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EFFECTS OF PARTICIPATION STATUS IN THE ARKANSAS AAIMS PROGRAM BY GENDER, RACE, AND SES ON AP CALCULUS ACHIEVEMENT

by

Wayne Fawcett

Dissertation

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EFFECTS OF PARTICIPATION STATUS IN THE AAIMS PROGRAM BY GENDER, RACE, AND SES ON AP CALCULUS ACHIEVEMENT IN ARKANSAS

by

Wayne Fawcett

Dissertation

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state of Arkansas. The strides made in gifted education in Arkansas, and people like me that continue to carry the torch, are directly attributable to these three women.

ABSTRACT

by
Wayne Fawcett
Harding University
December 2017

Title: Effects of Participation Status in the Arkansas AAIMS Program by Gender, Race, and SES on AP Calculus Achievement (Under the direction of Dr. Bruce Bryant)

The purpose of this dissertation was to explore whether the Arkansas Advanced Initiative in Mathematics and Science (AAIMS) as implemented by schools within the state of Arkansas had an effect on mathematics achievement as measured by the 2015 AP Calculus AB exam. In 1955 the College Board created the Advance Placement program to be implemented in high schools in an attempt to address the growing gap between secondary education and college curricula. Then, in 2007 the Arkansas Advanced Initiative in Mathematics and Science was established in Arkansas to further train high school AP teachers, support AP programs throughout the state, and to expand the AP footprint statewide. Specifically, the present study addressed whether the implementation of the AAIMS program through teacher training increased mathematics achievement for those students in AAIMS schools as opposed to mathematics achievement for students in non-AAIMS schools.

The potential impact of the program on mathematics achievement for students in terms of gender, race and socio-economic status (SES) was analyzed. The results of this study could have a potential impact on other high schools in Arkansas in terms of AP

programs, AAIMS, and academic achievement, particularly in mathematics achievement. Could the implementation of the AAIMS program statewide have an effect on student achievement for all students in Arkansas?

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CHAPTER I

INTRODUCTION

In the United States, there is an intuitive belief that teachers who have been through quality professional development training will produce students who achieve at a higher level on various assessments. In a review of nine different studies, it was discovered that teachers who participated in substantial professional development, which averaged 49 hours, boosted their students' achievement by approximately 21 percentile points (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Increased standards at the national, regional, state, and even local level have put increased pressure on teachers to have their students reach achievement goals, to close achievement gaps among groups, and with the advent of the Common Core State Standards, to have their students College and Career ready.

According to Snow-Renner and Lauer (2005), "Teachers tend to teach in the ways that they are taught. They develop instructional repertoires that are consistent with their beliefs and attitudes about content and student learning. Often, these are firmly nestled within the paradigm of teacher-oriented instruction" (p. 2). Teachers attend prescribed and mandatory in-service training that often has no follow-up and, arguably, may not have relevance to their content area. Seeking comfort, they may tend toward what is comfortable and known in their instructional strategies.

The Advanced Placement (AP) programs began in 1955 as a way for advanced

students to experience and receive college-level content and instruction (DiYanni, 2002). Consequently, high school teachers need to be trained in curriculum that is at the collegiate level, which covers more material in greater depth and breadth of understanding compared to regular high school courses. Since that time, it has grown and expanded to the point that over 700,000 students now take a variety of AP courses. AP Institutes are held primarily in the summer months for teachers that will be, or are currently, teaching AP courses. This training introduces them to a variety of instructional strategies that are widely used by AP teachers nationwide. According to Hansen (2005) in a research brief for Education Partnerships,

> Research indicates that students completing AP courses were better prepared to take on college course work and were able to earn college credit when successful on the AP exams. In addition, teachers participating in AP professional development have been credited with greater content and pedagogical knowledge. Finally, Advanced Placement programs are credited with improving the overall curricula of the school by creating a need for more rigorous prerequisite courses. (para.1)

DeWitt Clinton High School is located in the Bronx, New York. It is a classic urban, minority high school with 100% minority population and virtually 100% eligibility for free and reduced lunch. Since 1991 the school has focused on increasing rigor through increasing participation in the AP program. As stated by DiLorenzo (1999),

> Participation by our students and teachers in these rigorous courses permeates the school in a variety of ways and has lately been augmented by increased interest in

> higher standards and teacher training by the New York State Board of Regents and the New York City Board of Education. (p. 207)

AP is used in schools not only to increase rigor in academic courses but to use it as a way that encourages teachers to participate in more professional development for those courses they teach. It can also be used as a reference for teachers to navigate the various formative assessments that are used in various states.

AP courses are designed for a higher level of instruction. The Arkansas Advance Initiative for Mathematics and Science (AAIMS) began in 2008 with Arkansas being selected as one of seven states to receive a National Math and Science Initiative Grant. Schools apply for AAIMS grant funding with potential goals of strengthening the teaching of AP mathematics, science, and English courses and of building enrollment and increasing the number of students taking and earning qualifying scores on the AP exams.

In the schools that are served over a 5-year period, on average, the number of students scoring 3 or higher on AP English has tripled, the number of students scoring 3 or higher on AP mathematics exams has quadrupled, and the number of students scoring 3 or higher on AP science exams has quintupled. The strategies included extensive formal and informal training of AP and Pre-AP teachers, additional time on task for students, incentives based on academic results, and cultivation of lead teachers to provide leadership to the Program in their schools by mentoring other AP and Pre-AP Teachers.

The program began in 2008 with nine high schools, adding 37 high schools since its inception. In 2014-2015, the program expanded to include 46 schools throughout the state (AAIMS, 2014). Each year, other school districts are recruited and/or apply for the program adding more districts. Schools can drop out of the program at any time.

Statement of the Problem

The purposes of this study were threefold. First, the purpose of this study was to determine the effects by gender of students in schools that participate in AAIMS versus students in Arkansas schools that do not participate in the AAIMS program on academic achievement as measured by the AP Calculus exam. Second, the purpose of this study was to determine the effects by race of students that participate in the AAIMS program versus students in Arkansas schools that do not participate in the AAIMS program on academic achievement as measured by the AP Calculus exam. Third, the purpose of this study was to determine the effects by socioeconomic status (SES) of students in the AAIMS program versus students in Arkansas schools that do not participate in the AAIMS program on academic achievement as measured by the AP Calculus exam.

Background

Since the inception of AAIMS in 2008, data have been collected on AP scores for students in all participating schools. The program is housed at the University of Arkansas at Little Rock which acts as the repository of information. The data suggested that an increase in the number of students taking AP courses has occurred especially among minority students. The data also suggested that scores on mathematics, science, and English AP exams have improved since 2008. No data were kept comparing the schools that participate in the AAIMS program with non-AAIMS schools. AP scores can be obtained from the College Board for non-AAIMS schools.

Advanced Placement

AP programs have been used as an intervention strategy in schools. Leonard, Blasik, Dilgen, and Till (2003) found that AP programs used in Broward County Public

Schools in Florida were implemented in an attempt to increase achievement. They also found that the program could be extended to a greater range of students, especially minorities, as a way to close the achievement gap. Wiley (1989) showed that minority participation in AP programs had increased and that with participation, scores had also increased.

The state of Arkansas implemented the Arkansas AP Incentive Program to address course offerings for students in Arkansas high schools. The program offered schools incentives: (a) equipment materials and grants; (b) professional development reimbursements for teachers; and (c) funds to pay for students' exams. Professional development opportunities were available to train teachers in AP strategies at various locations around the state. Data analysis from 1990-1998 of two Arkansas high schools showed that minority participation in all AP courses increased (Robinson et al., 1999).

Alabama has a similar program in place to encourage schools to increase participation in the AP program, especially within minorities, and to better train teachers in AP strategies. Walker (2009) discovered that teachers did incorporate more AP instructional strategies after participating in AP institutes while encouraging more students from all classes to take and participate in AP programs. AP programs are being "pushed" throughout the American educational system. The College Board, the administrator of all AP programs and exams, offers extensive training programs in virtually every state (College Entrance Examination Board, 2014). National and regional events are held each year and in the summer with aggressive recruiting strategies in place for both students and teachers through programs like AAIMS (College Entrance Examination Board, 2014). School districts without funds to spare can find programs to

pay for materials, supplies, training, and testing in various states. Every school district in Arkansas is required to offer an AP course in each of the four core areas (mathematics, science, language, social studies) as a part of the minimally required 38 units (Arkansas Department of Education, 2009). Some districts meet the standard by offering one or more of the AP requirements through Compressed Instructional Video or satellite.

Teacher Training/Professional Development

All teachers in Arkansas are required to annually participate in and obtain evidence of 36 staff development hours. There are prescribed trainings for all teachers such as Arkansas History, parental involvement, and child maltreatment reporting. Dependent upon grade level and/or content area, the teacher then receives varying numbers of hours in his/her grade or subject areas. Elementary teachers receive training in all four core areas while middle school teachers may receive subject or grade level training, and secondary teachers (7-12) receive professional development in a subject specific area (Arkansas Department of Education, 2009). Blank and de las Alas (2010) partnering with the Society for Research on Educational Effectiveness confirmed results in a meta-analysis of the effect of teacher training and gains in student achievement. They showed that gains were closely correlated and tied to teacher professional development in mathematics education. Professional development is critical to ongoing success in schools. However, training that begins and ends with a professional development event should be expanded and ongoing.

Teacher training and professional development can, and often do, improve student achievement if properly used and implemented consistently over time. The high level of AP training that exists for teachers can, and does, boost a student's achievement on AP

exams. However, in AAIMS schools, there is a greater degree of on-site assistance with former teachers, most of whom taught AP, with member schools. Professional development, coaching, on-site evaluations, and consulting are all available and are an integral part of the participation in the AAIMS program. The former AP teachers are hired to conduct on-site evaluations of instruction, to partner with the content teacher as a mentor or source for help, and to provide feedback on instruction, assessments, strategies, and classroom activities. These teachers are assigned specifically to the individual school and teacher as a one-to-one resource.

Hypotheses

The researcher generated the following null hypotheses.

1. No significant difference will exist by gender between students in the two AAIMS schools versus the two non-AAIMS schools on academic achievement as measured by the AP Calculus exam scores.
2. No significant difference will exist by race between students in the two AAIMS schools versus the two non-AAIMS schools on academic achievement as measured by the AP Calculus exam scores.
3. No significant difference will exist by SES status between students in the two AAIMS schools versus the two non-AAIMES schools on academic achievement as measured by the AP Calculus exam scores.

Description of Terms

Academic Achievement. In educational institutions, success is measured by academic performance, or how well a student meets standards set out by local government and the institution itself.

Advanced Placement (AP). AP courses are college-level curriculum that a student can take in high school. Typically, the school offers these courses to students who are in their honors program or who have completed all the high school courses available on the subject. These courses tend to be, therefore, courses in mathematics and English, although they can be on virtually any subject. The courses are more rigorous than high school courses since they are, in fact, college courses and students can receive college credit for taking the courses, although not all colleges grant students college credit for the courses (College Entrance Examination Board, 2012).

AP Exam. AP Exams are rigorous, multiple-component tests that are administered at high schools each May. High school students can earn college credit, placement, or both for qualifying AP Exam scores. Each AP Exam has a corresponding AP course and provides a standardized measure of what students have learned in the AP classroom.

AP Score. The AP score shows how well a student did on the AP Exam. It is also a measure of achievement in a college-level AP course. This score will be used by colleges and universities to determine if they will grant credit for what was already learned or allow the student to skip the equivalent course once the student gets to college (this is known as AP). Each score is a weighted combination of one's scores on the multiple-choice section and on the free-response section. The final score is reported on a 5-point scale as follows:

- 5 = extremely well qualified,
- 4 = well qualified,
- 3 = qualified,

- 2 = possibly qualified, and
- 1 = no recommendation.

Qualified means that the student has proven themselves capable of doing the work of an introductory-level course in a particular subject at college (College Board, 2017b). Many colleges and universities grant credit and placement for scores of 3, 4 or 5; however, each college decides which scores it will accept.

Arkansas Advanced Initiative for Math and Science (AAIMS). AAIMS is an affiliate of the National Math and Science Initiative (AAIMS, 2013a). The primary goal of the National Math and Science Initiative and Arkansas AAIMS, Inc. is to increase the number of students taking and scoring 3 or higher on AP mathematics, science, and English with proven strategies.

College Board. The College Board is a mission-driven not-for-profit organization that connects students to college success and opportunity (College Entrance Examination Board, 2014). Founded in 1900, the College Board was created to expand access to higher education. Today, the membership association is made up of over 6,000 of the world's leading educational institutions and is dedicated to promoting excellence and equity in education. The College Board helps more than 7 million students prepare for a successful transition to college through programs and services in college readiness and college success—including the Scholastic Aptitude Test (SAT) and the AP Program (College Entrance Examination Board, 2014). The organization also serves the education community through research and advocacy on behalf of students, educators, and schools.

Professional Development. Professional development generally refers to ongoing learning opportunities available to teachers and other education personnel through their

schools and districts. Effective professional development is often seen as vital to school success and teacher satisfaction, but it has also been criticized for its cost, often vaguely determined goals, and for the lack of data on resulting teacher and school improvement that characterizes many efforts.

School District. A School District is a geographic organization of public schools within a state or a county that carries out public educational services for the state's or county's residents. Most local public primary and secondary schools are operated or managed by a school district. In some areas, school districts may be called or referred to as school divisions. School Districts are governed by a legislative body usually referred to as school boards, school committees, or board of trustees wherein the members are elected by popular vote or by appointment of government officials where the district is located. These school boards are usually headed by a practiced public school administrator who oversees the daily policy implementations, school functions, activities, and employee/student matters.

School Year. To constitute a school year in Arkansas, the student-teacher interaction time must include a minimum of 178 days (Arkansas Department of Education, 2009). Additionally, all public school teacher/administrator contracts must include a minimum of 190 days.

Socioeconomic Status (SES). A family's SES is based on family income, parental education level, parental occupation, and social status in the community (such as contacts within the community, group associations, and the community's perception of the family), noted Demarest et al. (1993). Families with high SES often have more success in preparing their young children for school because they typically have access to a wide

range of resources to promote and support young children's development. They are able to provide their young children with high-quality child care, books, and toys to encourage children in various learning activities at home. Also, they have easy access to information regarding their children's health, as well as social, emotional, and cognitive development. In addition, families with high SES often seek out information to help them better prepare their young children for school.

Significance

Research Gaps

There is ample research on teacher training/professional development and the effect that it has on student achievement. This appears to be across grade levels and across subject areas. There is also a growing body of research on AP programs and their effects on student achievement in secondary schools, college, and life. There is also a body of work on AP programs and the effects on minority populations. Hargrove, Godin, and Dodd (2008) found that students who did take AP courses and the corresponding AP exams had higher graduation rates than students that only took an AP course or a non-AP course in the same subject area. They also earned more credits and had higher GPAs in college. Participation in the AAIMS program encourages and increases the opportunities for students to enroll in, complete, and test in AP classes. However, there does not seem to be any research comparing AAIMS schools to non-AAIMS schools.

Possible Implications for Practice

The Arkansas Legislature has recently appropriated approximately $1 million over the next biennium for the AAIMS. This is a program that works to increase AP programs, training, and testing in high schools in Arkansas. If research does show that

AAIMS training for teachers has an effect on student achievement, specifically AP Calculus, the implication will be that the funds allocated to the AAIMS schools will benefit students in AP courses and the strategies, services, and program could help all schools increase AP participation, increase scores, and increase minority participation and theoretically college entry. It could also have implications for what teacher training concepts and strategies are used statewide. Teachers who do not teach AP courses could still benefit from the AP training by implementing those strategies in virtually every subject area.

Process to Accomplish

Design

In this quantitative study, the researcher used a multiple logistic regression strategy. Independent variables were gender, race, SES, and AAIMS participation. The dependent variable was AP Calculus AB achievement measured by AP scores. AP Calculus scores were dichotomized into pass and fail. As previously mentioned, all AP exams are scored on a 1-5 scale. A score of 3 or higher is considered to be passing, and any score of 2 or lower is considered to be not passing. The independent variables for Hypothesis 1 were gender and AAIMS participation. The independent variables for Hypothesis 2 were race and AAIMS participation. The independent variables for Hypothesis 3 were SES and AAIMS participation. The independent variable of AAIMS participation was also dichotomized into participation or no participation.

Sample

The researcher used a stratified random sampling technique to select the sample from the population of students who have taken the AP Calculus AB exam drawn from

four selected Arkansas high schools with similar enrollment (2 AAIMS/2 non-AAIMS). Schools were selected from within the state of Arkansas that had a sufficient number of students taking AP Calculus AB.

Instrumentation

All students who take AP Calculus AB, regardless of grade level, have the opportunity to take the AP Calculus exam given in early May of each school year. The exam is the same for every student. There are no variations or versions; every student takes the same test regardless of school, region, etc. The exam consists of a variety of AP Calculus problems determined by the College Board (College Entrance Examination Board, 2014).

Data Analysis

To address the first hypothesis, a binary logistical regression was used with gender and AAIMS participation as the independent variables and the 2015 AP Calculus AB achievement as the dependent variable for all students in the two AAIMS and two non-AAIMS schools. To address the second hypothesis, a binary logistical regression was used with race and AAIMS participation as the independent variables and the 2015 AP Calculus AB achievement as the dependent variable for all students in the two AAIMS and two non-AAIMS schools. To address the third hypothesis, a binary logistical regression was used with SES and AAIMS participation as the independent variables and the 2015 AP Calculus AB achievement as the dependent variable for all students in the two AAIMS and two non-AAIMS schools. Multicollinearity was a potential issue requiring collinearity diagnostics to be applied to each variable.

CHAPTER II

REVIEW OF RELATED LITERATURE

The emphasis of this study is on determining whether the AAIMS training, provided for teachers in the schools participating, has any effect on the AP Calculus AB scores in those schools. This will be accomplished by looking at the 2015 scores in terms of race, gender, and SES within the state of Arkansas. Specifically, the research questions that will drive the literature review are the following:

1. Does gender have an effect on AP Calculus AB scores for students in high schools that participate in the AAIMS versus students in high schools that do not participate in AAIMS?
2. Does race have an effect on AP Calculus AB scores for students in high schools that participate in AAIMS versus students in high schools that do not participate in AAIMS?
3. Does SES have an effect on AP Calculus AB scores for students in high schools that participate in AAIMS versus students in high schools that do not participate in AAIMS?

In order to understand the research, it will be important to identify previous literature to provide a sense of relevance to this study. This will be accomplished by looking at the concept of increasing student achievement as a broad category, the definition of student achievement, and the strategies that schools and school districts have used to improve

student achievement. Specifically, the AAIMS program, its history, purpose, and the number of schools statewide that are currently participating will be discussed. Further, other programs that might increase student achievement such as AP, its history, and its role in high school curriculum will also be examined. Additionally, the possible effects of teacher professional development on student achievement in terms of race, gender, and SES will be reviewed along with other programs and incentives nationally that have been used in an attempt to improve student achievement.

Increasing Student Achievement

Virtually every school in the United States focuses on student achievement as a central theme using various tools and programs in an attempt to increase student scores on multiple assessment tools. Student achievement is an all-encompassing term with broad definitions. Most studies use whatever state assessment is used, whether it is nationally normed with scores used for state purposes like the Iowa Test of Basic Skills or is developed by the state itself much like the former model of Benchmark exams used in the state of Arkansas. Some states use the Measures of Academic Progress with multiple measures to assess growth or achievement in multiple areas. The Measures of Academic Progress tests have even been used as a component of teacher evaluation. The focus of the study will be on student achievement as measured by a nationally normed score in the AP Calculus AB Exam. All students enrolled in AP Calculus AB will take the same exam on the same date. The exam is developed by the AP division of the College Board (College Entrance Examination Board, 2014). The exam is built around the syllabus as used by all AP Calculus teachers nationally, thus nationally normed. The exam is developed each year

with items that can be identical or similar to previous years' exams with computation and writing components.

In terms of improving student achievement relative to teacher professional development, this study will focus on the AP Program as administered by the College Board Professional Development program. Specifically, the focus will be on teacher training that would lead to an increase in student achievement, the AAIMS program as administered through the University of Arkansas-Little Rock, and other programs and incentives in various states.

Advanced Placement

The AP program began during the 1955-1956 school year as a result of a widening gap between secondary and higher education after World War II (College Entrance Examination Board, 2003). The intention was to develop courses and assessments that would be rigorous enough to grant college credit. Upon implementation, a focus on teacher training began in the 1960s. As the AP program progressed, more schools nationwide added it to their offerings. Beginning in the 1980s, the College Board, the administrator of AP programs, started to focus more attention on minority and low-income students (College Entrance Examination Board, 2003).

The AP program has become an integral part of the high school curriculum and has been used as a way to increase student achievement. Christiansen (2009) found that there was a direct relationship between AP student participation and school-wide student achievement, and there also existed a relationship between AP student performance and school-wide student achievement. The indication is that the more students take AP

courses, the greater the school-wide student achievement increase will be and the better the students do in AP courses, the better the school-wide student achievement.

Advanced Placement and Race

Ayres (2011) found that implementation of the Spring Board curriculum through the College Board had a positive effect on student achievement and AP participation, particularly for minority students. The Spring Board curriculum provides a customizable curriculum that integrates rigorous instruction, performance-based assessment, and professional learning in the areas of English Language Arts and Mathematics. Bragg, Kim, and Rubin (2005) determined that AP is an example of a program designed to encourage students' academic participation and to increase college access by increasing their content knowledge and preparation for college-level work. Increasing academic preparation through the AP program was a recommendation from Manos (2010) as was determining the effect of AP teaching. Even extending beyond high school, D'Aquino (2011) determined that AP college credits earned in high school were better predictors of success during the first year of college than were standardized test scores. D'Aquino noted that students who took AP courses were better prepared and did better during their first year in college.

As the AP program has grown, the idea of expansion has been a central expectation in education circles. During the Clinton administration, the U.S. Department of Education, in coordination with the College Entrance Examination Board (2000), issued a report concerning the expansion entitled, *Dispelling the culture of mediocrity: Expanding advanced placement,* in which the then Secretary of Education Richard Riley stated, "About the surest and fastest way to create an angry, 19-year old, illiterate drop-

out is to give that young person a watered down curriculum. Low expectations say to youngsters that they are not smart enough to learn anything more" (p. 20). The paper encouraged the use of AP as a way to challenge all students. It also encouraged the efforts to raise the number of competent teachers to provide high quality, demanding curricula.

Leonard et al. (2003) examined the use of AP as an intervention strategy to narrow the achievement gap. They found that the coursework can be extended to a wider range of students that included minority students. Similarly, Saunders and Maloney (2005) found that a Minority Scholars program at Central High School in Omaha, Nebraska, developed in 1996 to promote AP participation increased participation and achievement among minority students. In the same vein, Wiley (1989) indicated that an increase in minority participation in AP programs has improved scores and opportunities for college enrollment and success. In terms of ethnicity, AP participation seems to be one of the best predictors of academic success both in the short and long term (Burdman, 2000; Planty, Provasnik, & Daniels, 2007). A high number of Black students are taking and completing AP courses. However, the scoring gap seems to be widening indicating that while Black students take AP, they are not doing as well academically as other students ("More Blacks are competing," 2009). Although Black participation in AP is increasing, and AP courses can help to close the achievement gap within the regular curriculum, the gap persists relative to race in AP scores.

Advanced Placement and Gender

In terms of gender, Fnu (2011) determined that evidence exists indicating that ethnicity and gender are barriers to a top quality education, which can be overcome by

inclusion in AP programs and courses. Buck, Kostin, and Morgan (2002) found that males tended to perform better than females in most but not all areas of AP exams despite the same instruction, assignments, and assessments. Excluding AP as a factor, Tate (1997) found differences in race, SES, and gender in mathematics achievement, validating the need to consider all three variables in terms of increasing student achievement.

The College Board also administers the SAT, a national test designed to measure knowledge attainment before students enter college. It is a program similar to the popular ACT exam. In a College Entrance Examination Board (1998, 2014) and Office of Research and Development research study, it was determined that differences persisted between females and males in high school course preparation that affected performance on standardized tests. Gaps existed in the ratio of males and females that completed advanced courses in mathematics, science, and computer programming. The study also found that 75,500 more females took the SAT compared to males and the additional females were less likely to have taken rigorous academic courses. Additionally, Burton, Lewis, and Robertson (1988) found that there was a decline of 10 mathematical mean score points between males and females on the SAT. This confirms the national statistical gap between males and females in taking and succeeding in mathematics and science courses. It then perpetuates the mindset of a disproportionate number of males in mathematics and science dominated fields.

The AP program prides itself on the notion that it is one solution to closing the achievement gap by providing a college level curriculum taught in high schools. This idea is also supported by the national goal of college-ready students. King (1996) found

that most teachers did support open enrollment, in AP courses, for all students, but teachers stopped short of supporting it as a requirement for all students. In reference to King, it appears that most teachers do see AP as an avenue by which student achievement can be improved. Although not specifically related to student achievement, Stoker (2010) found that AP may assist in closing the gap between student's educational aspirations and the eventual outcomes over time.

Advanced Placement and SES

In 1997, Arkansas Legislative Act 929 offered additional incentives to high schools in Arkansas and expanded the meaning of AP programs. It allowed teachers in Pre-AP programs to participate in state subsidized teacher training and provided monetary incentives for schools, teachers, and students for success on AP assessments. The result was an increase in participation by minority and low-income students state-wide (Robinson et al., 1999). In an attempt to diversify the enrollment, Gewertz (2008) found that one Florida high school used the EXCELerator program for AP that increased the number of minority, low-income, and female students. As previously mentioned, Tate (1997) found differences in SES in mathematics achievement.

An offshoot of incorporating the AP program into a school in an effort to increase student achievement is the specific training that teachers receive in coordination with the preparation to teach college-level curriculum. Imig (2008) found in a case study of teacher effectiveness in AP courses that there was a high correlation in pass rate among students and the amount of class time that teachers spent teaching and a correlation in the pass rate and the number of assignments given to their students. Both strategies are teaching tactics taught specifically in AP teacher training (College Entrance Examination

Board, 2012). Laitusis and College Entrance Examination Board (2012) found that a school culture that included a significant amount of professional development (teacher training) was associated with higher student performance. AP-specific training contributes to and increases the chances of stud`ents passing any AP exam. However, there does not seem to be a suggestion that a crossover effect for teachers who teach other classes in addition to AP, of teachers in other classes, or for AP students taking other classes.

Teacher Training

As an avenue to increase student achievement, much time and effort have been dedicated to improving those that deliver instruction, the teachers. It appears that using AP courses to increase the rigor in the courses selected by students yields results in student achievement. Conversely, if teachers are better trained and prepared to deliver instruction, then student achievement should improve. Yoon et al. (2007) found that teachers who receive substantial professional development, defined as an average of 49 hours, can boost students' achievement by 21 percentile points. Snow-Renner and Lauer (2005) found that

> …if teachers are asked to shift to more student-centered ways of instruction, they also must adjust their beliefs to fit the new paradigm. To teach in the ways envisioned by standards reformers, teachers need strong content knowledge and the ability to change their pedagogical repertoire as well as their underlying beliefs and attitudes about it. To do this successfully, teachers need opportunities for deep learning of content, as well as opportunities to learn how to use reform-oriented strategies, practice those strategies in the classroom, and observe their

> effects on student learning. Therefore, standards-based professional development is the cornerstone of a successful standards-based system. (p. 2)

In order to effect change and increase student achievement, teachers need relevant professional development with ways to practice and observe along with time to increase the depth of their content knowledge.

It is well established that professional development for teachers enhances student achievement. However, it is important to understand how the focus of professional development relates to student achievement. Salinas (2010) ascertained that what professional development focused upon was a significant factor and an educationally important predictor of student achievement. Simply having professional development did not guarantee an increase in student achievement. In a specific example, Martin (2010) found that teachers who have feelings of preparedness to teach science content and implement more inquiry-based instruction produced higher achieving science students. By extension, teachers who are better prepared deliver instruction more effectively, and the result is an increase in student achievement.

Taking the notion of effective professional development, Lindsey (2010) determined that not only is the professional development important by subject but must be planned so that it links classrooms, teacher teams, the school, and student outcomes. The takeaway is that, in order to improve student achievement, professional development cannot be focused just on an individual but must have relevance to all teachers in the building. In another content specific study in North Carolina, Krupa (2011) determined that teachers using a specific instructional strategy (Core-Plus) needed professional development designed to strengthen their mathematical content knowledge. Once this

professional development was delivered, the results were encouraging for the students who were mostly underserved (minority, female, low SES). In another North Carolina study, researchers showed that teachers implementing a reform method of professional development reported favorable student growth results (Cockrell, 2011).

In the area of mathematics, focused professional development can improve student achievement. This notion was confirmed by Caban-Vazquez (2010). He found that there was a direct correlation in increasing mathematics achievement through strategic teacher training. Blank and de las Alas (2010) also found a consistently positive effect on gains in student achievement in mathematics from teacher professional development in mathematics education. Sparks (1997), in an interview with Linda Darling-Hammond, discussed the then new national report, *What matters most: Teaching and learning and America's future*. The report focused attention on improving teaching as a way to improve student achievement. In the interview, Darling-Hammond said,

> There's growing evidence that in-service development makes a big difference… The most recent study of which I'm aware is being conducted by David Cohen and colleagues at the University of Michigan in which they found that teachers' access to high-quality professional development affected their ability to implement reforms in a way that improved student achievement. (p. 34)

This appears to bolster the notion that if teachers receive quality professional development, the changes necessary to institute instructional and learning reforms resulting in improvement relative to student achievement are more successful.

Although previously discussed, AP programs can be directly linked to better preparation for students in college classes and can provide an opportunity for college

credit while in high school. Teachers who go through AP training have greater content and pedagogical knowledge, along with improving the overall curriculum, by creating a need for more rigorous prerequisite courses. However, as previously stated, there is an underrepresentation of students who come from low-SES homes and minority students. Hansen (2005), in a research brief, recommended that all students should have access to AP courses, particularly those from underserved populations and that there be a sufficient number of well-trained teachers for those AP courses. The Education Partnership brief emphasized that teacher professional development was essential to success. Although not directly linked to teacher professional development, Furry and Hecsh (2001) found that higher-performing classes have teachers with more years of experience teaching the AP subject than in lower performing classes. The feeling is that the better trained the teachers, the less likely they are to abandon the classroom, building years of experience and developing the skills that maximize instructional delivery thereby increasing student achievement.

Arkansas Advanced Initiative in Math and Science (AAIMS)

As an affiliate of the National Math and Science Initiative, AAIMS was established through a grant in 2007. In 2008, the first AAIMS grant was awarded to 10 schools in Arkansas with the goal of strengthening the teaching of AP mathematics, science, and English courses and building enrollment and increasing the number of students taking and earning qualifying scores on AP exams (AAIMS, 2014). The program includes the following:

- Voluntary participation on the part of students, teachers, and schools
- Annual incentives based on AP exam results

- Cultivation of teachers to mentor a vertical team of AP and Pre-AP teachers
- Advanced-level, content-focused training for teachers of AP and Pre-AP mathematics, science, and English courses
- More time on task for students, including face-to-face and online AP exam prep sessions
- Measurement and accountability for results through professional management by AAIMS, Inc.

Since the inception of the AAIMS program, six cohorts have been added for a total of 51 high schools in Arkansas. These schools are spread throughout the state in all five regions (Northeast, Northwest, Southeast, Southwest, and Central) of the state. Although all schools in Arkansas are required to offer AP courses in each of the four content areas (Quality Education Act of 2003, 2015), schools voluntarily participate in the AAIMS program. The goals of the programs are:

- To increase enrollments, including the traditionally underserved students, in AP mathematics, science, and English courses in all AR AIMS, Inc. schools.
- To increase the numbers of AP mathematics, science, and English test scores of 3, 4, and 5 in AR AIMS schools.
- To provide sustained professional development and targeted graduate level teacher preparation for Pre-AP and AP mathematics, science, and English teachers in AR AIMS schools.
- To build a cadre of AP teacher-leader content specialists in mathematics, science, and English statewide.
- To track students from AR AIMS schools from middle school (gain schools)

and high school (launch schools) through college admission, retention and graduation milestones.

- To institutionalize the AR AIMS organization at the University of Arkansas at Little Rock.

All goals are rooted in the belief that, by using AP programs, increasing participation, providing relevant professional development, and tracking students, overall student achievement will increase, specifically for those students involved in the program. Since beginning in the AAIMS programs, students participating in the program have recorded improvement in all AP content exams. They have also increased participation, especially for minorities and low-income students, and progressively increased the number of college hours awarded through the AP program (AAIMS, 2013b).

A key component of the AAIMS program is teacher training. Annual workshops are held in each of the AP courses in the three areas of focus for AAIMS (Mathematics, Science, and English-Language Arts). These workshops are made available to the teachers of the AP courses in their respective schools and are scheduled in various parts of the state to make them accessible to the teachers in the previously mentioned regions. Specific pedagogical information, teaching techniques, activities, and mentoring are made available to teachers. This professional development establishes a network of teachers, academic coaches, administrators, and personnel that assists in addressing the program's goals. Advisors or coaches are assigned to each school in each of the subject areas. These coaches travel to the school periodically to offer on-site assistance to the teachers, administrators, and occasionally the students. Coaches sit in classrooms

observing teachers in a non-threatening evaluation. Strategies in areas such as questioning, homework, assessment, and other areas are offered, discussed, and evaluated for possible inclusion into the program. As the year progresses, the relationship between the coaches and teachers deepens, greater trust is developed, and a level of trust about the nature of the visits becomes an integral part of the program. This relationship will usually last well beyond the first year. The program has received legislative and government support as an opportunity for students to become better prepared for college. The hope is that the program may increase to more schools and to blend with the curriculum to improve student achievement school-wide within the individual schools. This is especially true for underserved populations such as minorities, low-SES students, and females in areas such as mathematics and science.

Other Programs and Incentives

Other programs and incentives exist that are used by school districts in an attempt to increase student achievement. Closely related to AP is the International Baccalaureate (IB) program founded in 1968. The IB program is more international in scope than the AP program, which is used more widely in the United States. The concept of IB is more of a total, school-wide immersion in research, writing, and hands-on evaluation. Another difference is that IB has programs for elementary and middle school students (International Baccalaureate, 2014). AP has Pre-AP courses that are preparation for AP in high school and build on a scaffolding concept or vertical integration. Schools that have more international students, or in larger metropolitan areas, are more likely to use IB or use IB and AP in combination. The use of IB is another way in which talented minorities and low-income students may accelerate and be exposed to challenging curriculum that

would prepare them for university-level work (Kyburg, Hertberg-Davis, & Callahan, 2007). Kyburg et al. (2007) found that consistent, broad-based support from faculty and staff did indeed scaffold learning and assisted in promoting success for students that might ordinarily struggle with traditional school. Saaveda (2014) found that IB increased academic achievement, the probability of high school graduation, and the probability of college enrollment. Both males and females benefitted, but males more so.

Another contemporary idea for increasing student achievement is that of incentive pay, specifically in AP courses. Haessler (2007) determined that incentivized teachers of AP students did have higher levels of student participation and qualifying scores. Further analysis showed higher pass rates for students of incentivized AP teachers, as compared to non-incentivized AP teachers. Teachers themselves had mixed emotions about incentive pay, with incentivized teachers generally more in favor of pay dependent upon student performance than those non-incentivized teachers. The study did not determine any effect on incentive pay relative to race, gender, or SES.

Another model of incentive pay focuses on pay, not for teachers, but for students' performance on AP exams. The A+ Grant Program offers cash incentives for students who perform at a level of greater than or equal to three on any AP exam. Inman-Vann (2011), determined that differences in performance did exist, especially in terms of race and SES. There was not a significant difference by gender. Inman-Vann also found that the use of cash incentives was the strongest predictor of success on an AP exam. Minorities and low-SES students still had a relatively low pass rate, but the increase was directly attributable to cash incentives offered to students. Students who received cash incentives almost doubled the pass rate of non-incentive students.

Multiple states have established programs by which incentives are used in an attempt to bolster student achievement through AP programs. In 2012, the University of Notre Dame Institute for Educational Incentives worked in partnership with the National Math and Science Initiative and developed the Advanced Placement Training and Incentive Program (AP-TIP). Eight states participated: Alabama, Arkansas, Colorado, Connecticut, Kentucky, Indiana, Massachusetts, and Virginia (Adams, 2012). Teachers have the opportunity for summer staff development, with additional training during the fall and spring school semesters. The teachers received a $500 stipend for their extra time and had the incentive of $100 per student that passed (earning a score of greater than or equal to three) the AP exam for their course. Students also received $100 if they passed the corresponding exam. In Arkansas, students, teachers, and schools all receive monetary rewards for scores of greater than or equal to three on any AP exam.

Magnet schools are another attempt by educational leaders to address student achievement, with the idea of creating a school that has a focus, such as the arts, that would entice students to attend and theoretically increase their interest and educational focus. Although not purely academic in nature, magnet schools have also been used to address racial segregation in school districts. School districts have used them as a tool to lure students in a minority group into an area that may be predominate in one race in an attempt to balance the racial enrollment. This tactic can be used to draw White students into a predominate minority area or, conversely, to draw minority students into a predominately White area. The use of academic subject areas is one approach. In the Pulaski County Special School District and Little Rock School District, multiple magnets have been established in an attempt to address a federal court order to desegregate the

districts. There has been some success is drawing students into areas other than their home school zone, although there is little data to suggest that academically there has been an increase in student achievement. However, Villarreal (2010) did find that in Tennessee, a magnet school model did have a positive impact on academic achievement for males, females, and Latino students. Scores increased from 2007 to 2009 for each group. Gamoran (1996) found a widespread increase in student achievement, with schools using a magnet model drawing students into schools for specific reasons (arts, science/mathematics, etc.). Students scored higher in science, reading, and social studies than did their counterparts in regular high schools. There is research that counters the claim of increased student achievement. Viadero (1994) found no evidence of increased student achievement between students in magnet schools and those that attend non-magnet programs. She did not distinguish between the types of magnets schools.

One other, more contemporary approach, has been the integration of technology into school curricula with an eye toward improving student achievement. Children today are adept at many forms of technology. There are multiple videos of children who are not able to walk who appear to manipulate a cell phone, tablet, or computer successfully. Many, and many might argue most, students today have cell phones that are as powerful, in terms of data acquisition, as computers of just a few years ago. Schools have adopted strategies, such as 1:1 initiatives, that places a technological device, usually a laptop or tablet, with every student enrolled in grades K-12. In essence, the computer becomes their books. Since technology progresses at a very rapid rate, data to support the impact on student achievement are mixed. Sisco (2008) did find that there was a direct relationship between technology implementation and integration with student

achievement. Scores on the Tennessee Comprehensive Assessment Program exams increased in each year of technology integration from 2004 to 2006. The use of laptops has been a very popular approach, given the portable nature of the device, relatively low cost, and the ease with which students are able to use them in a classroom setting. In a study specifically looking at the impact of laptops on student achievement, Queener (2011) produced a study with research that technology initiatives do positively affect student achievement in mathematics, both short term and long term. As technological uses of devices progress in a classroom setting, teachers, administrators, parents, and most importantly students, will demand the use of devices.

There are many other programs, curriculums, and strategies designed to increase student achievement that are too numerous to mention in this study. It is clear from the research that programs that focus on college preparatory work (AP/IB) are used by many schools across many categories. Schools, regardless of their characteristics such as enrollment size, being urban or rural, high minority, low or high SES, or region, employ these programs as a way to prepare students for rigorous college course work. These programs are also used as a way to increase overall student achievement through students who take classes other than AP and as a way for teachers to develop skills in AP training that may carry-over into non-AP courses, thereby helping students that may not be taking AP improve academically.

CHAPTER III

METHODOLOGY

Increasing student achievement has long been a goal of any educational establishment. In the early days of education, students were informally educated in a one-room school house and moved along a somewhat arbitrary grade system where they could exit at virtually any level. In a more modern model, students in grade levels advance based on achievement of mastery in a grade or subject, ultimately graduating after 13 years in most American schools. At each level, teachers focus on mastery and increasing each student's achievement based on various formal and informal assessments.

The AP program as administered by the College Board has been a staple in many American schools for over 50 years (College Entrance Examination Board, 2014). It has a challenging college-level curriculum that is used by schools throughout the United States in an attempt to increase student achievement and to close achievement gaps. Leonard et al. (2004) looked at AP programs in terms of an intervention strategy to close the achievement gap for minority students. Similarly, Fnu (2011) found that barriers for minorities and gender can be addressed by the use of AP programs. The state of Arkansas, in 1997, passed legislation that provided incentives to schools, teachers, and students for participation in AP programs. The result was increased participation by minority and low-income students throughout the state. A critical component of AP programs is teacher preparation. Student achievement has been shown to increase by as much as 21 percentile points if teachers receive substantial professional development that

was defined as an average of 49 hours (Yoon et al., 2007). Teachers in high schools, teaching college-level curricula, require more than just a precursory workshop that introduces the curriculum. The College Board offers extensive training, in a variety of subjects, for teachers (College Entrance Examination Board, 2014). The AAIMS program takes school districts, schools, and teachers further than the one-time workshop. Schools that voluntarily participate have mentor-access for their teachers that is on-site, ongoing, and targeted to the specific needs of the teachers and their subjects.

The hypotheses of this study were threefold. First, no significant difference will exist by gender between students in the two AAIMS schools versus the two non-AAIMS schools on academic achievement as measured by the AP Calculus exam scores. Second, no significant difference will exist by race between students in the two AAIMS schools versus the two non-AAIMS schools on academic achievement as measured by the AP Calculus exam scores. Third, no significant difference will exist by SES status between students in the two AAIMS schools versus the two non-AAIMES schools on academic achievement as measured by the AP Calculus exam scores.

Research Design

The research design of the study was a quantitative, causal-comparative strategy that used logistic regression. Reliance on statistical analysis of data in numeric form allowed the investigator a quantitative look at a problem (Creswell, 2015). Gay, Mills, and Airasian (2012) found that a quantitative study allows for the collection of data with analysis that will describe, explain, and predict outcomes.

Researchers, as a general rule, are concerned with basic attributes such as simplicity and symmetry. They look for order and seek to make sense out of data that

can, and many times does, predict outcomes. The prediction of future events, based on a set of variables, is the goal of any research project. Horace (65-5 BC) stated, “There is measurement is all things.” Further, in 1882, Heike Kamerlingh Onnes (1882) stated, “Measuring is knowing” (Laesecke, 2002, para. 264). The idea is being that if something can be measured and measurement can also be applied to the impact, a prediction can be made.

The use of logistic regression is used to describe the relationship between an outcome (dependent) variable and a set of independent (predictor) variables. It is commonly used in medical research because diseases and most risk factors are categorical variables. Hosmer and Lemeshow (2000) related that the logistic regression model had become the standard method of analysis in this situation. The goal of the logistic regression analysis is to find the best fit and reasonable model to describe the relationship between a dependent variable and a set of independent variables. It is important to note the study focused on prediction, not outcome. In this study, the researcher attempted to predict the effect of the AAIMS program on AP Calculus AB achievement as measured on the 2015 AP Calculus AB exam administered by the College Board. The dependent variable of Calculus achievement was analyzed in terms of the active predictor variable of the AAIMS program and the independent attribute variables of race, gender, and SES. All three independent variables were dichotomized. Gender was divided into male and female. SES was divided into those students eligible for free and reduced lunches (F/R) and those not eligible (Regular). Students are eligible for free and reduced lunches either by being designated as homeless by their home school or by meeting guidelines established by the United States Department of Agriculture,

Food, and Nutrition Service (2016). These guidelines are established yearly, published, and disseminated to schools throughout the United States; they are also published for the general public in the Federal Register (United States Department of Agriculture, Food, and Nutrition Service, 2016). Students in 2014-2015 qualified for reduced meals if their families met 185% of household income levels as established by the Federal Poverty Guidelines. For example, a family of four with a combined annual income of $44,123 in 2014 would qualify for reduced-price breakfast and lunch. Students also qualify for free breakfast and lunch dependent upon the yearly family income and household size. For example, a family of four with an annual income of $23,850 in 2014 would qualify for free breakfast and lunch at their respective schools. This is a sliding scale that is based on the income and number of family members in a household (United States Department of Agriculture, Food, and Nutrition Service, 2016).

Race was actually divided into three categories: White, Black, and Other. All students in the data set could be dichotomized by gender and SES. Race presented a more complex problem. All of the students did not fit into a dichotomized Black or White; therefore, the category became White and non-White. This allowed the data set to be uniformly used in the analysis.

Scores were also dichotomized into Pass and Fail. All AP exams are scored on a scale of 1-5. A score of 1 is the lowest possible score ranging to a 5, the highest score (College Entrance Examination Board, 2014). Most colleges award college credit, based on their respective policies, for scores of 3, 4, and 5. Based on the practice of most colleges of awarding credit for those scores, the dichotomy established was Pass for a score of 3 and above, and Fail as a score of 2 and below.

Sample

The sample consisted of four public high schools located within the state of Arkansas. All of the schools were chosen based on similar size as determined by the classification system used by the Arkansas Activities Association (2015). Schools are categorized into classifications, 7A to 1A, with 7A being the largest classification. This classification system is based on enrollment of Grades 9-12. Schools are classified in 2-year cycles and then are reclassified every 2 years based on enrollment gains or losses (Arkansas Activities Association, 2015). Three of the selected schools are classified as 6A (second largest classification) with 9-12 enrollments ranging from 907.67 to 1,115.33. One of the selected schools is classified as a 5A school with a 9-12 enrollment of 542. Two of the schools were chosen because of their participation in the AAIMS program. Two were chosen because of their lack of participation in the AAIMS program. Table 1 indicates the total number of students in both the AAIMS and Non-AAIMS schools by gender, race, and SES who took the AP Calculus AB.

Table 1

2015 AAIMS and Non-AAIMS School Participants Taking the AP Calculus AB by Gender, Race, and SES

	Gender *n*		Race *n*		SES *n*	
School	M	F	White	Non-White	Free/Reduced	Regular
1	7	13	7	10	8	12
2	18	19	31	9	4	33
Total	25	32	38	19	12	45
3	15	10	23	2	2	23
4	6	14	0	20	13	7
Total	21	24	23	22	15	30

Note. AAIMS Participants = Schools 1 & 2; Non-AAIMS Participants = Schools 3 & 4.

The data suggests that a majority of students taking the 2015 AP Calculus AB exam are not minority students nor do they qualify for free/reduced lunch and breakfast. The distribution between males and females is not as pronounced although more females took that exam than males in the four selected schools.

All of the chosen high schools are considered to be in Central Arkansas although three of the schools are located on the outer edge of what is considered Central Arkansas and border other regions of the state. One of the selected schools borders the Southeast part of Arkansas, one borders Western Arkansas, and the other borders Northeast Arkansas. One of the selected schools is considered urban while the other three can be classified as suburban. Each of the schools is within a 75-mile radius of Little Rock, the capital of Arkansas.

Instrumentation

The researcher used the results from the 2015 AP Calculus AB exam. The exam is given on the same day to all AP Calculus AB students across the nation. Testing sites are approved by the College Board after individual schools complete the required participation form for AP programs and testing (College Entrance Examination Board, 2014). AP Coordinators selected by the individual schools follow the AP Coordinators Manual where various requirements relative to seating, materials, proctors, etc. are delineated (College Board, 2017a). In most instances, schools are large enough to accommodate multiple students taking the exam. Accepted practice in Arkansas is that most schools will administer the exams in the school in which the students attend. Administration of the exam is with administrators and proctors approved by the College Board (College Entrance Examination Board, 2014). The vast majority of the test administrators are NOT the teachers of the AP Calculus AB course.

The test is a national norm-referenced exam given on the same date across the nation (College Entrance Examination Board, 2014). The exams are shipped to the testing location and are secured to be opened only by the test administrator. Test security is highly promoted by the College Board with procedures that are uniform and expected to be followed precisely (College Entrance Examination Board, 2014). Once the exam is administered and completed by the students, the tests are boxed, secured, and shipped to the College Board, once again following a procedure expected to be followed explicitly. Once received by the College Board, they are graded by a set of specifically trained readers. The exams are then scored on a scale of 1-5 with 5 being the highest. All readers

are trained by the College Board in the specific criteria of the course and requirements for scoring (College Entrance Examination Board, 2014).

Data Collection Procedures

The 2015 AP Calculus AB exam was administered on Tuesday, May 5, 2015, beginning at 8:00 a.m. in each respective time zone across the United States. To gather the data, the researcher contacted the superintendent of each of the four school districts of the high schools and Ken James, Director of the AAIMS program. After a courtesy phone call, a letter requesting the data was sent to each of the superintendents of the non-AAIMS schools. Data collected from AAIMS schools were collected from the AAIMS office located on the campus of the University of Arkansas-Little Rock in Little Rock, Arkansas. The AAIMS program collects data on all AAIMS participants. Letters requesting the data were also sent to the superintendent of the AAIMS schools as a courtesy. Privacy and confidentiality were assured to each of the superintendents. Results were obtained in the spring of 2016 from each of the four schools with the relevant data coded and entered into *IBM Statistical Package for the Social Sciences (SPSS) Version 23*.

Analytical Methods

The analytical methods began by an examination of the data collected. Once collected and determined to be acceptable, the information was put into an Excel spreadsheet sorted by school. The data were categorized by race, gender, SES, score, and AAIMS participation with each student's score numerically assigned with columns identifying by race, gender, SES, and AAIMS participation. Once the spreadsheet was

complete, the data were imputted into the *IBM Statistical Package for the Social Sciences (SPSS) Version 23.*

Descriptive statistics were employed to address each hypothesis in the study. To test each null hypotheses, binary-logistic regression analysis was conducted to determine if the independent variables significantly predicted the dependent variables. In Hypothesis 2, Hosmer and Lemeshow tests determined a significant relationship between the IV of participation and the DV of race which precluded any analysis. Huck (2012) stated that logistic regression focuses on relationships among variables, with one dependent, categorical variable and one or more independent variables. The independent variables may be categorical and should be used to predict outcomes. The dependent variable was dichotomous (pass or fail), and the independent variables (participation or non-participation, gender, race, SES) were categorical. For each null hypothesis, 2-tailed tests were performed with alpha levels set at .05. The SPSS software was used to run a logistic regression of the hypotheses.

Limitations

This study examined the predictive effect of the AAIMS program on 2015 AP Calculus AB achievement. To accomplish this, the researcher examined the 2015 AP Calculus AB scores for four Arkansas high schools. Certainly, one limitation was choosing only one year, 2015, for statistical analysis. In order to accurately find trend data relative to AP Calculus AB scores, multiple years should be included. A longitudinal study of AP Calculus AB scores for all students in Arkansas by gender, race, and SES would yield far more data and would make statistical analysis more accurate given the

much larger sample size. The increase in participants would also produce more students in the respective categories of gender, race, and SES.

A second limitation was the availability and participation in AP programs in the state of Arkansas. In 1995, the state of Arkansas established the *Arkansas Advanced Placement and International Baccalaureate Diploma Incentive Program* (Saaveda, 2014). The Act provided funding for the start-up of AP and IB programs throughout the state. Grants for equipment, teacher and student incentives, exam fee assistance, and funds for initial training were allocated. Additionally, every school district in the state of Arkansas was mandated to offer at least one AP course in each of the four content areas: Mathematics, Science, Language, and Social Studies. Other courses in the arts were also encouraged. Schools began to develop and implement AP courses across the state. This was at a time when concurrent, online, CIV, and other contemporary methods of delivery were either not available or were in the infancy stages. Students had the opportunity to obtain college credit while in high school if they could pass (≥ 3) the relevant exam. In mostly rural states like Arkansas, there were mixed results. Many schools struggled to get more than a few students to take the courses and exams, and faculty assignments were difficult since one teacher had to be committed to only a few students. More students in urban areas and in larger schools took the opportunity. Consequently, the bulk of students taking AP courses and exams were from larger metropolitan areas, and as one might expect, had more students passing AP exams. After some 20 years, many medium to smaller high schools in Arkansas struggled to recruit students to take AP exams despite the financial assistance to low-SES students. Although mandated to offer AP courses, many schools have few, or only one, student taking the course.

Another limitation was the selection of only four Arkansas high schools to study. By comparing schools that participated or did not participate in the AAIMS program, the researcher was limited to looking first at the 50 high schools in Arkansas that did participate in the AAIMS program. Some of those schools were still listed as members in AAIMS but were not actively participating. Others may only have very few students enrolled in AP Calculus AB. As previously mentioned, the pool of students for data collection came from larger high schools in urban or semi-urban settings. Three of the schools had a semi-diverse population, but one school was homogenous in terms of race, which was the major factor in the inability to complete Hypothesis 2. It is clear that more minority students are taking AP Calculus AB, but there is still a lack of students in small, rural areas of low-SES taking the course.

An additional limitation was the lack of diversity of students who do participate in AP programs. The initial research was to focus on 10 Arkansas high schools spread geographically across the state. However, schools might offer AP Calculus AB, but in many instances, there were so few students, especially minority students, taking the exam that data collection was not possible. In many instances, while searching for high schools that had a large enough population taking the AP Calculus AB exam, the population was overwhelmingly, if not entirely, homogenous in terms of race. This was the major factor in this researcher being unable to complete a statistical analysis of Hypothesis 2 successfully. Even in school districts with high concentrations of minority students, there were very few, if any, students taking AP Calculus AB. Anecdotally, there did seem to be a larger percentage of Asian or Latino students taking the exam compared to Black students, although the percentages of Asian and Latino students were also inadequate,

unless the high school was exceptionally large as determined by the Arkansas Activities Association (2015) classification.

Closely following the previous limitation was the lack of low-SES students taking the AP Calculus AB course and exam. Although the fees for taking the exam are waived for low-SES students, few students statewide avail themselves of the course and exam.

Another limitation was the uneven approach to the offering and teaching of AP Calculus AB in non-AAIMS schools. High Schools in Arkansas must offer one AP course in each of the four core areas of mathematics, science, social studies, and language arts (Arkansas Department of Education, 2009). Many schools do offer AP Calculus AB, but if only one or very few students take the course, school administrators can use distance learning opportunities to administer the course. However, the delivery of instruction from teachers that are not physically present is problematic. Although distance learning can solve the problem of using a teacher for very few students, the quality and level of instruction many times ranges from good to very poor.

This chapter presented the research design for an investigation of the predictive effects of the AAIMS program on AP Calculus AB exam achievement. The various sections of this chapter discussed the research design, sample of the population, instrumentation, data collection, analytical methods, and the limitations of the study. The results of a quantitative logistic regression for the four Arkansas high schools are discussed in the following chapter.

CHAPTER IV

RESULTS

The researcher used a quantitative logistic regression for this study. Data for this study were comprised of existing 2015 AP Calculus AB scores for high school students in four high schools, in four separate school districts, in Arkansas. All four high schools were located within a 75-mile radius of Little Rock, the most populous area of Arkansas. One high school is considered urban; three are considered suburban. Two of the high schools participated in the AAIMS program; two did not.

The dependent variable for each hypothesis was mathematics achievement measured by the 2015 AP Calculus AB scores, dichotomized into pass (scores 3, 4, or 5 on a 1-5 scale) and fail (scores 1 or 2). The independent variables were also dichotomized and included gender (male or female), race (White or non-White), and SES status (free or reduced lunch/breakfast or regular paid lunch/breakfast). Logistic regression was run on two of the three research hypotheses. Prior to running a regression on Hypothesis 2, tests showed the existence of a linear relationship between each predictor and the logit of the dependent variable. Consequently, no analysis was performed. The results of the other two analyses are in this chapter.

Hypothesis 1

Hypothesis 1 stated no significant predictive effect will exist between gender and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam scores for students in two AAIMS schools versus two non-AAIMS schools. In

the model, all the variables were dichotomous: AAIMS participation (participating versus non-participating), gender (male versus female), and AAIMS achievement mathematics performance (pass versus fail). Table 2 provides a summary of demographic statistics associated with the analysis of this hypothesis.

Table 2

Demographic Statistics for AAIMS Participation and Gender on Mathematics Performance

	Participating				Non-Participating			
	Male		Female		Male		Female	
Math Performance	*n*	%	*n*	%	*n*	%	*n*	%
Pass	12	22.6	25	47.2	9	17.0	7	13.2
Fail	13	26.5	7	14.3	12	24.5	17	34.7

To test the hypothesis, a logistic regression was conducted to assess whether AAIMS participation and gender significantly predicted how well students performed in mathematics categorized as pass or fail. Prior to conducting logistic regression, the assumption of independent observations and the existence of a linear relationship between each predictor and the logit of the dependent variable were checked and met. Hosmer and Lemeshow test results ($\chi^2 = 5.29$, $df = 2$, $p = .071$) revealed that this relationship was not significantly different from normal (Field, 2009). A total of 102 cases were analyzed, and the full model (AAIMS participation and gender) significantly predicted performance in mathematics, omnibus $\chi^2 = 10.06$, $df = 2$, $p = .007$. Further

examination of the model's R^2 estimates indicated that it predicted 9.4 to 12.5% of the variation in mathematics performance, with 69.8% of those who passed mathematics successfully predicted. This would be considered a medium effect size (Leech, Barrett, & Morgan, 2015). However, only 59.2% of predictions for those who failed mathematics were accurate. Overall, the prediction accuracy of the final model that included both predictors had an overall prediction accuracy of 64.7%, which was better compared to the overall prediction accuracy of 52.0% for the initial model when only the constant was included. Table 3 gives the coefficient, the probability value, and the odds ratio with the 95% confidence limits for each of the predictor variables for predicting mathematics performance/achievement.

Table 3

Logistic Regression Predicting Mathematics Performance

			95% CI for Odds Ratio		
Variable	*B(SE)*	*p*	Lower	Odds Ratio	Upper
Constant	-0.360 (.356)	.313		0.698	
Participation	1.213 (.420)	.004	1.476	3.362	7.660
Gender	-0.469 (.419)	.263	0.275	0.626	1.422

Note: R^2 =.125 (Nagelkerke), .094 (Cox & Snell).

Based on the above table, the individual contribution of gender to the model for predicting mathematics performance/achievement was not statistically significant, and therefore, its odds ratio could not be clearly interpreted. However, participation in AAIMS reliably predicted mathematics performance/achievement. Based on the results,

it can be said that participation in AAIMS increased the logit of passing the mathematics test by 1.213 unit. Moreover, the resulting odds ratio suggested that the odds of passing the mathematics test were 3.362 times greater for participating students compared to non-participating students when controlling for gender (77.07% greater chance of passing).

Hypothesis 2

Hypothesis 2 stated no significant predictive effect will exist between race and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam scores for students in two AAIMS schools versus two non-AAIMS schools. In the model, all the variables were dichotomous: AAIMS participation (participating versus non-participating), race (White versus Non-White), and AAIMS achievement mathematics performance (pass versus fail). Table 4 provides a summary of demographic statistics associated with the analysis of this hypothesis.

Table 4

Demographic Statistics for AAIMS Participation and Race on Mathematics Performance

	Participating				Non-Participating			
	White		Non-White		White		Non-White	
Math Perf.	*n*	%	*n*	%	*n*	%	*n*	%
Pass	27	50.9	10	18.9	16	30.2	0	0.0
Fail	11	22.4	9	18.4	8	16.3	21	42.9

To test the hypothesis, a logistic regression was conducted to assess whether AAIMS participation and gender significantly predicted how well students performed in

mathematics categorized as pass or fail. Prior to conducting logistic regression, the assumption of independent observations and the existence of a linear relationship between each predictor and the logit of the dependent variable were checked and met. However, Hosmer and Lemeshow test results ($\chi^2 = 8.99$, $df = 2$, $p = .011$) revealed a statistically significant difference, and therefore, the model did not fit the data presented (Field, 2009). Therefore, because the model did not fit the data, no analysis was conducted.

Hypothesis 3

Hypothesis 3 stated no significant predictive effect will exist between SES and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam scores for students in two AAIMS schools versus two non-AAIMS schools. In the model, all the variables were dichotomous: AAIMS participation (participating versus non-participating), SES (free/reduced lunch versus regular paid lunch), and AAIMS achievement mathematics performance (pass versus fail). Table 5 provides a summary of demographic statistics associated with the analysis of this hypothesis.

Table 5

Demographic Statistics for AAIMS Participation and SES on Mathematics Performance

	Participating				Non-Participating			
	Free/Reduced		Regular		Free/Reduced		Regular	
Math Perf.	*n*	%	*n*	%	*n*	%	*n*	%
Pass	7	13.2	30	56.6	1	1.9	15	28.3
Fail	5	10.2	15	30.6	14	28.6	15	30.6

To test the hypothesis, a logistic regression was conducted to assess whether AAIMS participation and SES significantly predicted how well students performed in mathematics categorized as pass or fail. Prior to conducting logistic regression, the assumption of independent observations and the existence of a linear relationship between each predictor and the logit of the dependent variable were checked and met. Hosmer and Lemeshow test results ($\chi^2 = 3.59$, $df = 2$, $p = .166$) revealed that this relationship was not significantly different from normal (Field, 2009). A total of 102 cases were analyzed, and the full model (AAIMS participation and SES) significantly predicted performance/achievement in mathematics, omnibus $\chi^2 = 14.76$, $df = 2$, $p = .001$. Further examination of the model's R^2 estimates indicated that it predicted 13.5 to 18.0% of the variation in mathematics performance, with 56.6% of those who passed mathematics successfully predicted. This would be considered a large effect size (Leech et al., 2015). Yet, 69.4% of predictions for those who failed mathematics were accurate. Overall, the prediction accuracy of the final model that included both predictors had an overall prediction accuracy of 62.7%, which was better compared to the overall prediction accuracy of 52.0% for the initial model when only the constant was included. Table 6 gives the coefficient, the probability value, and the odds ratio with the 95% confidence limits for each of the predictor variables for predicting mathematics performance/achievement.

Table 6

Logistic Regression Predicting Mathematics Performance

			95% CI for Odds Ratio		
Variable	*B(SE)*	*p*	Lower	Odds Ratio	Upper
Constant	-0.888 (.310)	.004		0.411	
Participation	1.140 (.430)	.008	3.128	1.347	7.262
SES	1.184 (.500)	.018	3.268	1.227	8.706

Note: R^2 =.135 (Nagelkerke), .180 (Cox & Snell).

As indicated in the above table, the individual contribution of SES to the model for predicting mathematics performance/achievement was statistically significant. Based on the results, it can be said that participation in the regular lunch program increased the logit of passing the mathematics test by 1.184 unit. Moreover, the resulting odds ratio suggested that the odds of passing the mathematics test were 3.268 times greater for regular paid lunch students compared to free/reduced lunch students when controlling for program participation (76.57% greater chance of passing). In addition, participation in AAIMS reliably predicted mathematics performance/achievement. Based on the results, it can be said that participation in AAIMS increased the logit of passing the mathematics test by 1.140 unit. Moreover, the resulting odds ratio suggested that the odds of passing the mathematics test were 3.128 times greater for participating students compared to non-participating students when controlling for SES (75.78% greater chance of passing).

CHAPTER V

DISCUSSION

This study looked at the effects of gender, race, and SES coupled with the impact of participation in the AAIMS program on AP Calculus AB test achievement in four Arkansas schools. Findings indicate that participation in the AAIMS program does increase the potential of earning a passing score on the AP Calculus AB test for some students relative to gender and SES. Currently, there is a lack of research on the effects of the AAIMS program on AP test achievement for students in Arkansas schools. Achievement was improved by students participating in AP courses and, by extension, the performance of those students in those AP courses also affected their school-wide achievement (Christiansen, 2009). Additionally, when students who participated in AP courses entered college, the credits earned through AP courses while in high school were better predictors of success in college compared to standardized test scores (D'Aquino, 2011).

The researcher examined the scores of students in four Arkansas high schools. Two of the schools participated in the AAIMS program, and two did not participate. This chapter presents the researcher's conclusions based on an interpretation of the results for each of the three hypotheses. Any implications of the study are noted and interpreted for further study or impact on current education policy or practice. The chapter concludes with a discussion of the potential uses and expansion of the program within the state of Arkansas with recommendations for educators for AP programs.

Conclusions

Hypotheses 1 and 3 were analyzed using a quantitative logistic regression. Hypothesis 1 explored the interaction of the variables of gender and AAIMS participation on AP Calculus AB achievement as measured by the 2015 AP Calculus AB exam. Hypothesis 2 explored the interaction of the variables of race and AAIMS participation on AP Calculus AB achievement as measured by the 2015 AP Calculus AB exam, and Hypothesis 3 examined the interaction of the variables of SES and AAIMS participation on AP Calculus AB achievement as measured by the 2015 AP Calculus AB exam as well. Hosmer and Lemeshow tests were run on each of the hypotheses to examine the goodness of fit between the data and the model. The following hypotheses directed the study. Each of the hypotheses is presented with the conclusions drawn that were based on the findings.

Hypothesis 1

Hypothesis 1 stated that no significant predictive effect will exist between gender and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam for students in two AAIMS schools versus two non-AAIMS schools. Prior to conducting logistic regression, the assumption of independent observations and the existence of a linear relationship between each predictor variable and the logit of the dependent variable were checked and met. No significant interaction was discovered between the variables of gender and AAIMS participation. Examinations of the AP Calculus AB scores did find significant differences between the AP Calculus AB scores of students who had participated in the AAIMS program versus those that had not participated. Participation in AAIMS reliably predicted mathematics performance

showing that the odds of passing the AP Calculus exam were 3.362 times greater for students who participated in the AAIMS program than those that did not participate. This is a significant finding in terms of AAIMS participation for both male and female students. Upon closer examination, gender was not a statistically significant predictor of increased mathematics achievement on the AP Calculus AB exam. Therefore, no significant difference was found between males and females, regardless of their AAIMS program participation.

Hypothesis 2

Hypothesis 2 stated no significant predictive effect will exist between race and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam for students in two AAIMS schools versus two non-AAIMS schools. Prior to conducting logistic regression, the assumption of independent observations and the existence of a linear relationship between each predictor and the logit of the dependent variable were checked and met. Unfortunately, Hosmer and Lemeshow test results showed a statistically significant difference, which meant that the model was not a good fit for the data. This resulted in no analysis being conducted since the model did not fit the data as presented. This finding is a limitation and should become a consideration for further study.

Hypothesis 3

Hypothesis 3 stated no significant predictive effect will exist between SES and participation in AAIMS on mathematics achievement as measured by the AP Calculus AB exam for students in two AAIMS schools versus two non-AAIMS schools. Prior to conducting logistic regression, the assumption of independent observations and the

existence of a linear relationship between each predictor variable and the logit of the dependent variable were checked and met. No significant interaction was discovered between the variables of SES and AAIMS participation. Examinations of the AP Calculus AB scores did find significant differences between the AP Calculus AB scores of students who had participated in the AAIMS program versus those that had not participated. Participation in AAIMS reliably predicted mathematics performance showing that the odds of passing the AP Calculus exam were 3.128 times greater for students who participated in the AAIMS program than those who did not participate. Upon closer examination, SES was a statistically significant predictor of increased mathematics achievement on the AP Calculus AB exam. Regular students, or those that did not qualify for free/reduced lunch and breakfast had odds 3.268 times higher of passing the AP Calculus AB exam compared to those that did qualify for free/reduced breakfast and lunch. This is a significant finding in terms of AAIMS participation for students that qualify for free/reduced breakfast and lunch.

Implications

This study and the outcomes must be examined within a context of whether participation in the AAIMS program increases the likelihood that a student will receive a passing score on the AP Calculus AB exam. With no existing research on the impact of the AAIMS program on AP scores, this study is simply a first step in making a determination as to whether the program will increase the likelihood that students will make passing scores on AP exams. The findings indicated that there are greater odds for both male and female students who participated in AAIMS to perform better on the

exams. The findings also indicate that students who qualify for free/reduced breakfast and lunch may also benefit from participation in the program.

Increasing Mathematics Achievement

Students who took AP courses and the corresponding exam exhibited better preparedness and actually performed better during their first year of college than their counterparts who did not participate in AP courses (D'Aquino, 2011). By implementing the Spring Board curriculum, designed by the College Board specifically for Language Arts and Mathematics AP courses, student achievement increased, particularly for minority students (Ayres, 2011).

Gender

The current study focused on the effects of the AAIMS program by the gender of the students who participated in the AAIMS program and those that did not by quantifying mathematics achievement as measured by the 2015 AP Calculus AB exam. Because no significant difference existed between males and females and because a significant difference did exist for AAIMS participation, there existed a significant advantage for both male and female students. The researcher found that students who participated in the AAIMS program had statistically significant higher odds of passing the AP Calculus AB exam, thus indicating that participation in the AAIMS program could place students at a significant advantage relative to mathematics achievement. Participation increased the logit of passing the AP Calculus AB exam. When controlled for gender, students in schools that participated in the AAIMS program were more than three times more likely to have a passing score on the AP Calculus AB exam than students who took the exam in non-AAIMS schools.

As previously mentioned, there is little research on the AAIMS program and its effects on academic achievement. However, Burton et al. (1988) found a decline of 10 mathematical mean score points between males and females on the SAT exam. The SAT and AP are both administered by the College Board, and while not the same exam, they are similar in that both are tied to post-secondary studies. The SAT, like AP, is a nationally normed exam that is used to judge college preparation. AP exams are nationally normed exams on content specific curricula. A College Entrance Examination Board (1998) study indicated that differences persisted between females and males in high school course preparation, which did affect performance on standardized tests. Generally, females are less likely to take mathematics courses and, by extension, upper-level mathematics courses. Although only four Arkansas high schools were used, more females took AP Calculus AB exams in both the participating and non-participating schools compared to males. The success rate (≥ 3) for females was higher in the two high schools that participated in AAIMS compared to their male counterparts. Nearly half of all female students who took the 2015 AP Calculus AB exam in AAIMS schools produced a successful score, and only one in seven in non-AAIMS schools had passing scores. Participation in the AAIMS program does appear to have an impact on mathematics achievement. This is particularly encouraging given the continued lack of females in occupations that rely heavily on mathematics skills.

Race

The effects of the AAIMS program by the race of the students who participated in the AAIMS program and those who did not by measuring mathematics achievement as measured by the 2015 AP Calculus AB exam constituted a portion of the study. No

analysis was conducted due to a violation of Hosmer and Lemeshow tests that revealed that there was a statistically significant difference between the model produced and the data it was supposed to represent. The variable of race was dichotomized into White and non-White, which encompassed all students taking AP Calculus AB exams who did not identify as White. This included races listed as Black, Latino, Asian, and American Indian. One item of note was that within the two non-AAIMS schools, participating non-White students were successful in passing the 2015 AP Calculus AB exam. One in five of non-White students in AAIMS schools successfully passed the exam. Although the pass rate might not be seen as successful, when compared to their counterparts in non-AAIMS school, it brought attention to participation in the AAIMS program as having an effect on the possible success of non-White students. Another notable finding for White students in the AAIMS schools was that more than half had successful scores on the 2015 AP Calculus AB exam compared to less than a third of White students in non-AAIMS schools. This seemed to further support the conventional wisdom of existing racial achievement gaps, especially in mathematics. Leonard et al. (2003) found that the use of AP as an intervention strategy is commonly used to narrow the achievement gap. Later, Saunders et al. (2005) found that a Minority Scholars program developed in 1996 that promoted AP involvement increased participation and achievement among minority students. Burdman (2000) and Planty et al. (2007) found that AP participation was one of the best predictors of academic success in both the short and long term for minority students. However, there still exists a scoring gap between the races in AP exams (“More Blacks are competing,” 2009).

A major limitation of this study is the lack of Black students taking AP Calculus AB exams and the AP Calculus AB course. The use of only four Arkansas high schools was driven in large measure by the lack of numbers of Black students to use in the study. The data collection process revealed that highest schools in Arkansas do not have Black students taking AP Calculus AB. This is especially true in smaller schools below the 5A classification level as determined by the Arkansas Activities Association (2015). Although a generalization, it seemed that *if* a high school had Black students taking AP Calculus AB, *then* that school was a larger, more urban, high school. Accurately judging the impact of the AAIMS program on minority students' achievement will be hard if there is not a reasonable pool of Black students who take AP Calculus AB exams in Arkansas.

SES

The current study focused on the effects of the AAIMS program by the SES of the students who participated in the AAIMS program and those that did not by measuring mathematics achievement as measured by the 2015 AP Calculus AB exam. There does exist a significant advantage to participating in the AAIMS program relative to mathematics achievement. When controlling for SES, students in AAIMS schools were three times more likely to have successfully passed the 2015 AP Calculus AB exam than those in non-AAIMS schools. In a study that was not focused on AP, Tate (1997) found that there were differences in mathematics achievement relative to students' SES. Robinson et al. (1999) found that Legislative Act 929 in Arkansas that offered incentives to schools expanding AP programs increased low-SES students' participation in AP programs. The effect on mathematics achievement was not studied.

It is interesting to note that of the four Arkansas high schools studied, there were 27 students who qualified for free/reduced breakfast and lunch who took the AP Calculus AB exam compared to 75 students that did not qualify. This could be a function of the cost of taking the exam. The cost of the 2015 exam was $91 each, though the cost could be subsidized by local or state programs. Financial aid was available for students who qualified for it; the exam reduction was $26 or $28 per exam from College Board plus an additional $8 rebate per fee-reduced exam from the school. In addition, Arkansas state law allowed the state to pay in full the exam fees or a pro rata share of the exam (Arkansas Advanced Placement and International Baccalaureate Diploma Incentive Program Act of 1995, 2015). The success rate for the exam, for low SES students, in both participating and non-participating schools was significantly lower than those that did not qualify. However, it is noted that the percentage of low-SES students passing the exam in participating schools was higher compared to those in non-participating schools.

In some Arkansas high schools, there may be only a few students, or only one student, taking AP Calculus AB exams. Arkansas ranks near the bottom in many economic factors with an average yearly income of $42,000. Although more students are taking and successfully passing AP exams, there may exist a disconnect of students that need the challenge and opportunity of AP courses and exams but, due to economic factors, cannot afford to pay for them despite programs to subsidize the cost of the exams.

Recommendations

Practice and Policy

The concerted approach to developing and implementing AP programs in Arkansas in the late 1990s was significant. AP has been an important part of American schools since the late 1950s and has consistently grown in significance and influence across the nation. Christiansen (2009) determined that AP programs have been successful in addressing student achievement school-wide as well as in specific content areas. In addition, Ayres (2011) confirmed that the same was true especially for minority students. As school leaders are tasked with preparing students for college or career, AP programs should be considered.

There exists a distinct advantage for students in schools that participated in the AAIMS program relative to passing the AP Calculus AB exam. Specifically, both male and female students in schools that participated in the AAIMS program were more likely to have a passing score (≥ 3) than those students in schools that did not participate. Additionally, students that were classified as low-SES, as determined by free/reduced lunch eligibility as well as those that did not qualify, performed better on the AP Calculus AB exam than students of similar SES in schools that did not participate in the AAIMS program.

Although a thorough statistical analysis of students' mathematical achievement by race could not be performed, data did suggest a higher pass rate for students in schools that participated in the AAIMS program. Leonard et al. (2003) and Wiley (1989) determined that AP programs do have a positive effect for minority students. The AAIMS program goes further than the requisite AP training. The training that teachers receive as

part of the AAIMS program plays a part in the success of the students. Students in schools that did not participate in the AAIMS program still passed the AP Calculus AB exam but at a lower rate than those students who were in schools that participated in AAIMS.

There are potentially multiple reasons why the AAIMS program appears to have such a dramatic impact on student achievement, particularly in the area of AP Calculus AB. The program is voluntary, which indicates that teachers who receive the training are there of their own volition. Teachers are more likely to assume ownership and accountability if they choose to be involved in the training and implementation of the AAIMS program. This ownership then transfers to the classroom and to instructional delivery. By implementing those strategies, skills, and suggestions developed by the AAIMS training, there is a direct result on student achievement. Ongoing professional development and relationships developed between AAIMS mentors and teachers also help to ensure continuity in implementation. Incentives may also play a part in the success, both for teachers and students. Monetary awards given for score attainment to teachers and students incentivize the achievement. Inman-Vann (2011) and Hassler (2007) both found a correlation between incentives and higher scores on AP exams. Another potential impact of the AAIMS program is the coordinated, systemic approach to improving AP for students and teachers in Arkansas. The AAIMS program is housed on the campus of the University of Arkansas-Little Rock. The goals of strengthening the teaching of AP in the areas of mathematics, science, and English help to focus the resources in specific areas. Although not negating the impact of other AP areas (art,

music, social studies, etc.), a concentration in three content areas allows the impact of the program to be greater than a broader approach that might stretch resources and personnel.

In terms of academic achievement in high schools, school leaders should strongly consider joining and implementing AAIMS in every high school in Arkansas. Nationally, the implementation of AP programs has positive benefits. Bragg et al. (2005) found that AP encouraged academic participation, and Manos (2010) determined that AP increased academic preparation. Former Secretary of Education Richard Riley (2000) hailed AP as a way to combat mediocrity within schools, and Leonard et al. (2003) encouraged the use of AP to narrow the achievement gap between White and non-White students. Increasing student achievement, preparing students for college academics, closing the achievement gap, and encouraging females, minorities, and low-SES students to take challenging courses have been addressed by the incorporation of AP programs into high schools. The AAIMS program takes the training and support for schools, students, and teachers several steps further, which will only help Arkansas high schools address any academic need that may exist.

Future Research Considerations

There exists a significant difference in mathematical achievement as determined by the 2015 AP Calculus AB exam in terms of students in high schools that participated in the AAIMS program and by SES. As previously mentioned, there is no existing research on the impact of the AAIMS program in Arkansas. This reveals a ripe field for study. Therefore, several recommendations are proposed for future study. These include:

1. A comprehensive study of all students taking AP Calculus AB in Arkansas is warranted, particularly in terms of schools that are participating in AAIMS

and those that are not. This study looked at four Arkansas high schools during the 2014-2015 school year. Two participated in AAIMS, and two did not. A comprehensive study should encompass all Arkansas high schools over an extended period covering multiple years.

2. Studies could look at additional content areas with specific AP courses. These might include Language, Literature, American History, World History, Biology, Chemistry, and any other AP course taught in Arkansas schools. Ideally, any study of other courses should be comprehensive, longitudinal, and should be for all schools that teach the course in Arkansas.
3. Teacher training and professional development are integral to the academic success of students. Studies should look at the impact of the extended services of the AAIMS program and the impact that it has not only on AP courses but any possible carryover effect that may occur in non-AP classes taught by teachers in Arkansas high schools. Researchers could look at strategies used in AP courses that may be transplanted to other courses and the possible effects on student achievement.
4. Further study is warranted specifically for females participating in the AAIMS program. Given the success rate of female students on the 2015 AP Calculus AB exam in those schools studied, researchers should look at the potential impact of the AAIMS program on achievement by female students in mathematics. This is particularly important given the continued lack of females in the fields of science and mathematics.

5. Given that Arkansas has a larger low-SES population when compared to the national average, further study is warranted on the effects of the AAIMS program on all low-SES students in Arkansas. Students in low-SES households may not take more rigorous courses like AP Calculus AB. Future study may determine whether participation by low-SES students in a program such as AAIMS might increase their participation and success.

Although the AAIMS program has been implemented in over 50 high schools in Arkansas during the course of the last 10 years, research on its impact is minimal. Although this study revealed that the AAIMS program has an impact on student achievement on the 2015 AP Calculus AB exam, the potential for an even greater impact exists. Currently, there are over 50 schools in Arkansas that participate in the program, but as a result of this study, there should be far more that elect to participate. The program could potentially provide an influential way for all school districts in Arkansas to have an immediate effect on high school student achievement at a relatively low cost. Arkansas state law allows school districts to use National School Lunch Act funds to pay for the necessary associated costs of participation in the AAIMS program. There are any number of for-profit companies, curriculum packages, experts, and options available to schools to increase student achievement. However, this researcher sees the implementation of an AAIMS program as one of the most significant approaches to positively affect a spectrum of areas including student achievement, professional development, mentor relationships, and other incentives. Any study on the effects of AAIMS will only help school leaders make informed decisions about its usefulness in addressing academic issues within Arkansas high schools.

REFERENCES

Adams, C. (2012). *Program aims to improve AP scores with training and incentives*. Retrieved from http://blogs.edweek.org/edweek/college_bound/2012/08/grant_program_works_to_improve_ap_scores_with_training_and_incentives.html

Arkansas Advanced Placement and International Baccalaureate Diploma Incentive Program Act of 1995, Ark. § 6-16-804. (2015).

Arkansas Activities Association. (2015). *Arkansas Activities Association handbook*. Retrieved from http://members.ahsaa.org/public/userfiles/Admin/2015-16_AAA_Handbook.pdf

Arkansas Advanced Initiative for Mathematics and Science. (2013a). *AAIMS History.* Retrieved from http://ualr.edu/aaims/

Arkansas Advanced Initiative for Mathematics and Science. (2013b). *AAIMS Overview.* Retrieved from http://ualr.edu/aaims/

Arkansas Advanced Initiative for Mathematics and Science. (2014). *AAIMS Overview.* Retrieved from http://ualr.edu/aaims/

Arkansas Department of Education. (2009). *Rules governing standards for accreditation for Arkansas schools and school districts*. Retrieved from http://www.arkansased.gov/public/userfiles/rules/Current/FINAL_Standards_for_Accreditation.pdf

Ayres, K. D. (2011). *A summative program evaluation of a systemic intervention on student achievement and AP participation*. Retrieved from the ProQuest database. (No. 912031632)

Blank, R. K., & de las Alas, N. (2010). *Effects of teacher professional development on gains in student achievement: How meta-analysis provides scientific evidence useful to education leaders*. Washington, DC: Council of Chief State School Officers. Retrieved from http://www.ccsso.org/Documents/2009/Effects_of_Teacher_Professional_2009.pdf

Bragg, D. D., Kim, E., & Rubin, M. B. (2005). *Academic pathways to college: Policies and practices of the fifty states to reach underserved students*. Champaign, IL: Office of Community College Research and Leadership, Department of Educational Organization and Leadership, University of Illinois at Urbana-Champaign.

Buck, G., Kostin, I., & Morgan, R. (2002*). Examining the relationship of content to gender-based performance differences in advanced placement exams* (Research Report No. 2002-12. ETS RR-02-25). Retrieved from http://apcentral.collegeboard.com/

Burdman, P. (2000). Extra credit, extra criticism. *Black Issues in Higher Education*, *17*(18), 28-33.

Burton, N. W., Lewis, C., & Robertson, N. (1988). Sex differences in SAT® scores. *TOC, 1988*(2), i-23. doi:10.1002/j.2330-8516.1988.tb00314.x

Caban-Vazquez, V. (2010). *Exploring a supplemental educational service math program: The math achievement of economically disadvantaged students and teacher professional development.* Retrieved from the ProQuest database. (No. 839138924)

Christiansen, D. W. (2009). *The impact of advanced placement (AP) participation and success on school-wide student achievement*. Retrieved from the ProQuest database. (No. 305096065)

Cockrell, M. L. (2011). *A comparative analysis study of professional development models impacting student academic achievement*. Retrieved from the ProQuest database. (No. 872226394)

College Board. (2017a). *AP coordinator's manual 2016-17.* Retrieved from https://apcentral.collegeboard.org/pdf/ap-coordinators-manual.pdf

College Board. (2017b). *What is an AP score and what does it mean?* Retrieved from https://apscore.collegeboard.org/scores/about-ap-scores

College Entrance Examination Board. (1998). *SAT and gender differences* (Research Summary). New York, NY: Author.

College Entrance Examination Board. (2000). *Dispelling the culture of mediocrity: Expanding advanced placement*. New York, NY: Author.

College Entrance Examination Board. (2003). *A brief history of the advanced placement program*. New York, NY: Author.

College Entrance Examination Board. (2012). *Teaching and assessing modules*. New York, NY: Author.

College Entrance Examination Board. (2014). *About workshops & summer institutes.*

Retrieved from http://apcentral.collegeboard.com/InstitutesAndWorkshops

Creswell, J. W. (2015). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (5th ed.). Upper Saddle River, NJ: Pearson.

D'Aquino, E. A. (2011). *Understanding student academic performance differences in college based on advanced placement college credits earned in high school: A comparison between honors and non-honors*. Retrieved from the ProQuest database. (No. 900302457)

Demarest, E. J., Reisner, E. R., Anderson, L. M., Humphrey, D. C., Farquhar, E., & Stein, S. E. (1993). *Review of research on achieving the nation's readiness goal*. Washington, DC: U.S. Department of Education.

DiLorenzo, R. (1999). Teaching advanced placement United States history in the urban, minority high school: Successful strategies. *The History Teacher*, *32*(2), 207-221.

DiYanni, R. (2002). The origins and development of the AP, the college board's advanced placement program: Part I, American beginnings and American successes. *International Schools Journal, 22*, 31-42.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Los Angeles, CA: Sage.

Fnu, M. (2011). *Relationship between ethnicity and performance in AP courses: Results from a longitudinal study examining years 2001, 2005 and 2010*. (Unpublished doctoral dissertation). Southeastern Louisiana University, Hammond, Louisiana.

Furry, W., & Hecsh, J. (2001). *Characteristics and performance of advanced placement classes in California*. Sacramento, CA: Institute for Education Reform.

Gamoran, A. (1996). Do magnet schools boost achievement. *Educational Leadership, 54*, 42-46.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2012). *Educational research: Competencies for analysis and applications*. Boston, MA: Pearson.

Gewertz, C. (2008). Opening AP to all. *Education Week, 27*(2), 23-25.

Haessler, S. J. (2007). *Incentives and outcomes: An empirical analysis of variable pay for performance and advanced placement results in Texas*. Retrieved from the ProQuest database. (No. 304782497)

Hargrove, L., Godin, D., & Dodd, B. (2008) *College outcomes comparisons by AP and non-AP high school experiences* (Research Report No. 2008-3). New York, NY: The College Board.

Hansen, A. L. (2005). *Success in advanced placement courses*. Retrieved from http://www.educationpartnerships.org/

Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). Retrieved from http://resource.heartonline.cn/20150528/1_3kOQSTg.pdf

Huck, S.W. (2012). *Reading statistics and research* (6th ed.). Boston, MA: Allyn and Bacon.

Imig, A. (2008). *A case study of teacher effectiveness in advanced placement courses*. Retrieved from the ProQuest database. (No. 304807933)

Inman-Vann, J. (2011). *An examination of the relationship between the exposure to the use of cash incentives as a part of the A Plus Grant Program and performance on the Advanced Placement exam*. Retrieved from the ProQuest database. (No. 873553522)

International Baccalaureate. (2014). *Middle years programme*. Retrieved from http://www.ibo.org

King, J. E. (1996). *Improving the odds: Factors that increase the likelihood of four-year college attendance among high school seniors* (Report No. 96-2). New York, NY: The College Board.

Krupa, E. E. (2011). *Evaluating the impact of professional development and curricular implementation on student mathematics achievement: A mixed methods study*. Retrieved from the ProQuest database. (No. 898360625)

Kyburg, R. M., Hertberg-Davis, H., & Callahan, C. (2007). Advanced placement and international baccalaureate programs: Optimal learning environments for talented minorities? *Journal of Advanced Academics, 18*, 172-215.

Laesecke, A. R. (2002). Through measurement to knowledge: The inaugural lecture of Heike Kamerlingh Onnes (1882). *Journal of Research, 107*(3), 261-277. Retrieved from https://www.nist.gov/publications/through-measurement-knowledge-inaugural-lecture-heike-kamerlingh-onnes-1882

Laitusis, V. (2012). *An analysis of the relationship between school-level AP® professional development activity and subsequent student AP performance* (Research Report No. 2012-8). Retrieved from http://research.collegeboard.org/sites/default/files/info2go/2013/1/infotogo-2012-8-advanced-placement-professional-development-student-performance.pdf

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2015). *IBM SPSS for intermediate statistics: use and interpretation* (5th ed.). New York, NY: Routledge.

Leonard, S., Blasik, K., Dilgen, A., & Till, F. (2003). Advanced placement as a means of narrowing the achievement gap. *ERS Spectrum*, *21*(2), 4-14.

Lindsey, V. T. (2010). *Professional development planned by K-12 public schools to*

increase academic performance: Coherence counts. Retrieved from the ProQuest database. (No. 305245557)

Manos, M. (2010). *The advanced placement program: A case study of one urban high school*. (Unpublished doctoral dissertation). University of Southern California, Los Angeles, CA.

Martin, L. A. (2010). *Relationship between teacher preparedness and inquiry-based instructional practices to students' science achievement: Evidence from TIMSS 2007*. Retrieved from the ProQuest database. (No. 749931661)

More Blacks are competing in advanced placement programs, but the racial scoring gap is widening. (2009). *The Journal of Blacks in Higher Education, 63*. Retrieved from http://www.jbhe.com/features/59_apscoringgap.html

Quality Education Act of 2003, Ark. § 6-15-214. (2015).

Queener, R. (2011). *Effects of laptop initiatives on student achievement in mathematics.* Retrieved from the ProQuest database. (No. 3457213)

Planty, M., Provasnik, S., & Daniel, B. (2007). *High school coursetaking: Findings from the condition of education, 2007* (NCES 2007-065). Retrieved from http://nces.ed.gov/pubs2007/2007065.pdf

Robinson, A., Anthony, T. S., Liu, Y., Dickerson, L. R., Clowers, R. L., & Stanley, T. D. (1999). *A carrot is better than a stick: The effects of advanced placement incentive legislation in Arkansas*. Little Rock, AR: Center for Research for Teaching and Learning. Retrieved from the ERIC database. (ED453577)

Saaveda, A. (2014). The academic impact of enrollment in international baccalaureate diploma programs: A case study in Chicago public schools. *Teachers College Record, 116,* 4.

Salinas, A. (2010). *Investing in our teachers: What focus of professional development leads to the highest student gains in mathematics achievement?* Retrieved from the ProQuest database. (No. 577497530)

Saunders, T., & Maloney, K. (2005). Boosting Black academic achievement and AP enrollments. *Education Digest*, *70*(6), 54-57.

Sisco, H. T. (2008). *A correlation of technology implementation and middle school academic achievement in Tennessee's middle schools*. Retrieved from http://dc.etsu.edu/etd/1938

Snow-Renner, R., & Lauer, P. A. (2005). *Professional development analysis*. Denver, CO: Mid-continent Research for Education and Learning. Retrieved from ERIC database. (ED491305)

Sparks. D. (1997). An interview with Linda Darling-Hammond. *Journal of Staff Development*, *18*(1), 34-36.

Stoker, G. L. (2010). *Closing the gap between educational aspirations and outcomes: Is advanced placement (AP) the answer?* Retrieved from the ProQuest database. (No. 609291078)

Tate, W. I. (1997). Race, SES, gender, and language proficiency trends in mathematics achievement: An update (Research Monograph). *Journal for Research in Mathematics Education, 28*(6), 652-679. doi:10.2307/749636

United States Department of Agriculture, Food, and Nutrition Service. (2016). *Food distribution.* Retrieved from https://www.fns.usda.gov/fdd/regulations

Viadero, D. (1994). *Magnet schools seem to have little impact on student achievement.* Retrieved from http://www.edweek.org/ew/articles/1994/04/13/29nels.h13.html

Villarreal, J. (2010). *A magnet middle school longitudinal case study of student achievement, attitudes, and parental engagement* (Doctoral dissertation, University of California). Retrieved from http://escholarship.org/uc/item/32h0x14x

Walker, K. (2009). *The Alabama advanced placement initiative: The roles of the principal, teacher, and student in bridging the racial and socio-economic gap in college preparatory curricula*. Retrieved from the ProQuest database. (No. 3383764)

Wiley, E. (1989). Advanced placement program could spell benefits for minorities. *Black Issues in Higher Education*, *5*(21), 1-15.

Yoon, K. S., Duncan, T., Lee, S. W., Scarloss, B., & Shapley, K. (2007). *Reviewing the evidence of how teacher professional development affects student achievement*. Washington, DC: REL Southwest. Retrieved from https://ies.ed.gov/ncee/edlabs/regions/southwest/pdf/REL_2007033.pdf

APPENDIX

HARDING UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Status of Request for Exemption from IRB Review

(For Board Use Only)

Date: 8/26 /16
Proposal Number: 2016-090
Title of Project: Effects of the Arkansas Advanced Initiative in Mathematics and Science by Gender, Race and SES on AP Calculus Scores
Principal Investigator(s) and Co-Investigator(s): Wayne Fawcett
wfawcett@parissschools.org

■ Research exempted from IRB review.

☐ Research requires IRB review.

☐ More information is needed before a determination can be made. (See attachment.)

I have reviewed the proposal referenced above and have rendered the decision noted above.
This study has been found to fall under the following exemption(s):

1 ☐ 2 ☐ 3 ☐ 4 ■ 5 ☐ 6 ☐

In the event that, after this exemption is granted, this research proposal is changed, it may require a review by the full IRB. In such case, a ***Request for Amendment to Approved Research*** form must be completed and submitted.
This exemption is granted for one year from the date of this letter. Renewals will need to be reviewed and granted before expiration.
The IRB reserves the right to observe, review and evaluate this study and its procedures during the course of the study.

Rebecca O. Weaver

Chair

Harding University Institutional Review Board