the call for a process by which seniors could enter college with advanced standing college credit hours (College Board, 2003). As the program grew, it quickly became associated with high school students who were considered high ability or gifted as labeled by many school districts (Peters & Mann, 2009). In the 1990s, the AP program experienced a period of dramatic growth. Klopfenstein (2003) summarized the impetus for the growth as being due to increased competition in college admissions and promotion of higher education by states that have created incentive programs.

In the AP program today, students have an opportunity to earn college credit by taking a college-level course taught in their high school by teachers who must adhere to a College Board endorsed curriculum. At the end of the year, students take a standardized subject area test for which they could earn college credit, depending on their exam score and the policies of the college they will be attending (College Board, 2011b). Presently the AP program is the most popular high school delivery method for providing services for students who have been identified as gifted by school policy (Colangelo et al., 2010; Dixon, 2000; Herberg-Davis &

Callahan, 2008; Peters & Mann, 2009; Vanderbrook, 2006). Currently, numbers of minorities taking and succeeding in AP are increasing, but inequities still exist (College Board, 2010).

The growth of the AP program has stimulated both public speculation and scholarly research concerning its purported advantages for students, high schools, and universities. Public interest in the AP program's meteoric rise is presented in *The New York Times* 2009 article "The Advanced Placement Juggernaut" (Gunther, 2009). For this article, *The New York Times* contacted scholarly research authors along with a top official with the College Board for responses to questions reflecting the concerns of parents, teachers, and students about the AP program. The issues addressed in these interviews are indicative of the program's status in recent years. In the article, the question of whether the AP program is utilized to benefit schools or benefit students is raised along with an inquiry concerning the possibility of negative program consequences for encouraging more diverse students to enroll in the rigorous courses (Gunther, 2009).

One of the interviewees Philip Sadler, director of the science education department at the Harvard-Smithsonian Center of Astrophysics, was also an editor of the 2010 book *A Critical Examination of the Advanced Placement Program* combining the works of multiple authors in regard to several elements of the AP program (Sadler, 2010). Calling the AP program a "juggernaut," Sadler discusses the meteoric rise of AP and its impact (2010, p.3). The catchy reference is bolstered by data showing the growth of the AP program in recent years. Sadler explains the status of AP today by referencing changes in the program that are generating public interest, an interest that has lead some individuals to desire empirical research to support common opinion. Fifty years ago the program served mainly highly gifted students at private high schools but now has expanded to include more nontraditional students who are not

identified as gifted. He describes the use of AP for high ability students today as a way to embellish transcripts while common opinion demonstrates the belief that the less privileged students can gain more equality in the pursuit of higher education (Gunther 2009)

Kristin Klopfenstein, a researcher for the Texas Schools Project at the University of Texas and member of the Texas Christian University economics department, also served as an editor of the 2010 book *A Critical Examination of Advanced Placement* (Sadler, 2010). In her *New York Times* interview, she discusses the effect of AP on both students and schools. For schools, the AP program provides a measure for the general public to gauge the quality of the school (Gunther, 2009). Currently a formula to rank high schools uses the number of AP courses offered as a standard by which to judge the school (Morse, 2007). She notes AP courses are associated with increased rigor and thus provide more accountability for schools that seek to raise student expectations. For students, according to Klopfenstein, the AP program provides a means to demonstrate their academic ability and work ethic to prospective colleges (Gunther, 2009).

Saul Geiser, a research associate at the University of California, contributes to the article by pointing to the expansion of the AP program as a direct result of increased reliance of universities on AP classes in their admissions decisions. Geiser takes issue with the practice of awarding bonus points to a student's average in each AP course because this practice gives some students an unfair advantage. Minorities would be the ones at a disadvantage because they are underrepresented in AP programs (Gunther, 2009).

Problem Statement

Given the benefits of the AP program, it is important to ensure that all students have equal access to enrollment and equal opportunity to prepare for the challenge of a rigorous high

school curriculum that includes AP courses. A general problem in education is ensuring that all students are provided with educational opportunities that meet their needs. A more specific problem is the ability to identify students who could be successful in high school AP courses while these students are in middle school and can build the skills needed for success in a rigorous high school curriculum that includes AP courses. There is a lack of research addressing the identification of potentially successful AP students at an early point in their educational careers. As the most common service model for high ability students across the nation, the influence of AP is widespread and arbitrarily excluding students would be detrimental to their academic development (Peters & Mann, 2009). Peters and Mann (2009) indicate that requiring high performance on standardized tests and/or other assessments to limit participation in AP courses may prevent capable students from experiencing a more advanced level of instruction from which they may benefit academically.

An important issue in the AP program is inequity due to identification methods for gifted students that end up serving as a barrier to entry for the nontraditional student. Many methods of identification for high ability or gifted students use standardized testing as a part of the process (Gallagher, 2000). Examining standardized testing in middle grades as it compares to successful AP exam scores would yield useful information for curriculum planning and registration advisement purposes. Identifying potentially successful students at an earlier point in their academic careers would allow for more appropriate curriculum choices to build the skills and knowledge students need to be successful in a more rigorous curriculum. The College Board recognizes the benefit of early preparation and has developed a scaffolding program for middle grades, the Springboard program, as a means to better prepare students for a rigorous curriculum, in high school. However, the only subjects that have been offered are English and mathematics

(College Board 2013c).

Using AP as a delivery model to meet the needs of students identified as gifted means that the gifted identification processes would have an impact on those students later allowed to enroll in AP courses. Yoon and Gentry (2009) call for further studies in the area of gifted program enrollment, addressing which students are being allowed into the programs and which curriculum delivery methods, such as AP, are being utilized. In spite of efforts to open the doors to AP barriers to the program have continued to exist (Wakelyn, 2009).

In a *New York Times* interview, Trevor Packer, the vice-president for the AP program at the College Board was questioned about the opportunity for students to enroll in AP. In regard to both schools and students, Packer's response focused on the concern that schools are not giving qualified individuals the opportunity to enroll in AP courses (Gunther, 2009). Packer points to the problem of teacher preconceived ideas of who will be successful in these programs noting that it is often teacher opinion that leaves out minority students who have the same credentials as those who are easily allowed entry to the program (Gunther, 2009). A study by Taliaferro and DeCuir-Gunby (2008) supports Packer's concern, suggesting that African-Americans in particular are underrepresented in the AP program due to stereotypical viewpoints of teachers.

Purpose Statement

The purpose of this correlational study was to determine if a relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores. For the study district, CogAT is given in 6th grade, while AP courses, which culminate in an AP exam, are offered in grades 9–12. CogAT scores are reported as a continuous score while AP exam scores are categorical. For

this study, subjects could not be randomly assigned; rather AP student scores were divided into pass and fail groups. The pass group was based on scores usually accepted by most colleges and universities for awarding college credit; these were scores of 3, 4, or 5. The AP pass and fail groups were compared to previous testing achievement in CogAT. The AP exams selected for the study included two of those offered in the 12th grade: AP English Literature and AP Calculus. A point biserial correlation was used to determine if a correlation existed between the variables, and a logistical regression was utilized to explore the predictive merit of CogAT scores for future AP success.

Theories that provided the foundation for this study included the following: theories of incremental intelligence (Dweck & Leggett, 1988), self-efficacy (Bandura, 1993), successful intelligence (Sternberg, 1999) and the three-ring model of giftedness (Renzulli, 2002). Examining these theories offered a possible basis for a relationship between middle school CogAT composite, verbal, and quantitative battery scores and high school Advanced Placement (AP) exam scores for students in a rural northeast Georgia school district. The first variable of interest was defined as a standardized norm referenced mental abilities test used in elementary and middle schools known as the CogAT. The second variable of interest was defined as the College Board created AP exams that are used in the determination for college credit (College Board, 2013a)

Significance of the Study

The significance of this study is to add to the body of knowledge concerning equity in the AP program and early identification of students who exhibit the potential for success in high school AP courses. Much information exists concerning the impact of the AP program particularly for college outcomes, but there is little research addressing the connection between

early identifiers and high ability students who could potentially be successful in AP courses. Currently, to identify students who have a high probability of being successful on AP exams, schools can use the College Board resource, AP Potential. This resource uses scores from the Preliminary Scholastic Aptitude Test (PSAT). Research has shown a moderate to strong correlation between PSAT and AP exam scores for prediction of success in various subject areas (Ewing, Camara, & Millsap, 2006; Ewing, Camara, Millsap, & Milewski, 2007). Vaughn (2010) addressed the role of the PSAT as an identifier in a study concerning AP course taking in an urban district indicating that "...future analyses in this district and others needs to link students identified by means of PSAT scores and other measures with performance on AP exams" (p. 404). In the district for the study, the PSAT is generally given in 10th grade and does not allow for an early identification of students who could potentially be successful on AP exams.

Researchers are calling for additional studies to further explore the relationship between AP programs and various groups and types of students (Klugman, 2005; Kyburg et al., 2007; McBee, 2006; Peters & Mann, 2009; Yoon & Gentry, 2009). Lohman (2006) suggested the need for further research concerning testing for gifted identification, particularly longitudinal ones that include multiple testing and all types of students, stating that following learners over time could lead to additional information concerning how academic excellence is developed.

The current study contributed information to a gap in the literature concerning equity in the AP program and early identification of potentially successful AP students. Successful AP students are considered to be those that score a 3, 4, or 5, on a scale of 1 to 5, since these scores are accepted by most colleges for awarding college credit hours (Atkinson & Geiser, 2009; Chajewski et al., 2011; College Board, 2011b). The College Board uses the following scale to rank student performance on AP exams: 1 indicates "no recommendation," 2 indicates "possibly

qualified,” 3 indicates “qualified,” 4 indicates “well-qualified,” 5 indicates “extremely well-qualified.”

As studies contribute information concerning successful AP students, researchers can begin to look for commonalities that will lead to earlier identification and better preparation of students hoping to be successful in the AP program. Since many students who enroll in these courses are not prepared (Winnebrenner, 2006), early identification of potentially successful students would allow them the opportunity to pursue a course of study leading to development of the skills and knowledge needed to experience success in the AP program and accrue the benefits that are purported to be associated with the successful performance on AP exams. As a rural school with limited AP offerings, the information gathered can be effectively used to benefit numerous educational stakeholders by yielding information that would enable the school district to assist students in planning for academic experiences that best match their intellectual needs, interests, and career plans.

Research Questions

This correlational study sought to investigate a relationship between two variables, Cognitive Abilities Test (CogAT) and Advanced Placement (AP) exams. CogAT is a standardized norm-referenced mental abilities test (Lohman & Renzulli, 2007). AP exams are those taken at the end of an AP course and are used in the determination of possible college credit (College Board, 2012). Research has shown future academic benefits for students who are successful on AP exams. Success is considered as a score 3, 4, or 5 since most college accept these scores for awarding college credit hours (Atkinson & Geiser, 2009; Chajewski et al., 2011; College Board, 2011b). Gathering information on indicators of potentially successful AP students would be beneficial for students making curriculum decisions in anticipation of

attending college. Examining not only the composite score, but also the verbal and quantitative battery scores in relation to AP exam scores would yield additional information on a possible relationship between the two assessments. Lohman and Lakin (2011) note that “Tests that measure both the general and specific abilities required for learning in a particular domain better predict later performance in that domain” (p. 595). Verbal reasoning skills are important for vocabulary building and reading comprehension while quantitative reasoning relies on mathematical problem solving (Lohman & Lakin, 2011). Lohman and Renzulli (2007) suggest that the CogAT individual test batteries along with appropriate achievement scores are the best predictors of academic success in specific domains. Domains such as social studies and literature would be associated with the CogAT verbal battery score and domains relating to mathematics with the CogAT quantitative and nonverbal batteries (Lohman & Renzulli, 2007).

The following questions guided the research study:

RQ1: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores?

RQ2: Is there a correlation between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores?

RQ3: Is there a correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP English Literature exam pass-fail scores?

RQ4: Is there a correlation between increases in 6th grade CogAT verbal battery scores and increases in 12th grade AP English Literature exam pass-fail scores?

RQ5: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores?

RQ6: Is there a correlation between 6th grade CogAT quantitative battery scores and 12th

grade AP Calculus exam pass-fail scores?

RQ7: Is there a correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP Calculus exam pass-fail scores?

RQ8: Is there a correlation between increases in 6th grade CogAT quantitative battery scores and increases in 12th grade AP Calculus exam pass-fail scores?

Null Hypotheses

H₀₁: There is no significant correlation between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores.

H₀₂: There is no significant correlation between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores.

H₀₃: There is no significant correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP English Literature exam pass-fail scores.

H₀₄: There is no significant correlation between increases in 6th grade CogAT verbal battery scores and increases in 12th grade AP English Literature exam pass-fail scores.

H₀₅: There is no significant correlation between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores.

H₀₆: There is no significant correlation between 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores.

H₀₇: There is no significant correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP Calculus exam pass-fail scores.

H₀₈: There is no significant correlation between increases in 6th grade CogAT quantitative battery scores and increases in 12th grade AP Calculus exam pass-fail scores.

Identification of Variables

Variables of interest include the following:

1. *CogAT*. A group administered mental abilities test battery used to assess abilities in reasoning and problem solving. The test includes verbal, quantitative, and nonverbal batteries along with a composite score as a combination of the three. Validity measures support the use of *CogAT* for the identification of high ability students (Lohman, Korb, & Lakin, 2008).

2. *AP Exam*. The AP exam is the College Board standardized examination, given in May of each year for 37 different subject areas. These exams allow students the opportunity to earn college credit for courses taken while attending high school. Students earning a 3, 4, or 5 on the exam may receive college credit from the college or university they will attend based on that institution's AP credit acceptance guidelines. Most institutions award college credit for a 3 or better performance on the exam (College Board, 2011b).

Definitions of Key Terms

1. *College Board*. College Board refers to a non-profit member organization formed in 1900 as the College Entrance Examination Board. Functions of the College Board include test development and administration, educational services, and material related to the college admission process (College Board, 2011a).

2. *Advanced Placement*. The Advanced Placement program is under the College Board umbrella and consists of a variety of high school subjects that offer a college-level curriculum and an opportunity to obtain college credit. AP refers to the copyrighted College Board title of Advanced Placement (College Board, 2003).

3. *Gifted*. In the state of Georgia, gifted identified students refer to those who have been formally given the label according to set policies by the state and school district. These students

must have excelled in a combination of the given categories: intellectual ability, creativity, motivation, and/or academic achievement. Gifted identified students need special instruction or ancillary services to provide instruction appropriate for their ability levels. Georgia law mandates services for the gifted (Georgia Department of Education, 2012).

4. *Nontraditional students.* Nontraditional students refer to those students enrolling in AP courses who do not possess the common characteristics of a student typically enrolling in AP classes. These students usually include minorities and lower socioeconomic status (SES) students and are generally not identified as gifted by school policy criteria (College Board, 2010).

CHAPTER TWO: REVIEW OF THE LITERATURE

The review of the literature included searches in academic databases with combinations of the following key words: AP, college outcomes, gifted identification, gifted delivery model, inequity, criticisms, advantages, minorities, predictors of success, CogAT, and College Board. Results produced a plethora of articles, many of which were unrelated to the study topic. The selection of the peer reviewed scholarly articles used was based on relevance to the specific study topic. Little research was available on CogAT and in particular its use in predicting future academic success. Also lacking were studies on factors influencing success in AP courses.

Chapter 2 includes a discussion of theories that impact the identification of gifted students and the premise underlying achievement for high ability students. The history of the AP program and its recent expansion that has been supported at both the state and federal level is discussed. The impact of popular media on parent and student perception of AP courses is documented. A review of College Board sponsored research shows that one of the primary benefits for AP participation is improved college performance for those achieving a successful score on AP exams (Atkinson & Geiser, 2009). Although independent research studies vary in their support of specific College Board claims, the general consensus is that AP is a beneficial program (Sadler, 2010). The role of gifted identification processes on AP enrollment is explained with standardized testing being a primary element in the procedures for the district being studied. The College Board notes that inequity still exists in both gifted and AP programs (College Board, 2010). The need for better preparation for the more nontraditional student is noted (Winnebrenner, 2006).

Theoretical Framework

The idea of a connection between academic success and personal characteristics is a

theme for a number of theorists investigating indicators of academic success (Bandura, 1977; Bandura, 1993; Bandura & Wood, 1989; Dweck, 1986; Dweck, 2000; Dweck, 2009; Dweck & Legget, 1988; Renzulli, 2002; Sternberg, 1999; Sternberg, 2003). Seeking to determine those students who can potentially be successful in academically challenging courses can allow a more appropriate curriculum selection for them at an earlier age leading to improved preparation for such courses.

Dweck

Individuals who believe their ability to succeed academically is based on traits that can be influenced follow an incrementalist viewpoint. Carol Dweck's early research sought to answer the question of what determines a student's ability to persevere toward academic success when presented with challenging situations (Dweck, 1986; Dweck & Legget, 1988). Higher self-efficacy was found to predict improved performance when faced with challenges (Dweck & Leggett, 1988). As research continued, the concept of an incremental intelligence was explored, and the original question was soon applied to education in the area of motivation and behavior (Dweck, 2000). The resulting theory, implicit theory, encompasses the idea of both an entity and incremental viewpoint. With an entity perspective, an individual believes that psychological characteristics such as intelligence are fixed traits. On the other hand, those who believe in the incremental perspective believe that such traits are malleable (Dweck, 2009). Reliance on early gifted identification by standardized testing indicates an entity perspective in that the concept of giftedness is a fixed rather than malleable trait. Once students are identified as gifted, they are assumed to be gifted the rest of their academic career, and thus are able to maintain access to the available gifted curriculum. Findings from Ahmavaara and Houston (2007) suggest that students could be influenced by the results of a selection test, which if failed could lead to a belief that

intelligence is fixed.

Bandura

Feelings of self-efficacy have been related to achievement (Bandura, 1993, Dweck & Leggett, 1988). In Bandura's theory of self-efficacy, an individual's motivation deals with the activation and persistence of a particular behavior that has a basis in cognitive activities. An individual's self-efficacy will determine the choice of activities with which to be involved; moreover, how much effort is expended is directly influenced by the degree of self-efficacy. The expectation of eventual success will influence the use of coping strategies to deal with obstacles or adverse situations, once involved in an activity (Bandura, 1977). Bandura and Wood's (1989) study on complex learning and decision making found that those who felt their ability was based on inherent abilities showed a progressive decline in performance when met with challenging tasks. On the other hand, those who believed their performance would be based on acquired skill continued to work with diligence when presented with complex tasks. If traits can be influenced, a student's standardized test scores may not be a good predictor of future academic success. The general expectation that gifted students have the greatest potential to excel in AP courses is evidenced by the fact that many schools use this as their primary delivery model for gifted instruction, which creates barriers for more nontraditional student entry into AP courses (Hertberg-Davis & Callahan, 2008). In Georgia, gifted identification methods can include use of standardized testing as a primary piece of identification (Georgia Department of Education, 2012) suggesting a belief in performance based on inherent ability rather than acquired ability. For the study district, CogAT is generally used as one element of the gifted identification process.

Sternberg

Evaluations of individual competencies for various reasons is a common practice in our society; whether it is hiring, college admissions, elections to an office, admission to a particular class or any situation which calls for an elimination of some and an acceptance of others. Many of these evaluations are informal rather than formal and include some evaluation of intelligence (Sternberg, 2003). Sternberg (1999) challenged the commonly accepted intelligence theories that posited a general factor of intelligence underlying all adaptive behavior and suggested, instead, a theory of successful intelligence. Sternberg (1999) countered with the idea that intelligence operationalized as performance on an intelligence test is limited. Expansion of the concept of intelligence should include not only analytical and memory abilities, but also both practical and creative elements as well. Sternberg argues that it is not that conventional testing is invalid but that it not inclusive enough for a true prediction of an individual's intelligence. A belief in Sternberg's theory would make it incumbent on our school leaders to provide opportunities for any students who express an interest in pursuing a rigorous curriculum.

Renzulli

Renzulli, a leading authority in the area of giftedness, has developed one of the most relevant and well-known theories relating to advanced learners (Knobel & Shaughnessy, 2002). Renzulli's three ring conception theory of giftedness involves the identification of giftedness through the recognition of specific traits possessed by successful individuals. Renzulli's research has demonstrated the existence of creativity, above average ability, and commitment to a task for individuals who have demonstrated accomplishment. However, Renzulli cautions that it is not appropriate to use any of these as single criteria for gifted identification (Renzulli, 2002).

It is hoped that this study will show that the open door policy established by the College

Board should not be feared but rather embraced by AP educators. School districts that want to ensure equity in AP should pursue better preparation for a more diverse group of students, not just those labeled as gifted, and should endeavor to consider alternate methods of assessing for academic placement and curriculum selections.

Review of the Literature

History of the AP Program

Following WWII, a sentiment developed to promote higher education for increased numbers of students. In response, the Ford Foundation along with three of our nation's most prestigious universities, Princeton, Harvard, and Yale, led an endeavor to promote a more rigorous high school curriculum. By 1955, the program was initiated and the College Board came on as administrator naming the program the College Board Advanced Placement Program (AP) and targeting high ability students for participation. Growth of the program was steady with the 1990s seeing increased expansion in both AP and new programs related to the support of better preparing students for AP (College Board, 2003).

The AP program today influences millions of students each year and is perceived as providing benefits above simply earning college credit or placement (College Board, 2011c). The program is pervasive with over 90% of 4-year colleges in the U.S. and colleges in other countries maintaining policies referring to AP score acceptance and stating the qualifying scores to earn the student college credit, placement, or both (College Board, 2011c). With only 1,299 students participating in the first year (Willingham & Morris, 1986), the program has recently experienced phenomenal growth. In 2010, the program administered more than 3.2 million exams to high school students across the nation (College Board, 2011e). Coinciding with the AP expansion, the creation of the HOPE scholarship in the state of Georgia in 1993 allowed

increased numbers of students the financial ability to attend college (Cornwell, Mustard, & Sridhar, 2006). As a college readiness culture was being encouraged, the AP program gained funding from both state and national levels of government in support of the program's goal of increased rigor for high school students.

State and Federal AP Support

The AP program has undergone substantial expansion since its inception in 1955, particularly in the 1990s (Keng & Dodd, 2008; Klopfenstein, 2003). The program has increasingly garnered government support from both the federal and state levels. In the 2001 No Child Left Behind Act, support for AP was addressed through the AP Incentive Program (NCLB, 2001). In the incentive program, federal funding was offered to states that met criteria set forth by the federal government with those funds being utilized to encourage state expansion of AP programs and increase student participation (Holstead, Spradlin, McGillivray, & Burroughs, 2010). At the state level, in 2005, the National Governors' Association Center for Best Practices launched a six state initiative called the Advanced Placement Expansion Program. This program focused on increasing participation for low-income and minority students and included the following states: Alabama, Georgia, Kentucky, Maine, Nevada, and Wisconsin (Holstead et al., 2010; Wakelyn, 2009).

Continued national support for expansion of the AP program came in 2004 when addressed as a goal in President Bush's State of the Union Address. The 21st Century Jobs measures would include an expansion of AP in low-income schools along with larger Pell grants for those students choosing to pursue a more rigorous high school curriculum in anticipation of attending college (Bush, 2004). With federal and state support and encouragement, AP began to expand and a more diverse group of students began enrolling. The influx of nontraditional

students in the AP program led researchers to examine the effect of this enrollment. The first national survey of AP teachers was conducted with a sample of 1,024 teachers. Quantitative data was supplemented by qualitative information resulting from the inclusion of four focus groups in the states of Maryland, Utah, Wisconsin, and Texas. Findings indicated that while teachers remained pleased with the curriculum of the program, concerns existed about the impact of the expansion in other areas. With 52% of teachers stating that they would prefer to limit the program to the most able students, there was a clear concern for how students perform in AP courses. While the percentage of students achieving a score of 3 or above on all exams dropped from 62% to 58%, there was not a clear indication of the academic impact. Ninety percent of AP teachers stated their belief that the driving force behind the increased expansion had no relationship to academic aspiration of students but rather a desire to create a better transcript and be more competitive for college admissions (Farkas & Duffet, 2009). More recently, the Obama administration has provided funding allocated to promote increased rigor in high schools, with AP being a possible alternative to achieve this goal (U.S. Department of Education, 2010).

AP Participation

Advertised by popular media and fueled by an educational movement to increase college readiness, the AP program has expanded, which is indicative of the fact that students perceive they are receiving benefits from taking the courses. The College Board website states that benefits of the AP program include not only the possibility of college credit or placement, but also the opportunities to be more competitive in the admissions process and to acquire skills needed in order to be successful in college. Additionally, AP students are more likely to obtain a college degree in four years, thus obtaining a significant financial savings (College Board, 2011c). In recent years, an ongoing factor fueling the growth and popularity of AP courses in

the high school curriculum has been students' demand based on their assumption that AP courses will provide benefits for future academic pursuits. Increasing numbers of today's youth realize the need to pursue a higher education, and educational policies are encouraging more students to enroll in college. In response to growing numbers of applicants, colleges and universities have begun placing a greater emphasis on course rigor in their admission decisions process with AP classes being recognized as an indicator of rigor (Kyburn et al., 2007; Taliaferro & DeCuir-Gunby, 2008). With increased competition for admissions, students have begun enrolling in AP classes to create a high school transcript that will improve their likelihood of being chosen by the college of their choice (Santoli, 2002; Santos, Cabrera, & Fosnacht, 2010). High school programs responding to state and college policies that encourage an open door to AP are encountering a more diverse population of students. These increasing numbers of nontraditional students entering the program are those individuals that typically do not enroll in accelerated courses (College Board, 2010). These students did not follow an accelerated track as a basis for taking their high school courses and, therefore, lack a sound foundation in preparation for advanced courses (Winnebrenner, 2006).

Thus, the contentious dichotomy in AP centers on whether to have open access or to make enrollment dependent on specific criteria. Enrolling the more nontraditional student requires a greater emphasis on better preparing the student for rigorous courses to which they are unaccustomed. Concern about this new enrollment is evidenced by teachers' responses to surveys; in one study, 52% of teachers stated that only qualified students should be allowed to take AP courses. Teachers in the same study asserted that allowing unprepared students to enroll in the course would detract from the quality of the program and, thus, would not be fair to teachers or other better-prepared students who were taking the courses. As a suggested

improvement, 63% of teachers specified that a screening process should be in place to make sure students were prepared to take the course (Farkas & Duffett, 2009).

Recent data concerning AP participation was released in the 9th annual *College Board Report to the Nation* for 2012. Statistics showed that 954,070 high school graduates had taken at least one AP exam with 573,472 scoring a 3 or higher on at least one AP exam. Comparing the 2012 data to the 2002 numbers of 471,404 and 305,098, respectively, shows the increasing expansion of the AP program. The numbers of graduates having attained at least a score of 3 on one exam translate into 19.5% of our nations students who attained this benchmark success. Georgia ranked in the top ten states having increased the numbers of students scoring a 3 or above on one exam by 10.1%. The top ranking state, Maryland, achieved a 13.1% increase. Despite the progress made in increasing enrollment numbers and success, low income and minority students remain underrepresented in the AP program; therefore, states need to increase efforts to identify and better prepare students for the AP classroom (College Board, 2013a).

AP in the Public Media

Education is an important issue in our nation, and the media figures prominently in shaping and influencing popular opinion. Although these information sources generally do not use information based on scholarly studies, they have been very influential for the general public. Indicative of the prominence of the AP program, Jay Mathews, columnist at the *Washington Post*, has been ranking the most challenging schools for 15 years using a formula that takes the total number of AP and International Baccalaureate (IB) course tests offered by a school and divides this number by the total number of seniors graduating at the year's end. This formula, the *Challenge Index*, was invented by Mathews in 1998 and addressed the expansion and importance of the AP program in the nation. The list ranks public schools across the nation,

including public charter schools, and provides a quality score for schools, regardless of AP exam grades. Mathews indicated that he did not include the number of students making a score of 3 or above in his formula because many schools only allow the brighter students to take AP or allow all to take the course but encourage only the brightest to take the exams. However, Mathews did include another piece of data reported on this list, which accounts for the success of the schools based on numbers of students scoring a 3 or better. This metric called *Equity and Excellence* calculates the percent of seniors who have earned a score of 3 on at least one exam during their high school careers. Earning a 3 on the exam is considered the standard of success because most colleges will award credit for a 3 or above. For 2012, the average success rate was 19.5. The data is used to highlight how well schools have performed in encouraging the average student to participate in advanced courses. A separate list entitled Public Elites records public charter schools or any others that only draw from top students. Schools whose population of students exceeds average Scholastic Aptitude Test (SAT) or American College Test (ACT) score for normal enrollment are not included. The data also includes information related to subsidized lunches to address the issue of equity in AP courses (Mathews, 2013).

In response to Mathew's *Challenge Index*, *U.S. News and World Report* commissioned American Institutes for Research to develop a formula that included a more in-depth look at various criteria to evaluate America's high schools (Morse, 2007). Although including various other criteria, their formula also included an emphasis on using AP as a means to rank schools, including participation and performance in AP and IB as measures of a school's ability to produce college-ready students (Duhon, Kurki, Chen, & Noel, 2013). These formulas are only two examples of how AP is used to evaluate schools and how popular media can influence the American public. The AP program is a very conspicuous part of our educational system today,

which is why so many aspects of the program have elicited controversy and generated both public debate and scholarly research.

Importance of Academic Rigor

In the current educational climate, the issue of college readiness is critical, and AP is seen as the standard of rigor in high schools in pursuit of better preparing students for college (Sadler, 2010). Findings from scholarly research support the benefits of a more rigorous high school curriculum for most students (Adelmen, 2006; Long, Conger, & Iatarola, 2012). Adelmen's (2006) study replicates a 1999 study from the National Center for Educational Statistics concerning the effect of curriculum on college performance. The 1999 study included data from the graduating class of 1992. A change in the most recent study was the addition of criteria for the highest level of math, core lab sciences, and AP course work as indicators of rigor. Adelmen (2006) suggested that positive findings from both of these studies make an important statement about raising rigor and expectations for high school students. He indicated that stakeholders in the educational process would benefit from consideration of these study results and their support of academically preparing larger numbers of students through a rigorous curriculum. Although Adelman's study promotes a rigorous curriculum and even includes AP as one example, he does not advocate the course in particular as a means to achieve the goal.

Long et al. (2012) demonstrate the advantages of a rigorous curriculum and the impact on college outcomes. General findings from their study include an increase in 4-year college enrollment by 7% to 11% for those who move from taking no rigorous courses to taking at least one rigorous course in the first two years of high school. If a student enrolls in a rigorous course in any of the four years of high school, the likelihood of college attendance increases by 5% to 6%. Most relationships found in the study remain the same across all demographic groups. This

study presents strong evidence for the benefits of a rigorous curriculum and adds support for government policies that advocate educational reform that includes increased rigor through an enhanced curriculum for all students.

AP as a Standard of Rigor

The AP program has been identified as a standard of rigor in high school curriculums (Chajewski et al., 2011; Sadler, 2010). In fact, the most common methods that high schools used to meet the challenge of providing a rigorous curriculum included honors courses, AP courses, or dual enrollment. Sadler (2010) examined AP courses in relation to honors courses. The study included a compilation of surveys from 7,491 students enrolled in introductory science courses in 55 different 4-year colleges and examined course characteristics of regular and honors versus AP. Sadler found the following sequence when students were asked to rank courses from less difficult to most difficult: regular, honors, and AP. AP science courses were considered more demanding by students who put in approximately 26% more time for honors class work and 54% for AP. Sadler's characterization of students in AP concluded with a suggestion that studies should move away from comparing AP and non-AP students to determine course effects (Sadler, 2010).

Examining the impact of school level contextual factors on student achievement, with AP exam scores as a measure of school performance, Burney's (2010) findings demonstrated support for Adelman's (2006) call for a rigorous curriculum. School level factors such as school size, senior class size, and general ability were not related to performance; however, the number of AP course offerings was related to student achievement. As a school level factor, lack of access to AP courses contributes to the underrepresentation of minorities in AP (Barnard-Brak, McGaha-Garnett, & Burley, 2011; Ford & Whiting, 2009). Studies such as Adelman (2006) and

Burney (2010) give credence to government supported initiatives promoting a more rigorous high school curriculum. Most recently, federal initiatives under President Obama have included federal funds to promote rigor in high schools with AP noted as a possible avenue of implementation (U.S Department of Education, 2010).

College Board Research

One of the most important questions in education contemplates how schools should prepare students to meet the challenge of higher education. With rigor being recognized as a means to develop college ready students, the College Board suggests that AP is the answer. The College Board website lists benefits of the AP program as possible college credit, competitive admissions transcript, earlier degree completion, and financial savings (College Board, 2011c). Of these various benefits, one of the most discussed and debated areas deals with AP and college outcomes. As the administrator of the AP program, the College Board provides scholarly research supporting a connection between AP and college performance. Most of the College Board studies that deal with effectiveness of the program as it relates to higher education have been conducted since the AP expansion in the 1990s and have addressed more complex comparisons of student groups matching academics for comparison groups. These studies have also included a greater variety of comparison groups and subject areas with overall findings supporting a relationship between AP and college success (Dodd, Fitzpatrick, De Ayala, & Jennings, 2002; Hargrove, Godin, & Dodd, 2008; Morgan & Klaric, 2007; Patterson & Ewing, 2013) specifically for those scoring a 3 or higher on the exam (Dodd et al., 2002; Keng & Dodd, 2008; Mattern, Shaw, & Xiong, 2009; Murphy & Dodd, 2009; Patterson & Ewing, 2013).

AP and college outcomes. In general, students that participate in AP, and especially those that are successful on the AP exam as defined by a score of 3, 4, or 5, have been shown to

have better academic performance in college (Dodd et al., 2002; Mattern et al., 2009; Morgan & Klaric, 2007; Murphy & Dodd, 2009; Patterson, Packman, & Kobrin, 2011), and, moreover, this positive relationship exists across socioeconomic (SES) factors (Hargrove et al., 2008). In response to a concern by college professors that students within the 3 score range did not perform consistently well in subsequent courses, a College Board research study in 2002 was conducted to determine if there was a need for gradations with the 1 through 5 scores range for all AP exams. The study provided data to support better academic performance in college for both students who are successful on the AP exams and for AP versus non-AP students. To increase validity, the comparison with non-AP groups equated the groups using SAT and grade point average (GPA). Scores within the 3 range were examined to determine any effect resulting from gradation within the 3 scores. No significant difference was found for any gradation of the 3 scores or for comparison of high 2s and low 4s with any of the scores in the 3 range (Dodd et al., 2002).

A 2007 College Board research study addressing the performance of AP students in college compared students who had taken at least one AP exam to non-AP students and found that for most subjects, AP students (a) had higher averages in intermediate courses than non-AP students in introductory courses, (b) had a greater probability of graduating, and (c) tended to graduate earlier. Strengths of this study included large sample size and controls for SAT scores while limitations included not addressing SES characteristics (Morgan & Klaric, 2007).

An advantage of AP research has been the availability of large sample sizes. Mattern et al. (2009) conducted one of the largest AP sample sizes studied consisting of 196,364 students representing 110 colleges and universities across the nation. Data from the SAT Validity Study database was cross-referenced to include additional controls for SAT scores. Results from AP

courses including English Language, Biology, Calculus AB, and U.S. History were examined in the study. For the subjects studied, student scores of 3 or above on exams corresponded with three elements: (a) higher first year GPAs, (b) higher second year rate retention, and (c) matriculation at more selective higher education institutions. The effects continued even when controlling for SAT scores although the effect size was smaller. While exam scores of 1 and 2 did not correspond with higher first year averages as compared to non-AP groups, there was a correspondence to second year retention and exclusivity of institution attended. Positive contributions of this study included a control for SAT scores and subject size leading to greater ability to generalize findings (Mattern et al., 2009).

Further research, Keng and Dodd (2008), has examined the success of the AP program by comparing college outcomes for four different groups of students for 10 different AP subject exams. These groups included the following: (1) an AP credit group which consisted of students who took the exam and received college credit (2) an AP no credit group which consisted of students who took the exam and did not receive college credit (3) a concurrent group which consisted of students who enrolled in an the corresponding college course rather than taking the AP exam, and (4) a non-AP group that did not take an AP exam and did not enroll in a college course but who were matched with the AP credit group in terms of academic ability, high school rank, and SAT/ACT score. Study findings showed that the concurrent and AP credit groups outperformed the non-AP and AP no credit groups. Moreover, AP students who had earned college credit consistently outperformed the comparison groups. The concurrent group had more hours credit but their GPA was no higher. In comparison to the AP no credit group, the non-AP group was more proficient. However this was not surprising since the non-AP group was matched with the AP credit group on academic characteristics (Keng & Dodd, 2008).

The complexity of investigating the AP impact has been recognized by the College Board, which has sponsored research that includes a greater number of variables having the potential to influence AP programs. Murphy and Dodd (2009) compared college performance of three AP groups in 10 different subjects: (a) AP students earning college credit, (b) AP students taking the exam but not earning college credit, and (c) AP students earning course credit but electing to take an introductory course anyway. Matching these groups with non-AP groups on high school GPA and SAT scores accounted for academic differences. Additional research questions added three matched research groups already enrolled in college in the same areas as the AP subjects. Although effect sizes varied, overall findings for the AP and non-AP comparison indicated that AP student groups outperformed non-AP groups. For the 10 subjects, AP students had higher first year GPAs in the subject area of the exam they had taken. For five subject areas, AP students had a higher GPA overall not just in the subject area of the test taken. Credit earning AP students had higher first year GPAs than those not earning credit. For the comparison of AP with students enrolled in college courses, the effect was not as strong. Due to subject numbers, the sample size was smaller and GPA elements were eliminated and may have affected the outcome. Thus, the researchers suggest further studies in the area of comparisons to students enrolled in college courses (Murphy & Dodd, 2009).

AP and socioeconomic status (SES). As more nontraditional students have enrolled in AP, more attention has been focused on SES factors. To address this issue the College Board sponsored a 2008 study that included these factors. Findings from five subjects indicated that, overall, when controlling for SAT and family income, students taking both the course and exam significantly outperformed those taking the AP course only, or dual enrollment only. In general, results remained true even when gender and ethnicity were considered (Hargrove et al., 2008).

Addressing weaknesses in earlier studies, more recent College Board research from Patterson et al. (2011) included variables not previously considered. Utilizing data from a larger number of institutions increased the strength of the study, as did inclusion of matching for SAT and GPA. Other factors also considered were ethnicity, gender, parental education, high school demographics, and college demographics. Student characteristics were determined from the SAT questionnaire and included a sample size of 195,099 students entering their freshmen year in 2006. Cross-classified, multi-level modeling was utilized to account for variance in high school and college characteristics. Within the nine subject areas, ethnic groups performed lower than Caucasians in GPA with mixed results by subject and ethnic group. Significant effects were found for both demographics and parent education, and GPA showed a stronger relationship across all nine subjects. The relationship with SAT varied by subject. Across all nine subjects, the mean AP exam performance was a stronger predictor of GPA. For seven of the nine subjects, students earning a 3 outperformed the reference group. For four of the nine groups, students earning a 2 outperformed the reference groups as well. Despite the controls and complex group configurations of this study, limitations included not being able to consider AP students who only participated in the course and did not take an exam, difficulty separating courses taken in subject areas and AP course work, and corresponding the GPA within disciplines (Patterson et al., 2011).

Paralleling the change in student demographics, College Board studies concerning AP have continued to encompass additional variables potentially affecting college outcomes. With intent to address preexisting characteristics, the use of propensity scores to match preexisting characteristics strengthened a 2013 study (Patterson & Ewing, 2013). Gender and ethnicity were also considered along with covariates GPA and PSAT. New covariates included academic

interest and AP exam participation opportunity, with academic interest being determined through self-reporting on the PSAT questionnaire taken in the 10th grade and AP exam opportunity being determined by the number of available AP courses. Large sample size was strength of the study, which included 53 colleges and 72,902 subjects. Data for 15 exams met the criteria for the study that included a requirement of at least 100 subjects in matched groups of AP versus non-AP for each subject exam. Moving away from the traditional statistical analysis, the modified standardized differences displayed two differences for the pooled standard deviation: (a) the standard deviations were always based on pre-matching samples and (b) the computation was a simple rather than sample size weighted average of both group's standard deviation. Researchers used a standard analysis reference of 0.25 in absolute value to indicate meaningful differences. For three subjects, AP students outperformed non-AP students while in the remaining seven subjects, there was no substantial difference shown for the standardized difference of grades in subsequent courses; this indicates that non-AP and AP were comparable in performance. In sum, there were no exams in which the AP students underperformed the matched group of non-AP students (Patterson & Ewing, 2013).

Independent Research

Support for AP. With a national move to promote science, technology, engineering, and math (STEM) being supported by President Obama, AP has been included in the pathway to meet educational goals for these subject areas. In general, research has supported a connection between participation and success in AP science courses and higher college science GPAs and completion of science degrees (Tai, Liu, Almarode, & Fan, 2010; Sadler & Sonnert, 2010). Utilizing data from longitudinal studies conducted by the National Center for Educational Statistics, a study analyzing math and science students was conducted to determine if high school

math or science AP exams were predictive of a student's completion of a baccalaureate degree in science and engineering fields. A strong positive effect was found for participation in math and science exams, thus supporting the expansion of AP as a means of improving the STEM workforce. Limitations of the study included usage of data from an earlier period preceding the major expansion of AP and small sample sizes in some categories (Tai et al., 2010).

Research by Scott, Tolson, & Lee (2010) supported a College Board research study by Mattern et al. (2009) and further defined the success of the AP program at the college level by conducting a study accounting for variability of high school factors that could have influenced the outcome. Utilizing a research design that allowed a comparison of high school ability factors consisting of standardized test scores and class rank, the researchers investigated the success of first semester college students. The study benefited from a large sample size of 3,360 students who had received college credit by scoring a 3, 4, or 5 on the exam and 5,715 students who did not attain the AP credit. In all comparisons, the students who had earned the AP credit outperformed the students who had not earned AP credit.

College outcomes questioned. Numerous variables with respect to the impact of AP have been investigated through independent research with varying results reported. Some studies have supported all or parts of College Board research while some have produced findings directly opposed to College Board claims. Farkas and Duffet (2009) have suggested that, to avoid possible bias, researchers who are not affiliated with the College Board research department should conduct additional studies on AP.

Geiser and Santelices (2004) and Dougherty, Mellor, and Jian (2006) found that numbers of AP courses on a student's transcript were not predictive of college success. However, a statistically significant relationship was found for students passing AP exams with a 3, 4, or 5

and future college enrollment and graduation. These findings are in line with studies from College Board sponsored research (Keng & Dodd, 2008; Mattern et al., 2009; Murphy & Dodd, 2009; Patterson & Ewing, 2013).

Geiser and Santelices (2004) found that for most AP exams, students who took an AP exam and scored a 3 or above had higher GPAs in intermediate courses than students who did not take an AP exam but did take an introductory course in college. Controlling for SAT scores, students who elected to take AP exams and scored 3 or above had a higher probability of graduating, graduating earlier, and having higher GPAs in intermediate courses than students who did not take AP exams (Geiser & Santelices, 2004).

The Dougherty et al. (2006) study gives further support to the idea that the impact of AP is dependent on not just taking the course, but also passing the exam as is defined by achieving a score of 3, 4, or 5. The study participants included 67,412 graduates in 1998 who went on to enroll in a public college or university within the year following graduation. The relationship between those subjects who scored less than a 3 was not statistically significant to college graduation rates (Dougherty et al., 2006). Reflecting on their 2006 study, Dougherty and Mellor expanded their concerns about a true AP effect in their contribution for Sadler's (2010) book *A Critical Examination of the Advanced Placement Program*. Discussing the issue of inequity in the AP program, the authors cautioned that it is not enough to simply increase enrollment to include the more nontraditional student but that it is critical for these students to be better prepared for the courses. Preparation could start as early as pre-k (Dougherty & Mellor, 2010).

Sadler and Sonnert (2010) looked at the predictive value of AP for college science performance and the added value of taking AP courses in high school. The data was collected from college freshmen taking introductory biology, chemistry, and physics. Students who

reported passing AP exams in science earned college grades significantly higher than students taking high school science courses at other levels of difficulty. An exception to the finding included students who took honors chemistry or physics; these students performed equally as well. While a positive finding was indicated, college grades earned by those who passed their AP exam averaged only a B or B plus after another semester of biology, chemistry, or physics was taken. Sadler and Sonnert (2010) concluded that because the high school course would have taken the place of the introductory course, the college grades were not indicative of mastery and thus the value added of taking the AP course was questionable. Biology students who did not take or took and failed the AP exam did not show an advantage. For physics, those who failed showed no benefit, but those who passed or did not take physics did show an advantage. The authors summarized the data by stating that in general, while there is an advantage for science students in taking AP, it is not a substantial advantage and colleges should be cautious when relying heavily on AP as admissions criteria (Sadler & Sonnet, 2010).

Duffy (2010) examined the relationship between persistence and performance at a 4-year university for students completing advanced coursework during high school. As a former executive director at the University of Tennessee at Martin, his focus concerned dual credit programs at that university only. While the findings of the study supported previous studies identifying characteristics of students enrolling in advanced coursework, the focal point of the study was not supported. AP students did have greater persistence and better performance only when pre-entry characteristics were not controlled for in comparison to the control group. Duffy (2010) stated that the major finding of his study did not support a significant difference in academic performance between students taking AP courses, regular courses, or a type of dual enrollment. This finding contradicts earlier research establishing an advantage of persistence

and performance in college for students completing advanced course work in high school.

Causality concerns. Klopfenstein and Thomas (2009) noted serious concerns with the College Board studies indicating that successful AP exam scores are strong predictors of college success. They suggested that the general public, media sources, and our politicians have interpreted these results to mean that successful AP exam scores would cause college success. While their main contention was that a serious flaw in previous AP studies was neglecting to include information about a student's non-AP curriculum, such as math courses that have been shown to be a college success predictor, they also indicated that there were numerous variables and combinations of variables within the school setting that could be affecting results. In general, findings supported the College Board sponsored study Dodd et al. (2002) that indicated AP course taking alone was predictive of college success. However, the researchers did challenge the idea that for a typical student's participation in AP there is a positive causal impact on performance in college and suggested other variables such as school curriculum could be accounting for the positive results in previous studies. AP course taking was as predictive as other variables such as rigorous math and science courses and a plethora of other possibilities. For example, Klopfenstein and Thomas (2009) suggested that within their study, findings such as a positive relationship between Hispanics taking AP Science and college performance could be due to other factors such as quality support programs. A further suggestion was that predictive results shown in most studies is likely a product of AP signaling with brighter students tending to take more AP classes to aid in creating a better transcript for college admissions. These researchers suggested that the predictive power of AP will lessen as a more diverse and possibly less talented group of students move into AP classes. Klopfenstein and Thomas (2009) strongly suggest a need for more research concerning the advantages and disadvantages of the AP

programs, in general, along with studies of non-AP students as well.

Cost effectiveness. Governmental support of the AP program has helped fuel the exponential growth of the AP program across the nation (Farkas & Duffet, 2009). Aside from questions concerning program impact on students, the issue of program cost for schools has come to the forefront. Teacher training, incentive payments, and exam fees are areas in which the costs are highest and for which public money is used (Klopfenstein, 2010). The 2014 exam fee cost was \$89 with an \$8 rebate returning to schools to cover administrative costs. Fee reductions for students in financial need are available based on income criteria. In addition to College Board exam fee reductions, many states provide additional subsidy funding for exam takers (College Board, 2014). Klopfenstein (2010) reports that the exam fee subsidy cost alone for Texas statewide, was \$1.5 million in 1997, with an increase to 4.3 million by 2004. Using a cost benefit analysis formula based on relevant criteria, data findings included an estimate based on shorter time to graduation for the 1997 Texas cohort of seniors. The best estimate of return indicated that while \$1.5 million of taxpayer money was used to subsidize exams in 1997, the savings in college tuition equaled approximately \$500,000. Klopfenstein suggests that examining data after 1997 would likely yield a greater negative balance since after that period the AP program was expanding to include a more diverse group of students who were less likely to be prepared for the course and for college-level work. Benefits tend to accrue to only a small number of students who actually pass AP exams and use the credit awarded to graduate earlier, Klopfenstein argues. Many AP students achieving success on the exam use the flexibility of awarded credit to pursue other areas of interest rather than graduating earlier. Finding no evidence that the AP experience shortens the time to degree completion, Klopfenstein (2010) suggests that funding for AP diverts money that might be better spent on other programs that

could help disadvantaged students.

Teacher impact. Paek, Braun, Ponte, Trapani, and Powers (2010) conducted a study that examined AP program teacher qualifications and impact on scores with reference to science educators. With the increasing popularity of AP, many schools are expanding their programs without regard to documentation of whether or not those courses are successful. Findings included an indication that teacher characteristics accounted for 27% of the variance in scores above that of PSAT as a predictive variable. Separating the scores of 3, 4, and 5, it seems that teacher practices have a greater impact when more stringent requirements for performance exist. Three variables were linked to better performance of AP science students: increased meeting frequency, increased numbers of students taking the AP exam, and increased use of AP exam topics and rubrics by teachers. The authors indicated that schools should focus on investigating the effectiveness of their programs to provide greater opportunity for student success on the AP exam. Identifying program characteristics impacting success could lead to development of support structures for students less prepared for the rigor of an AP course.

Concurring Data: AP and College Admissions

Despite the conflicting information presented previously in the research on college outcomes, studies have established a strong connection between AP and college admissions (Atkinson & Geiser, 2009; Breland, Maxey, Gernand, Cumming, & Trapani, 2002). AP is utilized either directly or indirectly in most all institutions of higher learning. AP factors considered for admissions may include AP course grade, AP exam score, and/or number of AP exams taken relevant to the number of courses offered in the high school (Shaw, Marini, & Mattern, 2013). Prominent organizations such as the College Board, Educational Testing Service (ETS), National Association for College Admissions Counseling (NACAC), Association

for Institutional Research, and ACT, Inc. have conducted research on college admissions every four years since 1979. Within the factors affecting admissions, AP has an impact on six of the top nine factors. Listed separately is AP course enrollment, course grades, and exams. AP courses also influence the following: high school course work patterns, college-level high school coursework, and GPA (Breland et al., 2002). Course weighting of grades for AP can also be an important factor for students (Klopfenstein & Thomas, 2009; Lang, 2007; Sadler, 2010).

Colleges and universities rely on student performance in AP courses as a predictor for success at the college level (Atkinson & Geiser, 2009; Solorzano & Ornelas, 2004). Atkinson and Geiser (2009) note that the NACAC has suggested colleges and universities shift their focus on admissions criteria from achievement tests such as SAT and ACT to subject area tests such as those provided by AP and IB. These subject area tests are more closely linked to high school curriculum and accurate prediction of successful performance at the college level. Much attention has been and continues to be placed on AP in the admissions process. Atkinson and Geiser (2009) point out that over time the role of using AP in admissions has become more important than awarding credit for exams that are passed or allowing placement in advanced courses based on AP exam score.

Geiser & Santelices (2004) examined the growing importance of having AP on the transcript for students seeking entry into the University of California. Use of AP in admission to the University of California was examined along with performance of AP students admitted to the university from 1998 to 2001, including enrollees at several undergraduate campuses. The measure of performance was both first and second year GPAs examined as a separate calculation rather than cumulative. Findings indicated that AP is only a significant predictive factor for college performance when students score a 3, 4, or 5 on the exam. Merely taking AP, IB, or

honors level courses show no relationship with later performance in college. However, this study suffers from an interchangeable use of AP, IB, and honors courses mingled within the data, which prohibits singling out AP only effects.

Determining which AP factor would have the greatest predictive value for first year GPA would be advantageous for the college admissions personnel. For each student's AP participation behavior preceding their senior year, Shaw et al. (2013) examined the following: number of exams completed, number of exams on which a student earned 3 or above, the proportion of AP exams taken as related to the total number of AP courses offered by the high school, the average exam score, the highest exam score, and the lowest exam score. Data was taken from across the U.S. and thus constituted a large sampling from different universities and colleges. Academic controls included high school GPA and SAT scores, both of which have been shown to have a high predictive value for college performance. Of the AP variables studied, AP average yielded the strongest relationship to first year GPA (.42), followed by, in lower increments, the AP high score, scores above 3, AP low, and finally exam count proportion displaying the lowest relationship (.05). Analysis indicated that high school GPA showed the strongest relationship with first year GPA overall. Currently AP course taking behavior is a more common consideration for colleges in their admissions process than is the actual AP exam score information (Shaw et al, 2013).

Due to the importance of AP in college admissions, barriers to entry into the AP program leave those unable to enroll in these classes at a disadvantage. A recent study concerning the University of California's admission policy suggests that the process of admissions in the university may be discriminatory because minorities often do not have easy access to advanced classes (Santos et al., 2010).

Teacher Preparation

The AP academic advantage for students is not the only advantage offered by the AP program; researchers indicate that AP has benefits that accrue for teachers, schools, and universities. Students who take these accelerated courses benefit not only from possibly earning college credit but also from experiencing instruction from teachers who are better prepared because they are more enthusiastic about teaching at an advanced level (Darling-Hammond, 2004; Santoli, 2002). Benefits for teachers include being allowed to earn additional income as an incentive for providing quality instruction, based on numbers of students who are successful on the AP exam (Santoli, 2002). Schools benefit from an AP program by being recognized as an institution promoting accelerated curriculum with quality teachers and successful students who master a rigorous curriculum and earn credit for their efforts. Students who are more prepared and more likely to complete their degree are an asset for colleges and universities (College Board, 2010; Santoli, 2002).

AP as a Gifted Delivery Model

After its development, the AP program became one of the most popular acceleration alternatives for gifted or high ability students at the high school level (Colangelo et al., 2010; Dixon, 2000; Herberg-Davis & Callahan, 2008; National Association for Gifted Children, 2008; Peters & Mann, 2009; Vanderbrook, 2006). In fact, it is sometimes the only option for gifted students at the secondary level (Dixon, 2000). However, while AP is used as the primary delivery model for the gifted in many secondary settings, it has not been validated as being appropriate for gifted learners' needs (Boswell & Collett, 2006; Herberg-Davis & Callahan, 2008; VanTassel-Baska, 2006). Teachers of AP and IB are not encouraged or required by their programs to be trained in teaching gifted students, although some case study research suggests

that this training would be beneficial to the gifted students within the class (Vanderbrook, 2006). A study from the Texas Association for the Gifted and Talented found that AP could be suitable for some gifted learners but concerns were noted that if the goal to allow all students to enroll, as is the current direction of the AP program, it is likely that these courses could no longer adequately address the needs of gifted learners (Boswell & Collett, 2006).

Impact of Gifted Identification on AP

Because AP is used as a gifted delivery model, the gifted identification process indirectly affects AP enrollment. Georgia law mandates services for gifted students (Georgia Department of Education, 2012), so when resources are limited, schools must make decisions concerning allocation methods. If honors classes are not available in a particular subject area, students may instead be counseled to take the AP course in that subject area. The National Association for Gifted Children (NAGC) describes AP as an alternative that works, noting that gifted students function well in courses where there is advanced rigorous content and activities focused on higher order thinking skills. NAGC notes that an achievement gap exists between white and minority students and between economically disadvantaged and advantaged students. Moreover, NAGC suggests that large numbers of capable students are being overlooked at a point in their educational careers when they could be provided with curriculum that would enhance skill development pursuant to future academic achievement (National Association for Gifted Children, 2008).

Inequity of Gifted Identification

The definition of giftedness as it relates to school identification policy varies in states and school districts across our nation. Traditional methods of identification have relied on standardized test scores, which tend to result in lower numbers of non-traditional students, such

as those of diverse ethnicity and low SES status, being identified as gifted (Briggs, Reis, & Sullivan, 2008; Feng, & Evans, 2007; VanTassel-Baska). Concerns over inequity have led to research seeking to identify alternate methods of identification that would increase AP enrollment numbers of more nontraditional students. The use of a less traditional form of identifying gifted, such as performance-based criteria has been suggested as a means to identify a more nontraditional group of students who are capable of succeeding in gifted courses.

In a investigation of a performance-based identification process in a single state, VanTassel-Baska et al. (2007) found that the use of more nontraditional means of identifying gifted students led to an increase in identification of total numbers of students identified gifted by 7% statewide with an increase of 5% for African Americans and 3% for low income students. However accessing statewide results by district showed that some districts did not see any increase in the nontraditional population but instead reached a larger number of the traditional population of Caucasian high SES status students.

A more far-reaching study, utilizing data from across the nation, examined methods to increase the participation of nontraditional students in gifted programs. This qualitative study sought to determine which elements of gifted programs demonstrated success with involving more culturally, linguistically, and ethnically diverse (CLED) students. Findings included identification of three program elements leading to increased CLED participation in gifted programs. First, participation increased when district faculty and staff were made aware that that CLED students were underrepresented in gifted programs. Secondly, programs that took into consideration the cultural aspects of students that might affect academic performance led to increased CLED participation. Finally, making sure that the gifted teachers and program directors had the support they needed to implement necessary changes also led to increased

CLED participation (Briggs et al., 2008).

In 1994, Georgia state law changes were implemented to increase identification of typically underrepresented groups; however, inequity still remains in the gifted identification process (McBee, 2010). A comprehensive study utilizing data from the Georgia Department of Education included every public school student for the 2004 school year, resulting in a subject pool of 1,780,591 students. This study investigated the impact of race, SES, and transfer status on the probability of being identified gifted in Georgia public schools. Inequity in Georgia public schools was most prevalent for Hispanic and African American students, with Hispanics being less likely than African American students to be identified as gifted. Consideration should be given to the fact that some school climates are more conducive to the identification of nontraditional gifted students than others. In general, students of high SES had the strongest probability of being identified as gifted. High SES students were four times more likely to be identified gifted than were low SES students. While a large sample size was strength for the study, a weakness of the study was lack of accounting for student level achievement or ability variables (McBee, 2010).

Addressing a need for alternate ways to identify gifted students, a qualitative study was undertaken in a Texas school district. Utilizing data from interviews with 12 classroom teachers, and 11 African American parents Michael-Chadwell (2010) created the Chadwell Transformative Model for Gifted Program Reform (CTMGPR), an identification method that focuses on the impact of leaders in changing the culture of gifted identification. Specifically three recommendations were noted to guide identification. The first recommendation was for an adoption of a new definition of giftedness at the federal level, one that would reference nontraditional groups of students and alternate ways to access eligibility. Linking such a

definition to state funding would encourage leaders to make necessary changes. A second recommendation included seven areas of improvement to help in the assessment of processes involving not only identification, but also nomination and placement. The final recommendation focused on building an information system to improve staff development concerning many aspects of the gifted learner including nomination and identification processes, particularly for minorities. The researcher recognized that other rigorous programs also suffer from underrepresentation of minorities, and these programs would also benefit from increased accountability to include a more diverse group of students.

Inequity in AP Enrollment

Lack of diversity has been identified as a problem for the AP program (Barnard-Brak et al., 2011; College Board, 2010; Ford & Whiting; 2009; Schnieder, 2009; Wakelyn, 2009). A myriad of factors affect an individual student's decision to enroll or not enroll in AP courses; some of those reasons cannot be influenced by any program, initiative, or policy enacted by the public school system. Students may not take a class simply because they dislike the subject, their friends will not be in the class, it might not be the cool thing to do, or they do not like the teacher. There are also environmental circumstances that schools cannot completely change including such conditions as SES and lack of cultural support for academic endeavors. Existing research on inequity in AP addresses a variety of possible factors involving enrollment diversity. One such factor tends to be localized data that limits the generalization of findings. The growth of the AP program has given rise to questions about the likelihood of the College Board's ability to be successful in maintaining the quality of a program that is seen as a standard of academic excellence while simultaneously increasing the numbers of more nontraditional students. Schools must ensure that their AP programs are credible by (a) allowing only in-field teachers to

teach AP classes, (b) judging the quality of the program on factors other than exam scores, (c) ensuring teacher, parent, and student expectations of the program are clear, and (d) making responsible decisions about who is allowed to enroll in the courses.

AP is widely recognized as a rigorous curriculum, but not all students are capable of experiencing success in these courses. Some schools have embraced a policy of total open access and have removed all restrictions; some have maintained the use of selective criteria for enrollment; and yet others have required that all students take AP courses (Klopfenstein, 2003). Klopfenstein (2003) suggested that requiring all students to take AP courses would mean that unmotivated, unprepared students would end up in those classes, which would be detrimental to the quality of the course. However, no students should be turned away based on any single criterion, as is the practice in many schools. The AP program has been, in some high schools, the sole option for gifted student course selections (Dixon, 2000). An important concern with gifted identified students being tracked into AP classes is that minorities tend to be underrepresented in gifted programs (Ford & Whiting, 2009; Michael-Chadwell, 2010) and thus are underrepresented in AP programs that focus on serving gifted students. Data supports the idea that blacks in particular are underrepresented in both gifted and AP programs (College Board, 2010; Ford & Whiting, 2007). Other minorities underrepresented in gifted programs include American Indians, Alaska Natives, and Hispanics (College Board, 2010; Yoon & Gentry, 2009). Despite the fact that numerous definitions of giftedness abound in programs across our nation, many of those definitions and identification processes still exhibit a bias that most often excludes minority students (Michael-Chadwell, 2010).

Lacy (2010) highlights the more recent change in College Board enrollment recruitment to a more nontraditional group of students suggesting that the changes in our nation in regard to

increasing democracy in civil rights and educational opportunities have forced institutions to allow greater access to the program. The College Board's official equity statement stands as testament that it does not support the practice of requiring students to meet selective criteria before being allowed to enter the AP program because often these criteria serve as barriers to entry and discourage minorities from enrolling in these classes (College Board, 2010). The College Board has called for all high schools to embrace a policy of open enrollment or open access to their AP courses. This policy suggests that high schools remove restrictive criteria blocking entrance of any student into AP classes (Wakeyln, 2009). However, in spite of the call for open access, the College Board (2010) recognizes that inequity is still an issue. While educators in AP programs across the nation are beginning to enable the more nontraditional student to achieve success, significant inequities continue to exist prohibiting these underserved students from experiencing AP opportunities that serve as the best preparation leading to success in college.

The issue of minority participation and performance in AP courses is an issue of equity in the educational system. Schneider (2009) describes the opposing viewpoints concerning the open access policy as a dilemma between those attempting to achieve equity for all students and those insisting on creating distinction for a small group of selective students. Schools adhering to the College Board open enrollment policy must find ways to identify and encourage enrollment from a more diverse group of students and to provide the support that will improve their chances of achievement on the AP exam.

A connection between the gifted and AP programs in terms of diversity has been documented by researchers. The same issue of underrepresentation of minorities that plagues gifted programs also occurs in AP programs (Ford & Whiting, 2009). With the popularity of AP

courses leading to a phenomenal expansion of the program, Klopfenstein (2004) undertook an analysis of the Texas public high school system to determine the effect of the changes that were created to open the door to a more diverse group of students. Data indicated a continuing unequal access to AP courses, with underrepresented students experiencing an absolute increase but not a relative one. The benefit of state and federal funding led to limited increases (Klopfenstein, 2004).

Barriers to AP program entry leave nontraditional students at a disadvantage. Issues of equity are a concern when students are denied opportunities for appropriate instruction. Darling-Hammond (2004) raised the issue of equity as it applies to students unable to experience quality instruction from well-prepared teachers. Research involving early identification of potentially successful AP students will add to the body of knowledge concerning equity in the classroom. Kyburg et al. (2007) suggested that because AP courses are in many cases the only option for high ability students, educators and researchers should be focused on discovering ways to enable the nontraditional AP student to become successful in AP courses. With restrictive criteria in some school systems, AP has been recognized, by some researchers, as a form of tracking in high schools. In a 2004 paper presented to the Sociological Association, Klugman (2005) highlights the need for research concerning identification of students ready to meet the AP challenge noting that little research has been conducted to address how AP course enrollment opportunities are distributed. Because of the heavy reliance of high schools on the AP program to provide quality instruction for advanced learners, more research should be completed in the area of acceleration programs for high-ability students (Peters & Mann, 2009).

Factors Impacting Inequity

Research has shown that some nontraditional student groups experience greater

educational inequity than others. African Americans as a minority tend to be underrepresented in AP (Archibald, Glutting, & Quian, 2009; Ford & Whiting, 2009; Klopfenstein, 2004) and other categories of advanced learning including IB and gifted (Archibald, et al., 2009; Ford & Whiting, 2009). In recent years, studies have indicated that of all minorities, African Americans tend to be the most underrepresented for enrollment in AP courses (Ford & Whiting, 2009; Taliaferro & DeCuir-Gunby, 2008).

Building level factors have been suspected to impact participation and achievement in AP. Examining data from 339 schools in a midwestern state, Burney (2010) recognized two categories of school level contextual factors: fixed and controllable. Fixed factors are those for which there could be no manipulation, such as school size, poverty level, and ethnicity. Controllable factors are those which schools could manipulate by making a change in their programs or policies, such as social opportunities for students, grouping structures, and curriculum rigor. The study examined both fixed and controllable factors in relation to AP achievement as defined by a score of 3, 4, or 5 on the AP exam. The findings of this study indicated that fixed variables did not limit the AP achievement of students, but controllable factors were found to be influential.

Access to AP courses stands as a significant factor for minorities, with schools whose demographics exhibit high minorities and low SES being unable to provide these courses in which students can enroll (Barnard-Brak et al., 2011; Ford & Whiting, 2009). The number of AP courses offered in a high school relates strongly to high achievement (Adelman, 2006; Burney, 2010). In fact, a rigorous high school curriculum has been found to have greater impact than demographics when related to race, SES, and parent education as a predictive measure of degree acquisition (Adelman, 2006).

The impact of ethnicity, economic status, and educational level of parent on influencing students to take AP classes was investigated using the survey method in eight western high schools. Findings indicated that minorities were underrepresented with 17.5% enrollment in AP but 30% of the total population. Family income had a favorable effect on students enrolling in AP as did level of parental attainment of education (Ndura, Robinson, & Ochs, 2003).

Taliaferro and DeCuir-Gunby's (2008) qualitative study provided information on barriers to AP for African Americans. This case study involved 10 North Carolina schools and resulted in extensive descriptions of African American educators' perspectives of why enrollment was low for African American students. Researchers stated that there were AP class benefits for all students and established the fact that African Americans tended to be more underrepresented than other minorities. In one of their participating schools, African Americans made up 40% of the population and only 8% of those students enrolled in AP or honors classes. Interviews from African American educators acting as advisors yielded comments that focused on the need for schools to be more proactive in enrolling African American students. Advisor participants indicated that advisors did not suggest AP courses for African Americans, not because they didn't think they were capable, but rather because they believed that the students lacked the academic foundation and would be constantly trying to catch up to the academic performance of other students. Also emerging from the interviews was the idea that African American students at the school did not possess the self-efficacy to do well in the courses. Other factors noted as barriers to entry were lack of parent advocacy paralleled with a lack of ability to self-advocate. As a qualitative case study the findings are less generalizable, but much information emerged that could be pursued in later studies.

Hispanics have tended to fare somewhat better than African Americans in the AP equity

gap (Brown & Campbell, 2008; Ford & Whiting, 2009; Hinojosa, Robles-Pina, & Edmonson, 2009; Taliaferro & DeCuir-Gunby; 2008). Within this minority group, females had greater representation than males (Hinojosa et al., 2009). Another minority group that has received even less attention in the research than Hispanics and African Americans is Chicana/Latinas. Studying an urban area in California, Solorzno, & Ornelas (2004) examined the performance of these populations. In the target district, Chicana/Latinas made up 68% of the student population while constituting 45% of the AP enrollment. African Americans in the same district fared worse in terms of their population to enrollment ratio. For the Chicana/Latina population, low-income status seemed to be a prominent factor in determining whether or not students would enroll in AP. Even for those attending schools with strong AP programs, the group was underrepresented. Implications from this investigation of Chicana/Latina underrepresentation included the need for a greater school support system to pursue increased enrollment for this group of students.

McBee (2010) found that inequities continue to occur and many capable students are not being identified as gifted by enrollment policies of gifted programs in Georgia elementary schools. Students from traditionally underrepresented backgrounds include black and Hispanic students (McBee, 2010). In spite of the fact that some schools are dropping AP courses, the AP “juggernaut” (Sadler, 2010, p.3) still continues (Gunther, 2009). Students and parents still perceive AP as a means to get ahead. A student focus group comment summarizes the popular view: "AP represents a better future, a chance to succeed so that our dreams can come true" (Hertberg-Davis & Callahan, 2008, p. 209). Considering the preponderance of evidence suggesting benefits of AP participation and/or performance, denying access to AP courses could have a potentially negative outcome for students who sought to embrace the opportunity to meet the challenge of an AP curriculum but were not allowed to enroll due to school instituted

barriers, particularly for those who decide later in their high school career that they desire to pursue higher education. Scott et al. (2010) suggested, “Success in college following AP experiences should cause schools to redouble their efforts to increase access to Advanced Placement to all students, especially those with historically limited access to both the AP program and higher education” (p. 30).

Preparation for Success

Starting earlier to build the skills necessary to be successful in rigorous high school courses could enable more students to be successful on AP exams. Preparation could begin as early as elementary school (Dougherty & Mellor, 2010; Ford & Whiting, 2009; Taliaferro & DeCuir-Gunby, 2008). Important influences for Hispanic participation in a rigorous curriculum were found to be early intervention for support of academically challenging courses.

Intervention strategies implemented in elementary and middle school have been found to be effective for increasing enrollment in AP courses later in high school; in fact, school support was found to be one of the most important elements impacting Hispanic performance (Hinojosa et al., 2009).

Both the College Board and the NAGC support the appropriate preparation for gifted students leading to academic success in high school AP courses. The College Board has highlighted the importance of early preparation for rigorous high school courses by providing a program designed to begin development of academic skills needed for AP success at an earlier age. The College Board Springboard program is the only official pre-AP program under the College Board trademark and is sold as a packaged program to high schools across the nation. However, this program involves only math and English (College Board, 2013c). NAGC notes AP as a possible appropriate option for gifted students, and the official website for the

association offers information pertaining to the implementation of pre-AP programs in various states (National Association for Gifted Children, 2008). In reference to the exponential growth of the AP program and the relationship to preparation, Litchen (2010) reflects on the AP program expansion suggesting that the greatest advantage of the phenomenon may be the change in focus for appropriate educational stakeholders to the importance of preparation for a rigorous curriculum.

Testing in Gifted Identification and Academic Performance

In the state of Georgia, students identified as gifted must receive educational services to meet their unique learner needs (Georgia Department of Education, 2012). Most identification takes place in elementary grades with the use of CogAT scores as a primary indicator. The prediction of achievement can benefit many stakeholders in the educational system. The relationship of testing to prediction of achievement and the implications for evaluating intelligence through these assessments has been and continues to be one of the most controversial issues in the fields of both psychology and education, even though changes over time have resulted in tests that encompass more of a holistic perspective (Gottfreson and Saklofske, 2009). Also controversial is the process for formally identifying a student as gifted per school policy (Ford & Whiting, 2010; Lohman, Gambrell, & Lakin, 2008; VanTassel Baska, 2006). In the field of education, testing is used for academic placement with achievement tests identifying demonstrable traits and ability tests seeking to discover latent traits (Gottfreson & Saklofske, 2009). The validity of instruments to predict achievement has been criticized for being unfair for minorities due to cultural bias. However, the instruments being used are not seen by all researchers as being the culprit in causing underrepresentation (Ford & Whiting, 2010; Gottfreson & Saklofske, 2009). Gottfreson and Saklofske (2009) suggest that tests are not

the issue; it is how they are being used. The debate seems to have changed from a focus on measurement techniques to the social aims for the testing in light of a diverse society that is striving for democracy. Ford and Whiting (2010) suggest that a more effective method to address the issue is not to debate whether tests are fair but to investigate other factors such as recruitment and retention, in particular, as these factors relate to African American representation in gifted and AP courses.

Cognitive ability has been found to be the largest contributing factor to academic performance; however, trait and style measures can also be significant contributors (Furnham, Monsen, & Ahmetoglu, 2009). Lohman, creator of CogAT 7 (CogAT) supports the idea of multiple criteria for identification of high ability students, especially for the gifted. Due to the more common occurrence of discrepancies in profile scores for CogAT for high and low ability students, rather than average ability students, Lohman suggests that using the composite score could eliminate capable students whose scores are decreased when averaging across batteries (Lohman et al., 2008). CogAT scores were used in a 2010 study by Warnimont, which established a predictive relationship between 3rd grade CogAT scores and 4th and 5th grade state math and reading achievement test scores.

It is not only important to identify students who are currently demonstrating academic excellence, but also those who have the potential to do so in their future academic endeavors. The best method to accomplish this goal is to examine rank within the group based on local norming standards rather than utilizing national norms (Lohman et al., 2008). Lohman et al. (2008) indicated that achievement predictors for black, white, Hispanic and Asian American students are the same across core academics of reading, math, social studies, and science. He further suggested that academic learning is influenced by two important academic aptitudes; a

student's current achievement in a particular domain and a student's reasoning ability within a particular domain. Utilizing an aptitude perspective means that decisions must be made based on strength of particular domains. Examining creativity is good, but it is not the same as achievement.

Summary

AP has expanded in recent years and has been identified as a means to obtain academic advantages, in particular improved college outcomes (Dougherty et al., 2006; Geiser & Santelices, 2004; Mattern et al., 2009; Murphy & Dodd, 2009; Patterson & Ewing, 2013; Sadler & Sonnert, 2010; Tai et al., 2010). With state and federal support for AP as a standard of rigor and a means to prepare for college, more students are enrolling in the courses. Although the enrollment expansion has included more nontraditional students who may not be as prepared as the more traditional students (Winebrenner, 2006), minorities remain underrepresented (College Board, 2010). With the AP program being used as a gifted delivery model, gifted identified students are being channeled into these courses at a greater rate than more nontraditional students even though there is a question about whether or not these courses meet the needs of gifted learners (VanTassel-Baska, 2006). Gifted identification methods at the primary and middle school levels in a rural Georgia school district rely primarily on CogAT scores to determine eligibility in the area of mental abilities. Investigating the relationship between CogAT and AP exam scores may yield information as to which students could be successful in AP courses. This information could aid in the determination of middle school curriculum decisions that have the potential to impact high school achievement and ultimately college success.

CHAPTER THREE: METHODS

The purpose of this correlational study was to determine if a relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores. With the current emphasis on college readiness and the creation of a more competitive transcript, a greater number of nontraditional students are seeking to enroll in AP courses (College Board, 2010). AP courses have been purported to provide an advantage in college admissions and college performance (Atkinson & Geiser, 2009; Breland et al., 2002; Dougherty et al., 2006; Geiser & Santelices, 2004; Mattern et al., 2009; Murphy & Dodd, 2009; Patterson & Ewing, 2013; Sadler & Sonnert, 2010; Tai et al., 2010). Nontraditional students have been underrepresented in AP courses due to a number of barriers including school based criteria and identification processes that favor gifted identified students (Whiting & Ford, 2009), although the AP curriculum has not been proven to be an appropriate delivery model for the needs of gifted learners (Herberg-Davis & Callahan, 2008; VanTassel-Baska, 2006). Often nontraditional students have been noted to be unprepared for the rigorous curriculum, and thus better preparation is needed (Winnebrennar, 2006). Earlier identification of students, who could be potentially successful in AP courses, would enable those students to pursue a curriculum that would better prepare them for the demands of rigorous courses (Ford & Whiting, 2009; Taliaferro & DeCuir-Gunby, 2008). Determining if there is a relationship between the middle school reasoning abilities test, CogAT, which is used nationwide by many schools for the purpose of identifying gifted students, and high school AP exam scores would provide parents, teachers, and counselors with better information in making curriculum decisions. This chapter describes design of the study, instruments used for data collection, methods of data collection, and statistical measures used to analyze the data.

Research Design

The research design for this study is a quantitative correlational design. A review of the literature concerning the AP program revealed the lack of research on how to predict student success on AP exams. Since students in the study district were required to take the CogAT in 6th grade, these scores became a variable of interest. Considering the variables and the relationship of interest for the current study, a correlational design is a good fit. To determine predictive value of a variable, a relationship must first be established. Correlational research is used to determine if one variable is related to another, whether positive or negative; it is not intended to evaluate a causal relationship but instead to evaluate the direction and strength of a relationship between variables. In a correlational design, two or more variables are related for the same group of subjects; variables are naturally occurring and are not manipulated by the researcher (Ary, Jacobs, Razavieh, & Sorensen, 2006).

In a correlational design, statistical calculations produce a value, the correlation coefficient, which reflects the relationship between variables. A correlation coefficient ranges from -1 to 1 indicating the strength of the relationship. As coefficients move closer to the end of the ranges in direction, 1 or -1, the relationship is stronger. Variables that move in the same direction indicate a positive relationship, while variable movement in an opposite direction indicates a negative relationship (Salkind, 2008). When conducting correlational research, a large sample size is not required; however, sample size should be considered when interpreting results (Ary et al., 2006).

This study sought to determine if a relationship existed between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores.

Research Questions

Exam scores of 6th grade students taking CogAT in the years from 2004 to 2006 and then taking AP exams in either AP Calculus or AP English Literature their senior year were analyzed.

The following eight research questions guided the study:

RQ1: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores?

RQ2: Is there a correlation between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores?

RQ3: Is there a correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP English Literature exam pass-fail scores?

RQ4: Is there a correlation between increases in 6th grade CogAT verbal battery scores and increases in 12th grade AP English Literature exam pass-fail scores?

RQ5: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores?

RQ6: Is there a correlation between 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores?

RQ7: Is there a correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP Calculus exam pass-fail scores?

RQ8: Is there a correlation between increases in 6th grade CogAT quantitative battery scores and increases in 12th grade AP Calculus exam pass-fail scores?

Null Hypotheses

H_{01} : There is no significant correlation between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores.

H₀₂: There is no significant correlation between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores.

H₀₃: There is no significant correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP English Literature exam pass-fail scores.

H₀₄: There is no significant correlation between increases in 6th grade CogAT verbal battery scores and increases in 12th grade AP English Literature exam pass-fail scores.

H₀₅: There is no significant correlation between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores.

H₀₆: There is no significant correlation between 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores.

H₀₇: There is no significant correlation between increases in 6th grade CogAT composite scores and increases in 12th grade AP Calculus exam pass-fail scores.

H₀₈: There is no significant correlation between increases in 6th grade CogAT quantitative battery scores and increases in 12th grade AP Calculus exam pass-fail scores.

Participants

The study utilizes exam scores from 185 subjects who attended a rural school district in northeast Georgia from the years 2004 through 2013 and took the 6th grade CogAT and either the 12th grade AP English Literature exam or the 12th grade AP Calculus exam. This population constituted a convenience sample since exam scores were easily assessable to the researcher. The original population of AP test takers was 218; however, 33 scores were omitted because they did not have the corresponding 6th grade CogAT score needed for the study. Of the total subjects with both test scores, 80 took the 12th grade AP English Literature exam and 105 took the 12th grade AP Calculus exam. Ethnicity for participants in the study included 154 (83%)

white, 14 (8%) Hispanic, 12 (6%) Asian, 4 (2%) multiracial, and 1 (1%) black. Of the 185 participants, 80 (43%) were female and 105 (57%) were male. Scores were divided into two groups for the purpose of investigating the research questions: 12th grade AP English Literature exam scores with corresponding 6th grade CogAT scores and 12th grade AP Calculus exam scores with corresponding 6th grade CogAT scores.

Setting

The study took place at a rural high school in northeast Georgia. Enrollment information for the 2013 fiscal year included a total population of approximately 1919 students in grades 9 through 12. Ethnic makeup included the following: 69% white, 23% Hispanic, 3% Asian, 3% black, and 2% multiracial. Gender makeup included 48% female students and 52% male students (Georgia Department of Education, 2013). The school was chosen as the study site because the researcher had access to archived data needed for the study.

The AP program at this school grew slowly since its inception, beginning with the first course introduced in the late 1980s. Additional classes were added only gradually since there was little student demand for these rigorous courses until recently. To meet increasing student demand and interest in the previous six years, several new AP courses have been included in the high school's course offerings. In the past eight years, it has also become more common for AP teachers to teach multiple sections of their subject area classes. Nine AP courses are currently offered at this high school. Those classes include the following AP level courses: Biology, Chemistry, U.S. History, English Literature, American Language, Spanish, Art, Government, and Calculus.

In the current study setting, all AP teachers are required to either have a certificate with gifted endorsement or to have completed a 10-hour course on the characteristics of the gifted

learner. Either of these options allows the school to earn state funding for serving gifted students within the AP program. In this district, AP courses are utilized as a gifted delivery model. In the gifted handbook for the school district in this study, AP is listed under the Gifted High School Program as one of two delivery models available to students in grades 9 through 12. For subjects that do not offer an honors level course, it is the only option available. Fees for AP exams at the high school in the study may be subsidized based on state funding as is decided annually by the Georgia General Assembly.

The district policy for the high school in the current study specifically indicates that enrollment space in advanced classes designated as Honors will be reserved for gifted identified students. However, in some subjects there are no Honors level offerings, and by default the AP course becomes the delivery model to meet the needs of gifted learners. Students not officially identified as gifted who fill out an application and meet eligibility requirements will be enrolled in the courses, as space is available. The gifted coordinator for the county has indicated that, to her knowledge, this situation has never occurred; however, it is policy as stated in Honors applications (M. Cantrell, personal communication, July 7, 2013).

The gifted identification policy for this school district adheres to the state of Georgia requirements. Georgia provides two methods to meet eligibility requirements for gifted identification. Students may qualify by (a) achieving the standards for mental abilities and achievement criteria or (b) meeting the requirements under the multiple criteria rule. Under this rule, students must meet eligibility requirements in three of the following four areas: mental abilities, achievement, creativity, and, motivation (Georgia Department of Education, 2012). For the school district in this study, the CogAT is used to aid in the identification of gifted students for the mental abilities criteria (M. Cantrell, personal communication, January 20, 2013).

Instrumentation

Data generated from the instruments in this study were archived at the high school, middle schools, and county office as student academic records. Both instruments are widely recognized forms of assessment.

Cognitive Abilities Test

The instrument used as the first variable of interest was the Cognitive Abilities Test (CogAT). The CogAT is a nationally normed K-12 assessment instrument designed to measure a student's learned reasoning abilities. The test consists of three batteries including verbal, quantitative, and nonverbal along with a composite score, which is a combination of all three. CogAT is often used in the identification of gifted and talented students. Results of the exam are reported as a continuous score (Lohman et al., 2008). The validity of the CogAT is established through standardized national norming. The joint standardization with the Iowa Test of Basic Skills indicates that the predictive validity of the quantitative test batteries equal or exceed those of the figural tests. However, the composite predictive abilities are evidenced to be better than for either test battery alone (Lohman & Gambrell, 2012). Although nationally normed, Lohman and Gambrell suggested the use of local norms for improved identification of gifted and talented students (Lohman & Gambrell, 2012).

The CogAT research handbook provides information that the high reliability of CogAT was indicated by the use of the Kuder-Richardson Formula 20 to determine internal consistency reliability for CogAT with reliabilities of .95 for verbal, .95 for nonverbal, and .94 for quantitative. Long-term stability of the CogAT composite score had a reliability correlation coefficient ranging from $r = .82$ to $r = .87$ (as cited in Warnimont, 2010).

A concurrent validity study for CogAT and the Woodcock-Johnson III (WJ-III) was

conducted with general findings that “interbattery confirmatory factor analyses showed that the general factors on the two batteries correlated $r = .82$ ” (Lohman, 2003, p. 1) and additional data indicating that:

The CogAT Composite score correlated $r = .79$ with WISC Full Scale IQ. Latent g factors on the two tests were perfectly correlated. This concurs with an earlier study in which CogAT was found to correlate approximately $r = .77$ with IQ on the Stanford-Binet Intelligence Scale. (Lohman, 2003, p. 12)

Research by Lakin (2012) has substantiated the validity of using CogAT to predict future academic achievement across subgroups of English language learners, white, and Hispanic.

Advanced Placement Exams

The instrument for the second variable of study was the College Board AP exams for 12th grade AP English Literature and 12th grade AP Calculus. Scores from these exams are reported to parents, teachers, and students on a scale of 1–5. Committees of college and AP high school teachers have developed these assessments that are administered at specified times per subject each May. The purpose of these exams is to test a student’s ability to perform at a college level. Reliability and validity for all AP exams have been established through a rigorous College Board validation process, which includes a focus on standards for score validity and reliability. Each summer high school teachers and college faculty members meet to grade AP exams at AP readings across the nation (College Board, 2012). The assessment by readers yields a raw score that is then translated into a scale of 1 to 5 for reporting to all appropriate stakeholders. The College Board (2013d) uses the following scale: 1 indicates “no recommendation,” 2 indicates “possibly qualified,” 3 indicates “qualified,” 4 indicates “well-qualified,” 5 indicates “extremely well-qualified.” Success on an AP exam is considered as a

score of 3, 4, or 5 since most colleges accept these scores for awarding college credit hours (Atkinson & Geiser, 2009; Chajewski, et al., 2011; College Board 2011b).

ETS addressed the complexity of determining the reliability of AP exams. AP exams consist of both multiple-choice and free-response questions, thus posing a situation that allows for a greater demonstration of student knowledge but more difficult assessment in terms of reliability. Bridgeman, Morgan, and Wang (1996) examined steps used by the AP program to ensure reliability. Reliability of composite scores and multiple-choice sections was high being noted at approximately .82, although the reliability of free-response showed variability from .49 to .88 depending on subject. Math, science, and foreign language free response scores were more reliable than humanities and social sciences. Bridgeman et al., (1996) noted the following steps in the process: “Typically, Kuder-Richarson formula 20 (with the Dressel adaption for formula scores) is employed as a lower-bound estimate of the reliability of a multiple-choice section” (Bridgeman et al., 1996, p. 3). For the free response reliability estimate, allowance for different raters and topics were made. “Coefficient alpha is employed as the lower-bound reliability estimate that simultaneously includes both topic differences and rater differences as inseparable sources of error” (Bridgeman et al., 1996, pp. 3–4). The composite scores were examined by using reliability estimates of components. “Specifically, the error variance for each part score is multiplied by its weight (squared), the sum of these weighted variances is divided by the total composite score variance, and this product is subtracted from 1” (Bridgeman et al., 1996, p. 5). To determine the accuracy of the 1 to 5 grading scale, the composite score reliability was utilized.

An algorithm originally devised by Livingston and Lewis (1991) and subsequently revised RECCLAS-COMP Version 4, is applied to examine the reliability of

classification of AP composite scores into the five-point grade scale and to describe the accuracy of the reported grade. (Bridgeman, Morgan, & Wang, 1996, p. 6)

The percent of students who were appropriately classified into the 1–5 grading scale was estimated as ranging from 63% to 83%, showing pronounced variability. However, the correct identification of test takers scoring 3 and above or 2 and below was high at 87% to 93%. Suggestions made by the authors to increase reliability included increased training for exam readers and increased numbers of tasks on the exam.

Reschetar and Melican (2010) addressed the reliability and validity of AP exams as mixed-format large-scale assessments. The authors pointed to College Board studies focusing on academic success in college and improved graduation rates as evidence of AP exam validity. According to the authors, estimates of classification accuracy equaled approximately .90. Rigorous training of readers and procedures in place at the summer readings promote reliability. Backreading, the process of randomly having a second reader grade an exam to compare scores, is used to promote rater reliability (Reschetar & Melican, 2010).

The developments of AP exams include rigorous College Board procedures. Exam questions are written by college faculty teaching the designated subject area. Meeting statistical criteria assesses difficulty level of questions, and reuse of a certain number of items year to year ensures reliability. Free-response questions are created by a development committee and may go through up to a two year process of revisions by committee members. Free-response questions are only used once. Exams in their entirety are required to have an internal consistency reflective of the exam's ability to accurately assess student preparation in the subject (College Board, 2012).

Studies focusing on validity of the AP exam such as Mattern et al. (2009) specifically

examined the relationship between student achievement on AP exams and future college success for four courses: Biology, Calculus AB, English Language, and U.S. History. Separate paired contrasts and ANCOVAs were utilized for each AP exam. Paired contrasts indicated that a statistically significant relationship for AP test takers ($p < .01$) existed for each of the following categories: higher first year GPAs, attendance at more selective institutions, and likelihood of returning for a second year of college as compared to students having no AP experience or those scoring a 1 or 2 on AP exams. Further analyses through ANCOVAs were conducted to control for prior academic achievement in regard to high school GPA and SAT scores. All paired contrasts did remain statistically significant, although effect sizes were found to decrease in magnitude with effect sizes ranging from small, .2, for first year GPA to moderate, .5, for institution retention and for institutional selectivity (Mattern et al., 2009).

Mattern et al. (2009) also examined the relationship of participation in AP courses to future enrollment in a 4-year postsecondary institution using a logistic model and controlling for high school and student characteristics. This study yielded data concluding that with the completion of a single AP exam there was an increase of 171% for attendance at a 4-year postsecondary institution.

Procedures

Permission to conduct the study was procured from the director of secondary schools (see Appendix A). The school district gifted coordinator was contacted and requested to aid in the data collection process since exam scores would include information that would allow the student to be identified. The coordinator agreed to collect all data and remove any references to the identity of the student (see Appendix B). Prior to collection of data, the researcher submitted necessary forms to the Institutional Review Board (IRB) and received IRB approval (see

Appendix C). Once permission was granted, data collection began. The researcher contacted the counselor at the high school selected for the study to obtain a roster of all students who enrolled in 12th grade AP English Literature and 12th grade AP Calculus in the school years 2009 through 2012. Identifying characteristics were removed from the data before the researcher received the list. These student numbers were entered into an Excel program for data organization purposes. Next, the researcher contacted the school's gifted coordinator, who also has oversight over all AP courses, to obtain AP exam scores. These scores were then added to the Excel spreadsheet. The researcher then determined which middle school each student attended and contacted the appropriate counselors to obtain 6th grade CogAT composite and individual battery scores for appropriate students having taken the exam in 2004–2006. Identifying characteristics were removed from the data before the researcher received the scores. This information was also added to the Excel spreadsheet for data storage purposes.

The R program was used for statistical testing since it is a free and open source statistical computing environment with enhanced functionality that allows for flexibility and customization. Using R for each dataset and research question, visualizations were constructed and numeric summaries computed. Appropriate statistical testing and modeling were applied to assess correlational and predictive relationships, respectively.

Data Analysis

Two variables of interest were studied, 6th grade CogAT scores and 12th grade AP English Literature and AP Calculus exam scores. The data analyzed consisted of tests scores from both assessments that were obtained from archived files in the study district. Descriptive statistics were calculated for AP exams and included gender, ethnicity, exam frequency by year taken, and score distributions for all five categories. Descriptions for both CogAT composite,

verbal, and quantitative scores include mean score, median score, range, and standard deviation.

Raw scores generated at the AP reading are unavailable to parents, students, or teachers. The AP continuous score is converted into a categorical score ranging from 1 to 5. The 1–5 categorical AP scores were dichotomized into pass and fail groups with scores of 1 and 2 constituting the fail group and 3 through 5 comprising the pass group. Scores of 3, 4, and 5 were designated as the pass group since these are the scores that most colleges and universities accept for the purpose of awarding college credit hours. CogAT scores are continuous scores.

Since one variable was dichotomous and one continuous, a special type of Pearson correlation test, a point biserial correlation, was utilized (Salkind, 2008). A Pearson correlation coefficient was computed to assess the relationship between CogAT and AP exams. There are two underlying assumptions for the Pearson Correlation. First, variables are bivariately normally distributed and a linear relationship exists. Next, the case represents a random sample of the population and the variable scores are independent of each other (Green & Salkind, 2008). Random sampling was not needed since all subjects in the population were used. Variable scores were independent of each other.

If a relationship was found, the study also sought to explore the predictive merit of 6th grade CogAT scores for AP success through the use of logistic regression. Logistic regression testing is a statistical tool used to determine the dependence of one variable on another. The regression yields data to determine strength of the relationship between variables (Ary et al., 2006). The test is used as a means to predict a score on one variable from a score on the other, and the predictor variables can be continuous or dichotomous (Tabachnick & Fidell, 2007). This test was an appropriate analysis for the current study because data includes one variable that is continuous and one variable that is dichotomous (Ary et al., 2006; Starne, Yates, & Moore,

2010). Once a relationship is found, a logistic regression can be conducted. No assumptions for normality, linear relationship, or reliability of equal value are required for the regression (Tabachnick & Fidell, 2007).

The first and second research questions addressed the existence of a correlation between 6th grade CogAT composite and verbal battery scores and 12th grade AP English Literature exam pass fail scores. Assumptions were met and a Pearson correlation was computed. Pearson scores range between -1 and +1 to show a relationship (Ary et al., 2006). Thus the Pearson value is analyzed as the distance of r from 0 with 0 being no correlation. The alpha level used was .05.

The third and fourth research questions addressed the existence of a correlation for an increase of 6th grade CogAT composite and verbal battery scores and an increase in 12th grade AP English Literature exam pass-fail scores. A logistic regression was used as a means to determine predictive value. Logistic regression has no assumptions about the distribution of the predictor variables (Tabachnick & Fidell, 2007). The alpha level used was .05.

The fifth and sixth research questions addressed the existence of a correlation between 6th grade CogAT composite and quantitative battery scores and 12th grade AP Calculus exam pass-fail scores. Assumptions were met and a Pearson correlation was computed. The alpha level used was .05.

The seventh and eighth research questions addressed the existence of a correlation of an increase in 6th grade CogAT composite and quantitative battery scores and an increase in 12th grade AP Calculus exam pass-fail scores. A logistic regression was used as a means to determine predictive value. The alpha level used was .05.

CHAPTER FOUR: RESULTS

The purpose of this correlational study was to determine if a relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores. Further, the study was designed to determine that if a relationship did exist, would that relationship constitute a predictive one for both composite and individual batteries. In this chapter, descriptive statistics, assumption testing, and results for each null hypothesis are presented for the 12th grade AP English Literature group and the 12th grade AP Calculus group. The chapter concludes with a summary of the study findings.

Descriptive Statistics for the AP English Literature Group

Exploring the data set of 97 total 12th grade AP English Literature test takers from 2010 through 2013, 17 students were excluded because they did not have corresponding 6th grade CogAT scores. The total population of 12th grade AP English Literature test takers who had also taken the 6th grade CogAT was 80. Of the 80 subjects, 48 (60%) were female and 32 (40%) were male. Ethnicity was predominately white (see Table 1).

Table 1

Ethnicity of AP English Literature Test Takers

Ethnicity	<i>n</i>	<i>n%</i>
White	70	87.50
Asian	3	3.75
Hispanic	6	7.50
Multiracial	1	1.25
	80	100.00

The relationship between CogAT and AP English Literature exams was examined for students with successful AP exam scores, as defined by obtaining a score of 3, 4, or 5. These scores were considered as successful because most colleges award college credit for scores of 3

or above. For the 80 AP English Literature subjects over the 4-year period, 43 (53%) achieved a successful score on the AP exam and were included in the pass group while 37 (47%) were considered unqualified and categorized in the fail group (see Table 2).

Table 2

Score Distribution for AP English Literature Test Takers

AP Score	<i>n</i>	<i>n%</i>
1	3	3.75
2	34	42.50
3	31	38.75
4	11	13.75
5	1	1.25
	80	100.00

CogAT scores were expressed as a universal scaled score (USS). The USS is a number that describes a student's location on an ability continuum. The CogAT includes an individual verbal battery score, a quantitative battery score, and a nonverbal battery score in addition to a composite score that is a combination of the three. CogAT scores are reported to students, teachers, and parents as a continuous score. Descriptive statistics for 6th grade CogAT composite and verbal scores were computed (see Table 3).

Table 3

Descriptive Statistics for CogAT Scores for the AP English Literature Group

Test Battery	Range	<i>M</i>	Median	<i>SD</i>
Verbal	187–252	214	212	12.99
Composite	186–242	211	211	12.03

Assumption Testing for the AP English Literature Group

Null Hypotheses One and Three

A special type of Pearson correlation, a point biserial correlation, and a logistics regression were used in the study. Assumptions of normal distribution, linear relationship, and independent variable scores were met (Salkind, 2008). The two variables used in this study were AP exam scores, reported as categorical, and CogAT scores, reported as continuous. AP scores were dichotomized into pass-fail groups. For this data set of 6th grade CogAT composite scores by 12th grade AP English Literature exam scores shows no departure from normality (see Figure 1).

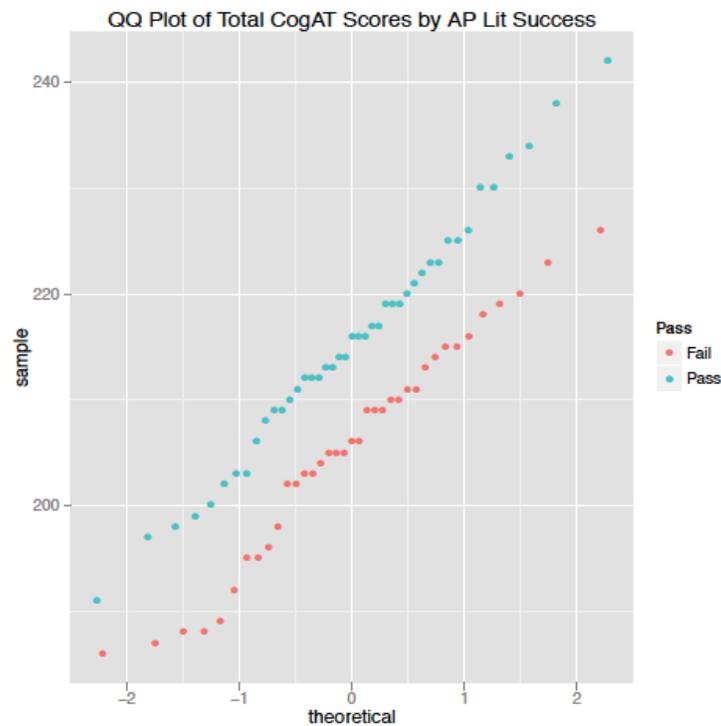


Figure 1. Assumption of normality for CogAT composite scores by AP English Literature exam success.

Visualization of CogAT and AP exam scores by boxplots (see Figure 2) shows that while there is overlap between the two groups, the median is higher in the pass group ($n = 43$) than in

the fail group ($n = 37$). There are no outliers and the distributions are symmetrical and similar in shape.

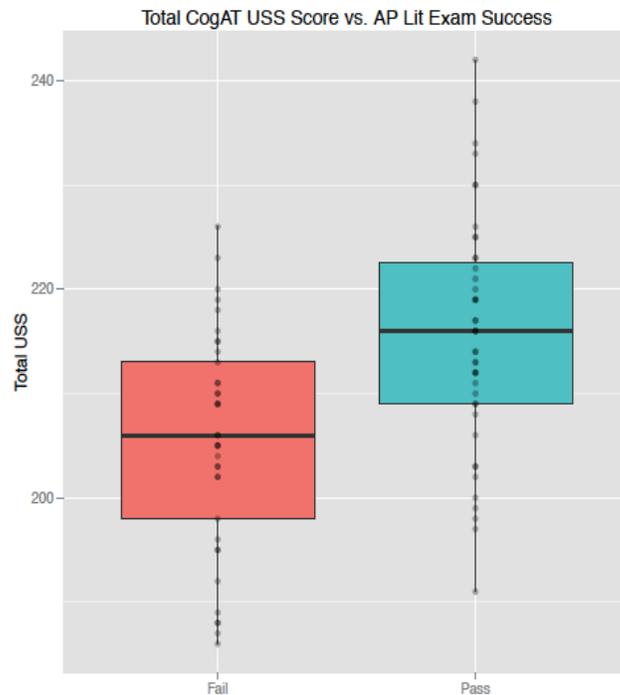


Figure 2. Boxplot visualization for CogAT composite scores and AP English Literature exam success.

Null Hypotheses Two and Four

A special type of Pearson correlation, a point biserial correlation, and a logistics regression were used in the study. Assumptions of linear relationship, and independent variable scores were met. The two variables used in this study were AP exam scores, reported as categorical, and CogAT scores, reported as continuous. AP scores were dichotomized into pass-fail groups. For this data set of 6th grade CogAT verbal battery by 12th grade AP English Literature exam scores shows some departure from normality (see Figure 3).

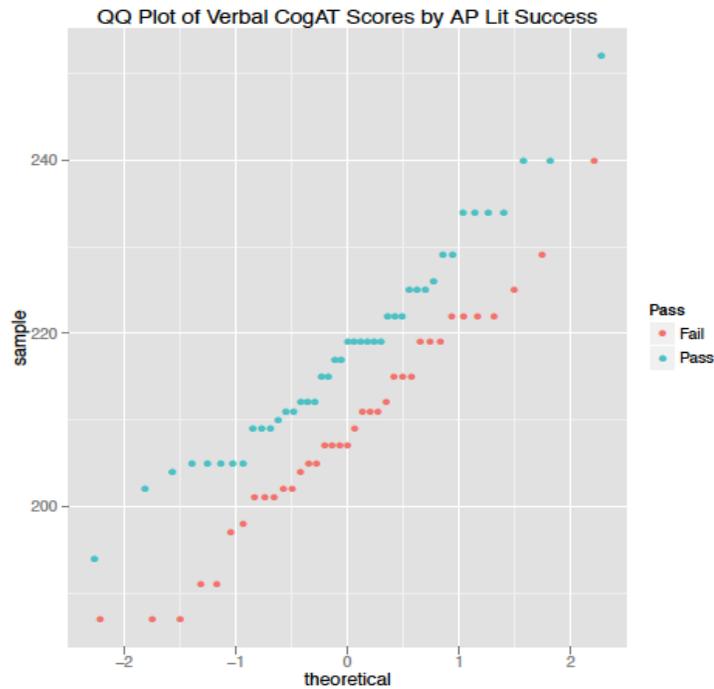


Figure 3. Assumption of normality for CogAT verbal battery scores by AP English Literature exam success.

Visualization of CogAT and AP exam scores by boxplots (see Figure 4) shows that while there is overlap between the two groups, the median is higher in the pass group ($n = 43$) than the fail group ($n = 37$). There are no outliers and the distribution for the fail group is left skewed while the pass group is right skewed. A left skew for the fail group indicates that the distribution was not symmetrical showing higher numbers of those failing above the median CogAT verbal battery score. The pass group demonstrates a right skew indicating a greater number of those passing below the median line.

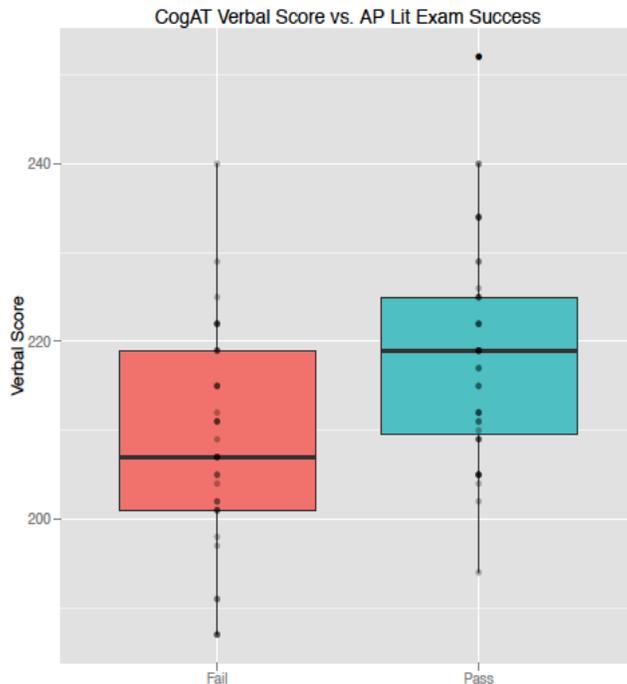


Figure 4. Boxplot visualization of CogAT verbal battery scores and AP English Literature exam success.

Results for the AP English Literature Group

Null Hypothesis One

A point biserial correlation, a special type of Pearson correlation, was used to analyze Null Hypothesis One, which sought to determine if a relationship existed between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores. A point biserial correlation is used when one variable is continuous and one variable is dichotomous. The Pearson correlation coefficient (r) and associated p value were computed resulting in $r = .42$ and $p < .001$. According to Ary et al. (2006), an effect size of $r = .42$ falls in the medium ($r = .30$) to large ($r = .50$) effect size range. The p value shows that this relationship is significant at the 5% significance level. The null hypothesis is rejected.

Null Hypothesis Two

A point biserial correlation, a special type of Pearson correlation, was used to analyze Null Hypothesis Two, which sought to determine if a relationship existed between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores. A point biserial correlation is used when one variable is continuous and one variable is dichotomous. The Pearson correlation coefficient (r) and associated p value were computed resulting in $r = .37$ and $p < .001$. According to Ary et al. (2006), an effect size of $r = .37$ falls in the medium ($r = .30$) to large ($r = .50$) effect size range. The p value shows that this relationship is significant at the 5% significance level. The null hypothesis is rejected.

Null Hypothesis Three

A logistic regression was used to analyze Null Hypothesis Three which sought to determine if there was a logistic relationship between the 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores; this statistical test is an appropriate test for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT composite scores. The p values indicate that the slope and intercept for the logistic relationship between CogAT and AP exams are statistically different from zero (see Table 4). An alpha of .05 was used.

Table 4

Statistical Data for CogAT Composite and AP English Literature: Coefficients

	Estimate	Std Error	z value	p value
Intercept	-17.80	5.25	-3.39	$p < 0.001$
CogAT composite.	0.09	0.03	3.42	$p < 0.001$

A predictive relationship was found between the 6th grade CogAT composite scores and

12 grade AP English Literature AP exam pass-fail scores. When a logistic regression is calculated, the regression coefficient is the estimated increase in the odds that the outcome per unit will increase. In this study, the data used for the logistic regression, CogAT scores, are a quantitative predictor rather than a categorical predictor. AP scores are categorical. At the alpha .05 level of significance, findings show that the 6th grade CogAT composite score is a significant predictor of the 12th grade AP English Literature exam score. For one unit increase in total CogAT composite score, the odds ratio for moving from fail to pass is multiplied by a factor of 1.08 (see Table 5). Thus, there is an 8.90% greater chance of passing the 12th grade AP English Literature exam for each point gained on the CogAT composite score. The null hypothesis is rejected.

Table 5

Statistical Data for Composite CogAT and AP English Literature: Odds Ratio

	Odds Ratio	2.5%	97.5%
Intercept	1.8601e-08	6.281e-13	0.00055084
CogAT Composite.	1.0890e+00	1.037e+00	1.14362163

Null Hypothesis Four

A logistic regression was used to analyze Null Hypothesis Four which sought to determine if there was a logistic relationship between the 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail score; this statistical test is an appropriate test for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT verbal battery scores (Tabachnick & Fidell, 2007). The p values indicate that the slope and intercept for the logistic relationship between CogAT and AP exams are statistically different from zero (see Table 6). An alpha of .05 was used.

Table 6

Statistical Data for CogAT Verbal and AP English Literature: Coefficients

	Estimate	Std Error	z value	p value
Intercept	-14.41	4.72	-3.06	.002
CogAT Verbal	0.07	0.02	3.09	.002

A predictive relationship was found between the 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores. When a logistic regression is calculated, the regression coefficient is the estimated increase in the odds that the outcome per unit will increase. In this study, the data used for the logistic regression, CogAT scores, are a quantitative predictor rather than a categorical predictor. AP scores are categorical. At the alpha .05 level of significance, findings show that the 6th grade CogAT verbal score is a significant predictor of the 12th grade AP English Literature exam score. For one unit increase in total CogAT verbal score, the odds ratio for moving from fail to pass is multiplied by a factor of 1.07 (see Table 7). Thus, there is a 7.06% greater chance of passing the 12th grade AP English Literature exam for each point gained on the CogAT verbal battery score. The null hypothesis is rejected.

Table 7

Statistical Data for CogAT Verbal and AP English Literature: Odds Ratio

	Odds Ratio	2.5%	97.5%
Intercept	5.5058e-07	5.3363e-11	0.0056870
CogAT Verbal	1.0706e+00	1.0252e+00	1.1180122

Descriptive Statistics for the AP Calculus Group

Exploring the data set of 121 total 12th grade AP Calculus test takers from 2010 through 2013, 16 students were excluded because they did not have corresponding 6th grade CogAT

score. The total population of 12th grade AP Calculus test takers who had also taken the 6th grade CogAT was 105. Of the 105 subjects, 57 (54%) were female and 48 (46%) were male. Ethnicity was predominately white (see Table 8).

Table 8

Ethnicity of AP Calculus Test Takers

Ethnicity	<i>n</i>	<i>n%</i>
White	84	80.00
Asian	9	8.57
Hispanic	8	7.62
Multiracial	3	2.86
Black	1	0.95
	80	100.00

The relationship between CogAT and AP Calculus exams was examined for students with successful AP exam scores, as defined by obtaining a score of 3, 4, or 5. These scores were considered as successful because most colleges give course credit for scores of 3 or above. For the 105 AP Calculus subjects over the 4-year period, 78 (74%) achieved a successful score on the AP exam and were included in the pass group while 27 (26%) were considered unqualified and categorized into the fail group (see Table 9).

Table 9

Score Distribution for AP Calculus Test Takers

AP Score	<i>n</i>	<i>n%</i>
1	18	17.14
2	9	8.57
3	22	20.95
4	22	20.95
5	34	32.38
	105	100.00

CogAT scores being examined are expressed as a universal scaled score (USS). This

USS score is a number that describes a student's location on an ability continuum. The CogAT includes an individual verbal battery score, quantitative battery score, and nonverbal battery score in addition to a composite score that is a combination of the three. CogAT scores are reported to students, parents, and teachers as a continuous score. Descriptive statistics for 6th grade CogAT composite and quantitative battery scores (see Table 10) were computed.

Table 10

Descriptive Statistics for CogAT Score for the AP Calculus Group

Test Battery	Range	<i>M</i>	Median	<i>SD</i>
Quantitative	105–273	215	213	19.21
Composite	187–242	215	216	12.86

Assumption Testing for the AP Calculus Group

Null Hypotheses Five and Seven

A special type of Pearson correlation, a point biserial correlation, and a logistics regression were used in the study. Assumptions of linear relationship and independent variable scores were met (Salkind, 2008). The two variables used in this study were AP exam scores, reported as categorical, and CogAT scores, reported as continuous. AP scores were dichotomized into pass-fail groups. For this data set of 6th grade CogAT composite scores by 12th grade AP Calculus shows a large departure from normality (see Figure 5).

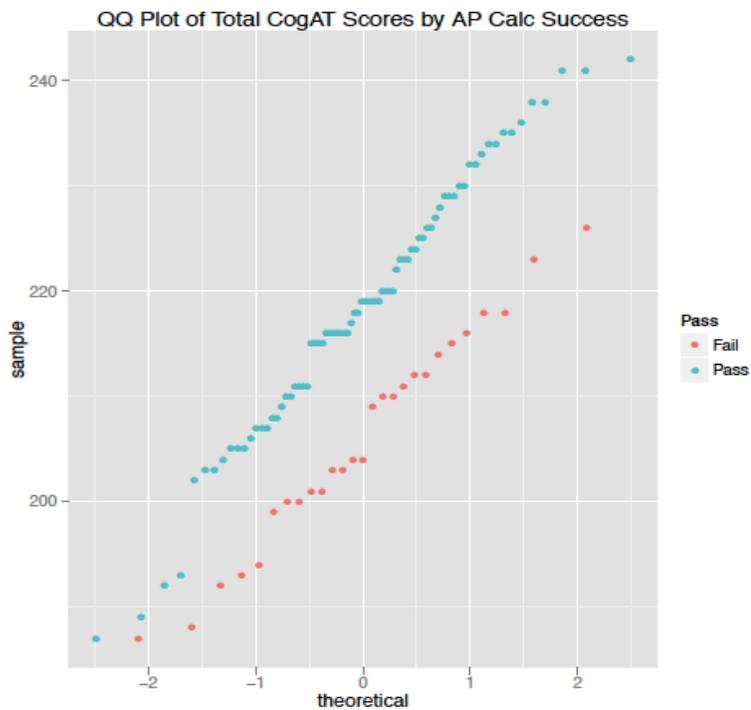


Figure 5. Assumption of normality for CogAT composite scores by AP Calculus exam success.

Visualization of CogAT and AP exam scores by boxplots (see Figure 6) shows that while there is overlap between the two groups, the median is higher in the pass group ($n = 78$) than the fail group ($n = 28$). There are no outliers and the distribution is symmetrical for the pass group and left skewed for the fail group. A left skew for the fail group indicates that the distribution was not symmetrical showing higher numbers of those failing above the median CogAT composite score.

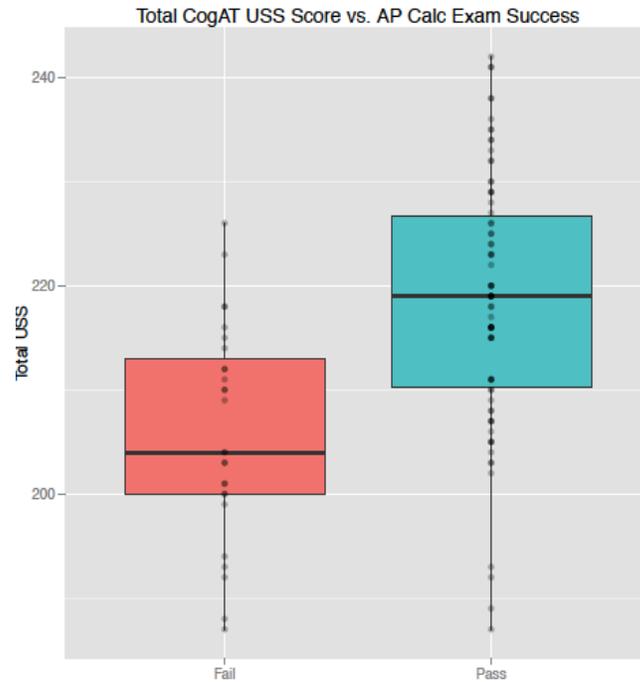


Figure 6. Boxplot visualization for CogAT composite scores and AP Calculus exam success.

Null Hypotheses Six and Eight

A special type of Pearson correlation, a point biserial correlation, and a logistics regression were used in the study. Assumptions of linear relationship and independent variable scores were met (Salkind, 2008). The two variables used in this study were AP exam scores, reported as categorical, and CogAT scores, reported as continuous. AP scores were dichotomized into pass-fail groups. For this data set of 6th grade CogAT quantitative scores by 12th grade AP Calculus exam scores shows a large departure from normality (see Figure 7).

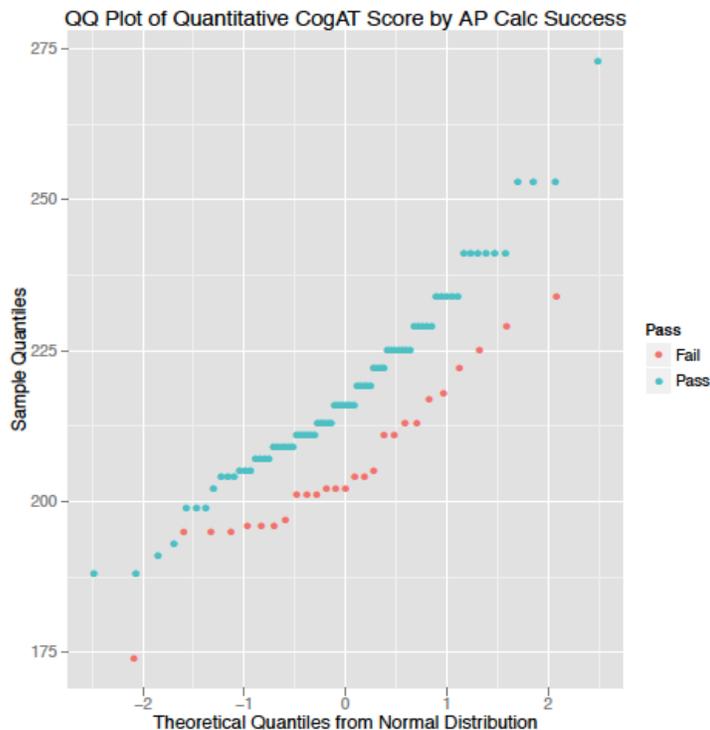


Figure 7. Assumption of normality for CogAT quantitative battery scores by AP Calculus exam success.

Visualization of CogAT and AP exam scores by boxplots (see Figure 8) shows that while there is overlap between the two groups, the median is higher in the pass group ($n = 78$) than the fail group ($n = 28$). There is one outlier for the pass group. The distributions for both groups are slightly left skewed showing higher numbers of those failing above the median 6th grade CogAT quantitative battery scores (see Figure 8).

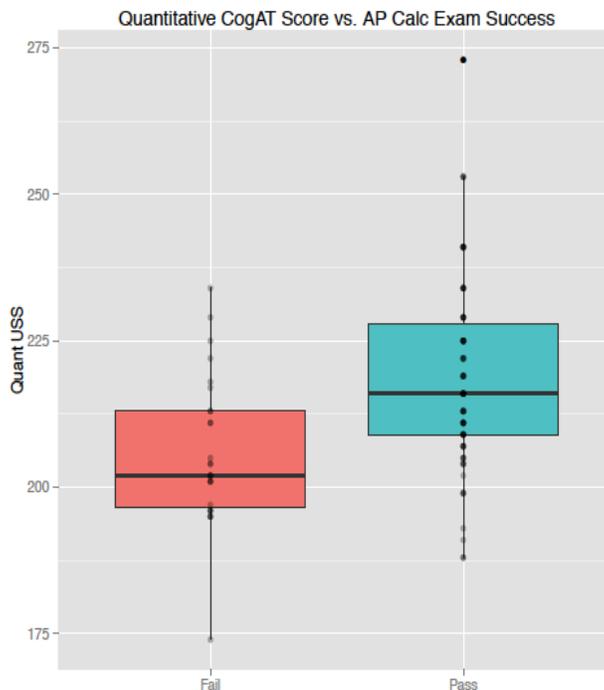


Figure 8. Boxplot visualization for CogAT quantitative battery scores by AP Calculus exam success.

Results for the AP Calculus Group

Null Hypothesis Five

A point biserial correlation, a special type of Pearson correlation, was used to analyze Null Hypothesis Five, which sought to determine if a relationship existed between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores. A point biserial correlation is used when one variable is continuous and one variable is dichotomous. The Pearson correlation coefficient (r) and associated p value were computed resulting in $r = .42$ and $p < .001$. According to Ary et al. (2006), an effect size of $r = .42$ falls in the medium ($r = .30$) to large ($r = .50$) effect size range. The p value shows that this relationship is significant at the 5% significance level. The null hypothesis is rejected.

Null Hypothesis Six

A point biserial correlation, a special type of Pearson correlation, was used to analyze Null Hypothesis Six, which sought to determine if a relationship existed between 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores. A point biserial correlation is used when one variable is continuous and one variable is dichotomous. The Pearson correlation coefficient (r) and associated p value were computed resulting in $r = .42$ and $p < .001$. According to Ary et al. (2006), an effect size of $r = .35$ falls in the medium ($r = .30$) to large ($r = .50$) effect size range. The p value shows that this relationship is significant at the 5% significance level. The null hypothesis is rejected.

Null Hypothesis Seven

A logistic regression was used to analyze Null Hypothesis Seven which sought to determine if there was a logistic relationship between the 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores; this statistical test is an appropriate test for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT composite scores. The p values indicate that the slope and intercept for the logistic relationship between CogAT and AP exams are statistically different from zero (see Table 11). An alpha of .05 was used.

Table 11

Statistical Data for CogAT Composite and AP Calculus: Coefficients

	Estimate	Std Error	z value	p value
Intercept	-18.14	4.86	-3.73	$p < .001$
CogAT Composite	0.09	0.02	3.91	$p < .001$

A predictive relationship was found between the 6th grade CogAT composite scores and

12th grade AP Calculus exam pass-fail scores. When a logistic regression is calculated, the regression coefficient is the estimated increase in the odds that the outcome per unit will increase. In this study, the data used for the logistic regression, CogAT scores, are a quantitative predictor rather than a categorical predictor. AP scores are categorical. At the alpha .05 level of significance, findings show that the 6th grade CogAT composite score is a significant predictor of the 12th grade AP Calculus exam score. For one unit increase in total CogAT composite score, the odds ratio for moving from fail to pass is multiplied by a factor of 1.09 (see Table 12). Thus, there is a 9.47% greater chance of passing the 12th grade AP Calculus exam for each point gained on the 6th grade CogAT composite score. The null hypothesis is rejected.

Table 12

Statistical Data for CogAT Composite and AP Calculus: Odds Ratio

	Odds Ratio	2.5%	97.5%
Intercept	1.3290e-08	9.6342e-13	0.00018332
CogAT composite	1.0947e+00	1.0462e+00	1.14544160

Null Hypothesis Eight

A logistic regression was used to analyze Null Hypothesis Eight which sought to determine if there was a logistic relationship between the 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores; this statistical test is an appropriate test for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT quantitative battery scores. The p values indicate that the slope and intercept for the logistic relationship between CogAT and AP exams are statistically different from zero (see Table 13). An alpha of .05 was used.

Table 13

Statistical Data for CogAT Quantitative and AP Calculus: Coefficients

	Estimate	Std Error	z value	p value
Intercept	-13.5	4.28	-3.16	.002
CogAT Quantitative	0.07	0.02	3.37	$p < .001$

A predictive relationship was found between the 6th grade CogAT quantitative battery scores and 12th grade AP Calculus exam pass-fail scores. When a logistic regression is calculated, the regression coefficient is the estimated increase in the odds that the outcome per unit will increase. In this study, the data used for the logistic regression, CogAT scores, are a quantitative predictor rather than a categorical predictor. AP scores are categorical. At the alpha .05 level of significance, findings show that the CogAT quantitative score is a significant predictor of the AP Calculus exam score. For one unit increase in total CogAT quantitative score, the odds ratio for moving from fail to pass is multiplied by a factor of 1.07 (see Table 14). Thus, there is a 7.13% greater chance of passing the 12th grade AP Calculus exam for each point gained on the CogAT quantitative battery score. The null hypothesis is rejected.

Table 14

Statistical Data for CogAT Quantitative and AP Calculus: Odds Ratio

	Odds Ratio	2.5%	97.5%
Intercept	1.3393e-06	3.0513e-10	0.0058789
CogAT Quantitative	1.0713e+00	1.0292e+00	1.1150595

Summary

Significant and predictive relationships were found between the 6th grade CogAT composite and verbal battery scores and 12th grade AP English Literature exam success.

Significant and predictive relationships were also found between 6th grade CogAT composite and quantitative battery scores and 12th grade Calculus exam success. A point biserial correlation coefficient was used to determine a relationship between variables, and a logistics regression was used to determine predictability (Ary et al., 2006).

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this correlational study was to determine if a relationship exists between 6th grade CogAT composite, verbal, and quantitative battery scores and 12th grade AP English Literature and 12th grade AP Calculus exam pass-fail scores. Additionally, if a relationship existed, the study investigated whether or not the relationship was a predictive one. The purpose of the study did not include establishing cause and effect between the two tests. Chapter 5 includes an overview of the study and a summary and discussion of study findings. Implications for practical application are addressed along with limitations of the current study. Recommendations for future research arising from this study are also presented.

Study Overview

A current problem in education is the identification of a means to predict students who will be successful in high school AP exams. The preponderance of research evidence suggests achieving success on AP exams accrues various benefits including better college performance, (Dodd et al., 2002; Mattern, et al., 2009; Morgan & Klaric, 2007; Murphy & Dodd, 2009; Patterson et al., 2011). Moreover, this positive relationship exists across SES factors (Hargrove et al., 2008). The AP program is the most popular delivery model to serve gifted students (Colangelo et al., 2010; Dixon, 2000; Herberg-Davis & Callahan, 2008; Peters & Mann, 2009; Vanderbrook, 2006) and in many instances is the only delivery model available for gifted students (Dixon, 2000), although questions still exist in relationship to the effectiveness of these courses for the gifted (VanTassel-Baska, 2006). Typically, teachers and counselors assume that students identified as gifted are more likely to be successful in AP courses. Thus, because minorities are underrepresented in the gifted population fewer are encouraged to enroll in AP courses (Taliaferro & DeCuir-Gunby, 2008). Finding a way to predict which students have the

potential to be successful in AP courses earlier in their educational careers, specifically in the middle grades, could lead to better preparation and increased success for a greater number of students. Establishing a relationship between standardized tests in the middle school years and exams from rigorous courses in high school could be important information in making critical curriculum decisions.

Summary of Findings

Correlation for AP English Literature Group

Specifically, the findings of this study support a positive relationship between 6th grade CogAT exam scores and 12th grade AP English Literature exam scores.

RQ1: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP English Literature exam pass-fail scores?

RQ2: Is there a correlation between 6th grade CogAT verbal battery scores and 12th grade AP English Literature exam pass-fail scores?

Since this study did not seek to determine causality but rather to determine if a relationship existed between CogAT and AP exam scores, a correlational design was appropriate (Ary et al, 2006). The two variables were related for the same group of subjects and were not manipulated by the researcher. A point biserial correlation test was appropriate because one variable was continuous, CogAT exam scores, and one variable was dichotomous, AP exam scores (Salkind, 2008). When evaluating correlation results, consideration should be given to the relationship that is being evaluated in addition to the actual numerical coefficient values produced. A correlation coefficient size of .75 would be seen as low when comparing two similar standardized tests, while the same value would be considered high for correlation of a high school aptitude test and GPA in the freshmen year (Ary et al., 2006). In the current study, a

correlation coefficient of .42 for the composite and .37 for the verbal battery shows a moderately strong positive relationship between the two variables. If a simple ordinary least squares linear regression were constructed, it could be said that $r^2 = .176$ indicating that 17.6% of the variation in the CogAT composite scores is explained by the 12th grade AP English Literature exam score status. If the regression were constructed for 6th grade CogAT verbal battery scores, it could be said that $r^2 = .136$ indicating that 13.6% of the variation in the 6th grade CogAT verbal battery scores is explained by the 12th grade AP English Literature exam score status. The correlation for both 6th grade CogAT composite and verbal battery scores with 12th grade AP English Literature exam pass-fail scores was found to be statically significant at the .05 levels. Thus, the null hypotheses were rejected indicating that there is a positive relationship between the two variables. As the 6th grade CogAT composite and verbal scores increase, success on the 12th grade AP English Literature exam tends to increase.

Logistic Regression for the AP English Literature Group

RQ3: Is there a correlation between an increase in 6th grade CogAT composite scores and an increase in 12th grade AP English Literature exam pass-fail scores?

RQ4: Is there a correlation between an increase in the 6th grade CogAT verbal battery scores and an increase in 12th grade AP English Literature exam pass-fail scores?

A logistics regression was used to determine if the positive relationships between 6th grade CogAT composite and verbal battery scores and 12th grade AP English Literature exam pass-fail scores were predictive. This statistical test is appropriate for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT composite and verbal battery scores (Tabachnick & Fidell, 2007). Study findings show the 6th grade CogAT composite score is a significant predictor of the 12th grade AP English

exam pass scores. There is an 8.90% greater chance of passing the 12th grade AP English Literature exam for each point gained on the 6th grade CogAT composite score. The statistical significance also holds true for the relationship between 12th grade AP English Literature exam scores and 6th grade CogAT verbal battery scores with a 7.06% greater chance of passing the 12th grade AP English Literature exam for each point gained on the 6th grade CogAT verbal score. Thus, the null hypotheses were rejected.

Correlation for AP Calculus Group

Specifically, the findings of this study support a positive relationship between 6th grade CogAT scores and 12th grade AP Calculus exam scores.

RQ5: Is there a correlation between 6th grade CogAT composite scores and 12th grade AP Calculus exam pass-fail scores?

RQ6: Is there a correlation between 6th grade CogAT quantitative battery scores and 12th grade AP English Literature exam pass-fail scores?

Since this study did not seek to determine causality but rather to determine if a relationship existed between CogAT and AP exam scores, a correlational design was appropriate (Ary et al, 2006). The two variables were related for the same group of subjects and were not manipulated by the researcher. A point biserial correlation test was appropriate because one variable was continuous, CogAT exam scores, and one variable was dichotomous, AP exam scores (Salkind, 2008). A correlation coefficient of .42 and .35 for composite and quantitative battery, respectively, shows a moderately strong positive relationship between the two variables. If a simple ordinary least squares linear regression were constructed, it could be said that $r^2 = .176$ indicating that 17.6% of the variation in the 6th grade CogAT composite scores is explained by the 12th grade AP Calculus exam score status. If the regression was constructed for 6th grade

CogAT quantitative battery scores, it can be said that $r^2 = .122$ indicating that 12.2% of the variation in the 6th grade CogAT quantitative score is explained by the 12th grade AP Calculus exam score status. The correlation for both 6th grade CogAT composite and quantitative battery scores with 12th grade AP Calculus pass-fail scores was found to be statically significant at the .05 level. Thus, the null hypotheses were rejected indicating that there is a positive relationship between the two variables. As the 6th grade CogAT composite and quantitative scores increase, success on the 12th grade AP Calculus exam tends to increase.

Logistic regression for AP Calculus Group

Examining the predictive value between the 6th grade CogAT composite score and 12th grade AP Calculus exam scores, a statistically significant relationship exists.

RQ7: Is there a correlation between an increase in 6th grade CogAT composite scores and an increase in 12th grade AP Calculus exam pass-fail scores?

RQ8: Is there a correlation between an increase in the 6th grade CogAT quantitative battery scores and an increase in 12th grade AP Calculus exam pass-fail scores?

A logistics regression was used to determine if the positive relationships between 6th grade CogAT composite and quantitative battery scores and 12th grade AP Calculus exam pass-fail scores were predictive. This statistical test is appropriate for modeling the relationship between the dichotomous variable of pass-fail AP exam scores and the continuous variable of CogAT composite and quantitative battery scores (Tabachnick & Fidell, 2007). Study findings show that the 6th grade CogAT composite score is a significant predictor of the 12th grade AP Calculus exam scores. There is a 9.47% greater chance of passing the 12th grade AP Calculus exam for each point gained on the 6th grade CogAT composite score. The statistical significance also holds true for the relationship between 12th grade AP Calculus exam scores and the 6th

grade CogAT quantitative battery scores with a 7.13% greater chance of passing the 12th grade AP Calculus exam for each point gained on the 6th grade CogAT quantitative battery score.

Thus, the null hypotheses were rejected.

Discussion

Considering the fact that gifted identified students are those that most often enroll in AP courses (Colangelo et al., 2010; Dixon, 2000; Herberg-Davis & Callahan, 2008; Peters & Mann, 2009; Vanderbrook, 2006), school districts using mental abilities tests in early grades as a means to identify gifted students would be operating on the theory that intelligence is a fixed trait (Dweck, 2009). Theorists who support the idea that intelligence is malleable believe that other factors besides test scores should be considered when planning curriculum. One such factor is higher self-efficacy, which researchers found to be predictive of academic achievement (Bandura, 1993; Dweck & Leggett, 1988). Sternberg (1999) supports the idea that intelligence operationalized as performance on an intelligence test is limited. While it is appropriate to gauge both analytical ability and the ability to recall information when evaluating intelligence, both practical and creative elements should be considered as well. Thus, Sternberg does not argue that conventional testing is not valid and should not be used but rather that it is simply not inclusive enough for a true prediction of an individual's intelligence. Renzulli who developed his three ring conception theory based on demonstrated existence of creativity, above average ability, and commitment to a task as indicators for giftedness also supports agreement with a multiple criteria approach. Lohman, creator of CogAT 7 supports the idea of multiple criteria for identification of the high ability student and in particular the gifted.

In the current study school district, standardized exams serve as the primary identifier of gifted identified students who are among the majority of students who are enrolled in high school

AP classes. Examining CogAT scores to determine appropriate curriculum placement is supported by the findings of the present study. The study findings are also in line with Dweck, Sternberg, Bandura, and Renzull's theories that support the idea that future achievement can be impacted if identified early with appropriate curriculum provided.

The school for the current study has sought to expand AP offerings and has encountered the problem of identifying students who might be successful in these courses (M. Cantrell, personal communication, March 12, 2015). The problem of equity and access in the AP program has been identified not only by the College Board (College Board, 2010), but also other researchers who indicate that a lack of access to these rigorous courses is an issue of equity for minorities (Barnard-Brak et al., 2011; Ford & Whiting, 2009). Descriptive statistics from the current study demonstrate the existence of inequity, supporting findings of prior research, with 87% of AP English Literature test takers and 80% of AP Calculus test takers being identified as white. Underrepresentation for Hispanic students is a particular issue in the study district. While AP participation numbers were in line with overall demographics for white, Asian, black, and multiracial, a rising Hispanic population has led to a greater underrepresentation of this ethnic group in AP courses. In 2013, Hispanics constituted 23% of the population, while for the study period 2010–2013 approximately 8% of Hispanics were enrolled in 12th grade AP English Literature and 12th grade AP Calculus.

Also in line with prior research is the current study district's utilization of AP courses as the primary delivery model for gifted students. Previous studies have shown that when AP courses are generally used as the sole delivery model for the secondary level gifted program, the equity issue is exacerbated (Colangelo et al., 2010; Dixon, 2000; Herberg-Davis & Callahan, 2008; Peters & Mann, 2009; Vanderbrook, 2006). Manifestation of minority inequities in the

gifted identification processes is evident in the AP equity issue. These identification processes most often rely on standardized testing to identify those students (Ford & Whiting, 2009; Michael-Chadwell, 2010) just as in the school district for the current study. Current study findings show a predictive relationship between 6th grade CogAT composite, verbal, and quantitative batteries and 12th grade AP English Literature and 12th grade AP Calculus exams, thus demonstrating a predictive relationship between cognitive abilities and future academic achievement. These findings support earlier research by Furhman et al. (2009) showing that cognitive ability has been found to be the largest contributing factor to academic performance. Findings for this study support Warnimont's (2010) study that established a predictive relationship between 3rd grade CogAT scores and 4th and 5th grade state reading and math achievement tests. Findings from the current study show a stronger correlation between the 6th grade CogAT composite scores and both 12th grade AP exam scores as opposed to 6th grade CogAT verbal and quantitative battery scores and corresponding 12th grade AP exam scores. These findings do not support an earlier study by Lohman and Lakin (2011) that suggested test domain specific test measurements better predict later performance in that same domain. However, considering that AP exams not only test domain specific material but also assess other academic abilities of a student such as critical thinking, it would be reasonable to surmise that the composite domain of the CogAT may better reflect the skills of a students who might be successful on a more comprehensive exam.

In light of current educational trends and the impact of the AP program for college performance, it is important that all students have equal access to an AP curriculum and are being prepared for the curriculum by the school system. The predictive relationship established between 6th grade CogAT composite, verbal, and quantitative scores and 12th grade AP English

Literature and 12th grade AP Calculus suggests that it would be beneficial to consider CogAT scores when making curriculum decisions. Providing opportunities for students to improve skills needed to do well on the CogAT exam through curriculum selections could have an important impact on students' future academic goals. Since the preponderance of evidence supports the idea that students who are successful on AP exams are more successful in college, encouraging student participation in AP courses and providing a greater opportunity for them to be successful could be instrumental to their academic performance in college. For students who score above the CogAT mean scores that were found for the AP pass group, an advanced curriculum would be important to enhance development of an identified academic aptitude. Especially for those students whose CogAT scores are slightly below the mean CogAT scores found in the AP pass groups, special attention should be given to determine courses that would build necessary skills to help prepare these students for a more rigorous curriculum. This study is beneficial for schools and districts seeking research study findings on which to base immediate important instructional and curriculum decisions.

Conclusions

A rigorous high school curriculum is more beneficial for students (Adelmen, 2006; Long, et al., 2012). In today's high schools, AP is a standard of rigor (Chajewski et al., 2011; Sadler, 2010) and the hallmark of a quality education that leads to college readiness (Mathews, 2013). Benefits of the AP program are purported to include (a) the development of a more competitive admissions transcript, (b) the possibility of earning college credit while in high school, (c) the possibility of finishing a degree at an earlier date due to acquiring college credit while in high school, and (d) the possibility of financial savings due to fulfilling college credits while in high school (College Board, 2011c). Despite some inconsistent findings in research studies, the

preponderance of evidence indicates that there is value in providing AP courses for students; those with successful scores on AP exams tend to perform better in college (Geiser & Santelices, 2004; Keng & Dodd, 2008; Mattern, et al, 2009; Murphy & Dodd, 2009; Patterson & Ewing, 2013). Accordingly, many schools are embracing the AP expansion and seeking to provide additional AP curriculum options for their students.

As school districts move forward with expanding their AP programs, they should also focus on a means to identify and prepare increased numbers of students to enroll and be successful in these courses. The current study supports using CogAT scores from middle school, not just as a means to identify gifted students at a predetermined score, but also as a source for curriculum decisions. With the current emphasis on data driven decision-making and instruction, this study is timely and contributes to a gap in the literature concerning predictors of AP exam success. Ultimately these curriculum decisions could lead to larger numbers of students enrolling and succeeding in high school AP exams.

Implications

Using CogAT scores as an indicator to guide curriculum decisions for students, parents, teachers, and counselors could lead to a more appropriate selection of courses designed to meet the student's academic needs. Identification of academic strengths in middle grades could lead to increased academic success in rigorous high school courses that could also affect college performance. With the current trend in education for data driven differentiated instruction, identifying both strengths and weaknesses through the data will allow teachers to provide the instruction needed to serve academically strong students in a manner different from those who need additional support to reach their highest potential. In the school district for this study, CogAT is given in 6th grade, allowing ample time to identify students who will need additional

aid in preparing for the challenges of a more rigorous curriculum in high school that can lead them to greater success in higher education. In recognition of the importance of higher education, President Obama has called for the government to provide two years of free community college (Obama, 2014). If passed, this initiative would mean that more students would be attending higher education institutions and high schools would be expected to ensure that a more diverse population of student is prepared for the challenge. Thus, identifying what students require in order to develop those needed skills at an earlier point becomes even more important not only for an individual success, but also for our society in general.

Education will continue to be an important part of our nation's foundation, and following recent trends, high school students will increasingly seek to advance their education as early as possible in anticipation of saving time and money in their pursuit of higher education. The expanding AP program will continue to provide a means by which students may earn college credit while in high school, and students who are prepared for those courses will reap the benefits of obtaining successful scores in a variety of AP subjects. The field of education is continually developing and changing to meet the needs of students in their academic goals; discovering ways in which schools can better prepare students has been and will continue to be a primary goal. Identifying student academic potential at an early point can allow the identification of a more appropriate curriculum for academic advancement and future success. Because our nation's long history of reliance on standardized tests to determine achievement, aptitude, and ability will continue, educators should work to discover improved ways in which these scores can be used to aid in preparing students for future achievement. Determining the relationship, and in particular a predictive relationship between testing in the primary grades and academic success in high school could be important for curriculum planning and ultimately

student academic success.

Limitations

Several limitations impacted this study with threats to both internal and external validity centering on issues with subjects, variables, population, and sample size (Ary et al., 2006).

Internal validity was threatened because the study used a convenience sample of available students thus introducing possible selection bias. Since the students were not random, internal validity could also have been threatened by confounding individual characteristics of students who chose to take AP courses versus students who did not choose to take AP courses

External validity was threatened by the use of a small-defined population. The study district is a rural area with a student body population that may differ from urban areas or even rural areas with a greater population in general. Thus generalizability is limited to school districts with similar demographics. Small sample size also posed an external validity issue. Finally, this correlational study design did not seek to establish cause in the relationship between CogAT and AP exams.

Recommendations for Future Research

The current study is significant because it revealed a relationship between 6th grade CogAT exam scores including composite, verbal, and quantitative batteries and 12th grade AP English Literature and 12th grade AP Calculus exam scores. Findings of the study indicate that successful student achievement on the 12th grade AP English Literature and 12th grade AP Calculus exams can be predicted when 6th grade CogAT scores are considered. Further research could include the following:

1. Replicating this study would lend validity to the findings, particularly in school districts with different demographics.

2. Bringing in additional factors such as gender, economic status, and ethnicity would broaden the scope of the study.
3. Including other subject areas such as AP Biology and AP U.S. History would not only bring in different subject areas but also different age groups.
4. Utilizing a qualitative research design would allow the examination of personal characteristics, such as motivation, of successful AP test takers.
5. Examining other qualitative variables such as teacher effectiveness in the selected AP courses, course curriculums of study subjects, and student learning styles could aid in explaining AP exam success.

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APPENDIX A: SCHOOL DISTRICT PERMISSION

May 30, 2014

Kathy Daniel

Dear Ms. Daniel,

On behalf of the _____ School System, I am pleased to grant permission for you to conduct research through the _____ High School Gifted Department for your doctoral dissertation.

We wish you much success as you continue the process for your doctoral degree.

Sincerely,



Director of Secondary Schools

APPENDIX B: GIFTED COORDINATOR DATA COLLECTION

June 3, 2014

To Whom It May Concern:

I will be assisting Kathy Daniel in her research to examine the relationship between middle grades Cognitive Abilities Test (CogAT) scores and high school AP exam scores by providing data from the _____ or the years 2010 - 2013. Historical AP exam data will be accessed through system-level online reports from the College Board. CogAT scores will be accessed from permanent student records. The data will be coded to ensure the anonymity of participants. Coded data that does not contain any identifying student information will be provided to Ms. Daniel for her research.

We look forward to reviewing the results of this important study and are happy to provide assistance to Ms. Daniel in securing data in the manner described above.

Please do not hesitate to contact me if additional information is required.

With best regards,

APPENDIX C: IRB APPROVAL**LIBERTY UNIVERSITY.**
INSTITUTIONAL REVIEW BOARD

June 9, 2014

Kathy Daniel

IRB Application 1895.060914: The Relationship between Middle-Grades, Cognitive Abilities Test Scores and High School Advanced Placement Exam Scores

Dear Kathy,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your approved application.

Your study does not classify as human subjects research because your study involves deidentified archival data.

Please note that this decision only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued non-human subjects research status. You may report these changes by submitting a new application to the IRB and referencing the above IRB Application number.

If you have any questions about this determination, or need assistance in identifying whether possible changes to your protocol would change your application's status, please email us at irb@liberty.edu.

Sincerely,

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

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