A LONGITUDINAL STUDY OF GENDER DIFFERENCES IN ADVANCED PLACEMENT PARTICIPATION AND SCORING

by

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Abstract

A longitudinal study on the differences in Advanced Placement examination participation and scoring between males and females from 1996 through 2007 revealed that more females participate in AP exams than males, but for most exams, more males are successful by passing the exam with a 3 score or above. The foreign language courses have a significantly higher female participation and scoring than males while many other courses, including those in mathematics, science, and computer science, have significantly higher participation and scoring for males. Advanced placement exams in economics and social studies also favored males both in participation and scoring on most Advanced Placement exams over the 12-year period.

Dedication

To my loving husband who encouraged this endeavor and pushed me forward.

Acknowledgments

The journey to pursuing this degree has been decades long. At times, I was not sure it would ever become a reality. I am most grateful to my chair, Dr. Gail Hughes, who provided corrections, suggestions, encouragement, and thoughtful questions along the way. I am sure that I would not have been able to accomplish the task without her appropriate direction and guidance.

Dr. Clay Hensley, the Associate Director of International Services for The College Board, was instrumental in providing the information needed to pursue this research study. Without his knowledge of my school and my work at the school, it is doubtful the research data would have been released to me. I am sincerely thankful for his assistance in providing me the 12 years of data analyzed in this study.

My committee has been supportive and encouraging throughout the entire process, which has been a critical component in motivating me to keep working. With Dr. Dennis Lawrence, Dr. Christie Grunwald, and Dr. Gail Hughes, I have been able to see the light at the end of the tunnel and have been able to make my dream a reality.

Without question, my husband provided a great deal of continued positive pressure throughout the process. Oftentimes in the first couple of years while taking three classes at a time, I would tell him that I didn't have enough sleep and energy to do this. He, too, was pursuing a PhD, and he would say the magical words, jokingly, "just quit," which he knew would make me push on and try to persevere. It became our way of saying, "don't complain; just keep trying."

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CHAPTER 1. NATURE OF THE PROBLEM

Introduction to the Problem

Gender-related differences on standardized tests were an issue of debate during the 1990s (Stumpf & Stanley, 1998). In the past 7 years, little research has been focused on gender differences on the Advanced Placement exam. This is a course-specific standardized exam in which a passing score of 3 or above out of 5 represents that a student has learned university-level course-specific knowledge and skills while in high school. Depending on the university requirements, a score of 3 or above could provide the student college credit and is used as a factor in the college entrance process. During the past 7 years, increased participation in the Advanced Placement program has occurred across the United States (College Board, 2007b). This increase in participation is expected to continue over the next several years due to increased federal financial support (Viadero, 2001) and the precedence given to Advanced Placement programs by President Bush's Advanced Placement Incentive (Isaacs, 2001; The White House, 2004). While there has been an increase in participation (College Board), the author has not found a study that revealed if there have been differences in participation or successful scoring between males and females for most of the 37 different Advanced Placement exams.

Background of the Study

Before 1900, the college entrance process was specific to each university. In 1901, the College Board was formed to assist the transition from high school to college by developing a college entrance exam which simplified the college application process

(College Board, 2007d). In 1955, the College Board expanded its services by developing the Advanced Placement program, a program that offers high school students college credit for mastery on the Advanced Placement exam (College Board). To receive credit, a student must score a 3 or higher on the Advanced Placement exam in a particular field of study. The exam scoring is a numeric scale from 1 to 5. Five is the highest score and represents work that is well-qualified, whereas a score of 1 represents work that is not qualified (College Board). Passing scores are 3 and above, but not all colleges accept a score of 3. A student's AP course history from high school can assist his or her college acceptance process and provide college credit depending on the student's score and intended major (College Board). Many universities offer some college credit for an AP exam score of 3 or above.

Since 2000, there has been an increase in Advanced Placement course enrollment and mastery on the Advanced Placement College Board Exams (College Board, 2007d; Samuels, 2005). Mastery on the Advanced Placement exam requires a minimum score of 3. In 2006, 1.2 million students took AP course exams (Wasley, 2007), and 406,000 of those earned an AP exam grade of 3 or higher on one or more AP exams (College Board, 2007a). With 2.7 million students graduating from U.S. public schools in 2006, 406,000 represent 14.8% of the high school students. Only 10.2% of the graduating high school students earned an exam grade of 3 or higher in 2000 (College Board, 2007a). More students are taking and passing at least one Advanced Placement exam than in previous years (College Board, 2007a).

The Advanced Placement exams are significant components for determining college admission (Stumpf & Stanley, 1996) and because the Advanced Placement (AP) courses reflect the first-year college course experience (College Board, 2007a), participation and success on AP exams are important. The College Board's *Report to the Nation* revealed that participation and success in the Advanced Placement program is correlated with future coursework in college. "AP students who place directly into a higher level college course take more college courses in that same subject area, on average, than students who did not take an AP exam in that subject area in high school" (College Board, p. 11). With more than 75% of high school graduates enrolling in college (Haycock, 2001), the increase in Advanced Placement participation and mastery increases participation in some college programs and majors.

While there has been an increase in participation and success in AP exams over the past few years (College Board, 2007b), it has not been universal between genders. For example, there has been a decline in female participation and performance in the Advanced Placement Computer Science AB Exam (Bombardieri, 2005; Gilbert, 2002; Stumpf & Stanley, 1997; Tillberg & Cohoon, 2005). There is a connection between the low participation and success on Advanced Placement and participation in college majors. Dr. Jane Margolis, a UCLA computer scientist and researcher, stated that computer science is a major that has had a very low percentage of women (as cited in Gilbert).

> At top research universities about 15 to 20 percent of (computer science) majors are female, and in advanced computer science exams at the high school level, it's only 15 percent women. That's been dropping over the last couple years. And computer science is one of the AP exams with the lowest number of female participation. (Margolis, as cited in Gilbert, ¶ 8)

Low female participation in computer science is not the only area identified as having a gender gap. Stumpf and Stanley (1996) identified the gender gap closing on scholastic achievement tests, but multiple studies have supported continued gender gaps in mathematics, computer science, and physics (Heller & Ziegler, 1996; Lamb, 1997; Seligman, 2005; Stumpf & Stanley, 1998). Advanced Placement physics and chemistry has been under-represented by females every year for the past 12 years (College Board, 2007b).

Many of the studies on gender and College Board Exams occurred in the 1990s, with little research on gender differences on the Advanced Placement exam in the past 5 years. It is during recent years that a large increase in participation has occurred without research to determine if the gender gap in participation and achievement on this exam has changed significantly.

Problem

Little attention has been given to gender-related differences on the Advanced Placement exam in recent years (Ackerman, 2002), although these tests are particularly important because they have strong influence on admission into and placement within college (Stumpf & Stanley, 1996). Students who participate and are successful in a particular field of Advanced Placement take more courses in college in that field than students who do not participate in the AP program (College Board, 2007a). As a result, more males are entering some fields of study than females, including computer science, mathematics, and physics (Stumpf & Stanley, 1998).

Problem Statement

Although there has been an increase in student participation in the Advanced Placement program (Samuels, 2005; Wasley, 2007), there is no current research on gender differences in participation and achievement on the Advanced Placement exam.

Purpose Statement

The purpose of this descriptive longitudinal study was to examine gender-related differences on the College Board Advanced Placement tests from 1996 through 2007 to identify participation and achievement differences between males and females.

Research Questions and Hypotheses

Research Question 1: Is there a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

H_1: There is a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007.

H_0: There is not a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007.

Research Question 2: Is there a significant difference in successful scores on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

H_1: There is a significant difference between males' and females' successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

H_0: There is not a significant difference between males' and females' successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

Nature of the Study

A descriptive longitudinal trend design was used for this study. Quantitative methods were utilized to investigate the differences in male and female participation and success on the Advanced Placement exam from 1996 through 2007. Student scores range from 1 to 5, and scores of 1, 5, and the minimum passing standard of 3 or above were compared for 33 Advanced Placement subjects over a 12-year period.

Significance of the Study

The AP program is relevant to scholars and practitioners in tertiary education because the program prepares students for collegiate academic rigor and participation in future coursework (College Board, 2007a). AP exam participation in high school programs were studied by Keng and Dodd (as cited in College Board) of the University of Texas and included in the *Advanced Placement Report to the Nation*. Keng and Dodd stated "AP students statewide in Texas earn higher college GPAs and have higher four year graduation rates when compared to students with similar SAT scores and socioeconomic backgrounds who did not take AP courses and exams" (as cited in College Board, p. 12). Thus, the Advanced Placement program is an important background study to postsecondary education because it prepares students for college and increases graduation rates.

Another study, by Hargrove, Godin, and Dodd, included in the *Advanced Placement Report to the Nation*, revealed differences between students who took the AP course but did not take the AP exam and their success in college as compared to students who did take the exam. Students who took one or more AP exams significantly outperformed students who did not take any AP exams over the 4 years of college (as cited in College Board, 2007a). Participation in the Advanced Placement program and its exams is relevant to postsecondary education because college students who took one or more AP exams while in high school have outperformed college students who did not take any AP exams; therefore, students should be encouraged to participate in the AP program while in high school.

The two previous studies indicate the importance of the Advanced Placement program to postsecondary studies, but are not specific to the relevance of gender differences on the Advanced Placement exam. By writing to College Board, the researcher obtained the scores of males and females for each year from 1996 through 2007. During that time frame, an increase in Advanced Placement exam participation occurred without statistical examination and report of gender differences. This is relevant because some courses could be under-represented by males or females, and the implications of this could mean fewer males or females entering particular fields of study.

Certain fields of Advanced Placement seem to be under-represented by a particular gender. For example, the Advanced Placement language courses are represented by females at a 2:1 ratio or higher compared to males in English, Spanish, and French language and literature, but the Advanced Placement Physics C and

Computer Science A/AB courses have 3 or 4 times more males than females (College Board, 2007b).

Based on the current increase in participation in Advanced Placement exams (Samuels, 2005), and because increased participation in exams increases a student's participation in the subject in college (College Board, 2007a), it is important to determine if particular AP course participation and success are significantly different between males and females.

Definition of Terms

Advanced Placement exam. College Entrance Examination Board (CEEB) specific subject test given to high school students that upon passing can provide college credit to introductory-level college coursework. It usually consists of a 3-hour test consisting of two parts: a multiple-choice section and an essay section. Language exams and Studio Art exams have specific exam requirements for their respective courses.

Advanced Placement program (AP). CEEB-developed programs offered to high school students that, upon passing a CEEB external exam, can result in a student receiving college credit while still in high school.

ANOVA. A statistical procedure that analyzes the variance that occurs between two sets of data; analysis of variance.

College Board (CB). College Board Entrance Examination Board is often shortened to the College Board; its most widely recognized programs and exams are the SAT, PSAT, and AP exams.

College Boards. Subject-specific exams developed by the College Entrance Examination Board in 1901 that have been replaced with other types of exams; the College Boards were given by the College Entrance Examination Board.

College Entrance Examination Board (CEEB). A nationally recognized organization that develops college entrance examinations and programs that provide students challenging coursework; colleges use the results of the exam results to identify qualified students for their admissions process.

Educational Testing Service (ETS). A nonprofit private organization that provides research, assessment development, and assessment analysis for standardized testing. The College Board utilizes ETS for its Advanced Placement and Scholastic Achievement Test development and administration.

Gender gap. A difference in participation or academic achievement between males and females.

GPA. A score representing the grade point average of a student's work in school.

Scholastic Achievement Test (SAT). A College Board Entrance Examination of general aptitude and achievement whose results are often used in the college admissions process.

Scholastic Aptitude Test (SAT). A College Board Entrance Examination whose name has been changed to Scholastic Achievement Test.

Successful performance. Successful performance on an Advanced Placement exam is defined by College Board as passing with a 3 score, but this is not standard for all universities; some universities expect scores of 4 or 5.

Assumptions and Limitations

Assumptions

The design of this study was dependent on several assumptions. It was assumed that the scores from each year were statistically analyzed by the College Board to provide reliability and credibility to the consistency of Advanced Placement exams from one year to the next. It was assumed that the development of each exam question was appropriate to the Advanced Placement curriculum, and that change to exam expectations or formats were published by College Board in advance. It was assumed that all exams were given following College Board regulations, and that no compromised exam scores were included in the data analyzed. It was assumed that College Board released all the exam scores for every course for each year, and that all scores of U.S. and international students were analyzed in the study.

Limitations

The findings of this study may be affected by the following limitations.

1. The population used in this study were all students taking Advanced Placement exams in the world. The results of the study may not be generalizable to students taking the exam in international schools only or national schools of other countries because the vast majority of the scores are from the United States.

2. The findings of this study are limited to gender differences on the Advanced Placement exam and cannot be generalized to other standardized exams.

3. The study used all Advanced Placement exams from 1996 through 2006, but some subjects did not have exams developed for all 12 years. Advanced Placement exams in Statistics, Italian Language, Human Geography, Art Studio Design, and Environmental Science have been developed within the past 2 to 5 years and have less data available than other exams.

Organization of the Remainder of the Study

The study consists of five chapters. Chapter 2 is a review of the literature which includes (a) the Advanced Placement program description and growth trends, (b) the history of the Advanced Placement program, (c) the use of Advanced Placement exam scores by colleges and universities, (d) research describing gender differences in participation and academic achievement on Advanced Placement exams, (e) the implications of gender imbalances on the Advanced Placement exam participation and achievement, and (f) the implications of gender imbalances in technology based careers. Chapter 3 describes the research method, including research design and its limitations, instrumentation, data collection and analysis procedures, and expected findings. Chapter 4 presents the analyzed data. Chapter 5 provides a summary of the findings and recommendations for further research.

CHAPTER 2. LITERATURE REVIEW

Introduction

The implications of gender differences on Advanced Placement tests have been given less attention than other standardized tests, such as the Scholastic Achievement Test (Ackerman, 2002). Advanced Placement tests are administered to high school students who have completed an Advanced Placement curriculum in a specialized field of study. College Board provides sample syllabi of highly structured coursework that is oriented towards obtaining college credit and providing foundational knowledge and skills of an introductory course in college. Gender differences have been identified on both participation and passing rate of the exam (Ackerman; College Board, 2007b). Passing an Advanced Placement exam requires a score of 3 out of a possible 5. Females were found to perform more poorly than males on the 2000 Advanced Placement exams (Ackerman). The rate of passing for males was 39.2%, versus 32.6% by females on the 2000 exams; yet approximately 85,000 more females took exams than males (College Board). More females took the 2000 Advanced Placement exams, yet more males passed.

Inequity in participation and achievement on the Advanced Placement exams between genders results in some fields of study being under-represented by males or females. “Gender imbalance in specific areas becomes a problem when the gender spread has a detrimental effect on some sections of society” (Annemieke, 2006, p. 7). An implication of gender imbalance is a loss of the perspective from one group of society in certain fields of study. For example, the computer science field is under-represented by females both on the Advanced Placement exam participation (College Board, 2007b; Stumpf & Stanley, 1997) and in college computer science programs (Mason, 2007).

> Women comprise 51 percent of the United States population. They earn more than half of all bachelor-level degrees awarded every year. But according to the Computing Research Association, nationally only 17 percent of undergraduate computer science degrees were awarded to women in 2004. (Mason, p. 161)

The implications of women being under-represented in the computer science field are significant to many fields of study. Computer science technology is critical to many careers today. Anyone who lacks the skills in computers today will be at a disadvantage in many career choices (Mason). In the mid-1980s, 35% of the instructional technology (IT) workforce were women, but that number has declined to 25% today (Fox, 2007). With fewer women pursuing computer science and instructional technology careers in the years ahead, computer technology will become more male-prominent if the gender crisis in instructional technology continues.

The implications of more males taking science and computer science courses in the Advanced Placement program means that more males will enter these fields in college and ultimately enter the IT workforce. In the past, taking as much mathematics as possible was important because mathematics was the key to high-paying technical careers. “For the new generation, however, science and technology have replaced math as the gateways to a wide variety of technical careers in the sciences and in engineering” (Sanders & Nelson, 2004, p. 75). High school females represent one third to one fourth of the students in AP Physics, depending on the year, and a smaller fraction is represented in AP Computer Science, with more males scoring 5, the highest possible score (College Board, 2007b).

Why does it matter if there is a gender gap in mathematics, science, and computer science? Why does it matter if females are under-represented in these fields of study? It matters because women comprise half of the U.S. population, and many of the jobs in the mathematics, science, and computer science fields are prestigious and highly paid careers. “By limiting the number of women in mathematics and science, we lose different perspectives that can enrich, expand and revitalize these disciplines” (Campbell & Clewell, 1999, p. 4).

Rationale for the Research

Advanced placement programs have increased across the United States over the past 4 years (College Board, 2006), and they will continue to increase because of federal precedence placed upon them by President Bush’s Advanced Placement Incentive Program (The White House, 2004). During the 1990s, a gender gap was present in some Advanced Placement courses, including Computer Science, Physics, and Chemistry (Stumpf & Stanley, 1996), but no longitudinal study has occurred in the past 12 years to determine if gender differences in participation and performance are present. The rationale for the research was to provide research data to bridge the gap of the AP exam participation and scores from 1996 through 2007, considering an increase in participation has occurred on the AP exams in the past few years.

Theoretical Framework

History of the College Entrance Examination Board

More Americans are pursuing enrollment in universities than in the past (Christ, 2002), causing challenges for decision makers in university admissions offices. One criterion used by student selection committees for college entrance is participation and success on College Boards Advanced Placement exams, college introductory subject-specific tests taken by high school students.

AP exams were not the first standardized tests developed by College Board. In 1901, about 50 years before AP tests were developed, the College Board Entrance Examination Board (CEEB) developed a college entrance exam. The CEEB was developed by a few college officials with the direction of Harvard University's Charles William Elliot and Columbia University's Nicolas Murray Butler (Hacsi, 2004). The 1901 entrance exam was known as the College Boards and was administered to 1,000 students in 1901 (Hacsi). The original purpose of the College Boards was to connect high school students to colleges by providing a standard for universities to compare student applicants and to make secondary schools more alike in their curriculum by providing a clear standard (Hacsi). The developers of the original test hoped its exam would be widely received because their developers believed uniformity of standards would be a better approach for college admissions (Hacsi).

The College Boards were subject based, and during the first 25 years were well received, but with some criticism because the exams had increasing influence on the secondary school curriculum. The College Boards lost influence when the CEEB developed the Scholastic Aptitude Test (SAT) in 1926 (Hacsi, 2004). As the SAT approached its 10th anniversary, the number of students taking it had increased while the number taking the College Boards had decreased (Valentine, 1987). The more general aptitude test, the SAT, had replaced the more subject-based College Boards by the mid-1930s (Hacsi). The SAT has had more effect on college entrance than any other exam over the past 6 decades (Hacsi). In 1994, the Scholastic Aptitude Test was renamed to the Scholastic Achievement Test (Hacsi), and further changes occurred in 2002, expanding the test from a 1,600-score test to 2,400.

Around 2000, the SAT started having less significance in determining college admission, and a student's participation in a rigorous high school curriculum has become more important (Hacsi, 2004). In 1999, the Education Department reported that the academic rigor of the high school curriculum was a strong predictor of college success. One way to increase academic rigor in a high school curriculum is to add an Advanced Placement program. AP courses on a high school transcript increase a student's application for college admission (Hacsi; Lawrence, 1996; Lord, 2000).

History of the Advanced Placement Program

The Advanced Placement program began in 1951 by the combination of two projects financed by the Fund for the Advancement of Education of the Ford Foundation (Santoli, 2002). The first project was developed by John Kemper, the headmaster of Andover Academy, and comprised a group of individuals from Andover, Exeter, and Lawrenceville, and three universities, Harvard, Yale, and Princeton. The focus of the study was to investigate whether the most capable high school students could be provided more demanding coursework like that offered in the introductory university courses. The project recommended that achievement examinations be developed in the core subjects to provide college credit to students while still in high school (Isaacs, 2001). This differed from the College Boards in that it would have course outlines, syllabi, and an external examination that could provide college credit depending on the student's success on the exam.

The second project, the Kenyon Plan, was a group of high school teachers, university professors, and representatives from the Educational Testing Service who developed high school course curricula and tests (Santoli, 2002). The Kenyon Plan groups included colleges Bowdoin, Brown, Carleton, Haverford, Kenyon, Massachusetts Institute of Technology, Middlebury, Oberlin, Swarthmore, Wabash, Wesleyan, and Williams. Eleven subjects were chosen to be included in the pilot study, with 18 high schools teaching these first Advanced Placement classes in English, biology, physics, chemistry, French, Latin, German, Spanish, and history. The tests developed from the Kenyon Plan were first administered in 1954, and in 1955 College Board assumed the responsibility in conjunction with the Ford Foundation project (Santoli).

The 1951 Ford Foundation-sponsored project included a team of professors from Harvard, Yale, and Princeton Universities working with Andover, Phillip's Exeter, and Lawrence Academy to develop a set of exams that measure college-level achievement in specific subjects (Isaacs, 2001). The first 11 course sets were developed in 1954 and given at 18 high schools (Isaacs); these were the first Advanced Placement exams so called because they affected student placement on college admission entry. The Educational Testing Service developed the examinations, and the Advanced Placement exams have been given the aegis of the College Board since 1955 (Isaacs, 2001), with the first AP exams administered in 1956 (Santoli, 2002).

Advanced Placement Examination Description

The Advanced Placement program is a College Board subject-matter-based series of examinations taken by high school students to prepare them for college-level coursework. Currently there are courses and examinations in 37 subjects (College Board, 2007b). Each of the examinations is based on introductory-level college course subject-specific curriculum that is outlined in an AP course description published by College Board (Isaacs, 2001). College Board provides the course syllabi, conferences for teacher training, and course outlines, and the ETS and an AP Development Committee develop the exams. The ETS manages the grading and statistical analysis of the annual May exams for the College Board.

Each exam has specific testing components and time frames, but on average the exams are 3 hours long and consist of two parts: multiple-choice and free-response sections. Test specifications are unique to each course and change periodically based on research studies about changes that have occurred in the introductory college courses they represent. As university courses change, the specific AP course associated with the changed college courses are reexamined, modified, and a new course description and exam is developed. The ETS develops statistical analyses to ensure each test from one year to the next and from one subject area to another to maintain reliability and consistency. The ETS wants to ensure that the reasoning skills and problem-solving skills of each test standard are maintained even though it is a different exam each year. Each exam "tests students reasoning skills and the ability to apply knowledge and solve problems, analysis of facts and data, synthesize information, think critically about complex issues, and recognize different perspectives" (Isaacs, 2001, p. 402).

After the Advanced Placement exams are administered, each AP exam is evaluated using an item analysis (Isaacs, 2001). Faulty questions are eliminated from scoring. The Educational Testing Service statistically analyzes each test. “After scoring is completed ETS statisticians write a test analysis report for each exam, which covers how well the exam met the specifications, the grade distribution, overall difficulty, score distributions, and reliability” (Isaacs, p. 402). The final scores are released to students, secondary schools, and universities in July. The scoring is a numeric scale ranging from 1 to 5. College Board (2007a) defined the scores as 5 = *extremely well-qualified*, 4 = *well-qualified*, 3 = *qualified*, 2 = *possibly qualified*, 1 = *not qualified*.

Lichten (2000) reported approximately 66% of the students taking Advanced Placement exams score a 3 or higher, and 49% receive college credit. Lichten’s research noted that the majority of the universities still award credit for scores of 3 or above, but many of the selective universities require higher scores. The criterion-referenced exams typically provide college credit for scores of 3 or above. Some universities only provide scores for a 5 score in some subjects. For example, Harvard University allows each department to decide if a 4 or a 5 is the minimum requirement for college credit, and Stanford University has a similar policy in which Calculus requires a 5 for credit, but a student can receive credit for a foreign language with a score of 4 (Isaacs, 2001). While some universities give credit for only scores of 4 and 5, College Board reported that “88% of colleges and universities accept predominantly ‘threes’ or a mixture of ‘threes’ and ‘fours’ for course credit” (as cited in Isaacs, p. 404).

Growth of Advanced Placement Programs

In 1955, 1,229 students took AP exams; in 2000, 845,000 students took AP exams; and in 2007, 1.3 million students took AP exams. An increase in students is partially the result of an increase in schools participating in the Advanced Placement program. In 1955, 18 U.S. secondary schools participated in AP exams, but by 2000, over half of the schools in the U.S. offered AP courses (Lord, 2000). Part of the reason increased participation has occurred is due to an increase in funding. In 1999, $2.7 million of government funding was spent on AP programs in secondary schools, but 2 years later, in 2001, $15 million was provided for Advanced Placement programs (Viadero, 2001). “Former Secretary of Education, Richard Riley, in February 2000 called for all U.S. high schools to offer at least one AP course by the autumn of 2001 and to add one AP course annually for the next 10 years” (Isaacs, 2001, p. 403).

In 2004, President Bush proposed improvements in secondary education by increasing the Advanced Placement program and allocating a $28 million increase to ensure that teachers in low-income schools were trained to teach Advanced Placement and international baccalaureate courses (The White House, 2004). President Bush’s AP Incentive Program encourages secondary schools to offer more AP courses. “Under the President’s AP Incentive Program, we will increase the number of students taking AP math and science exams from 380,000 today to 1.5 million by 2012” (Spellings, as cited in College Board, 2006, ¶ 2). The Advanced Placement participation increase is greatly due to President Bush’s AP Incentive Program.

Importance of Advanced Placement on a Student's Pursuit of a College Education

Traditionally the Advanced Placement program was developed to allow advanced students the opportunity to learn introductory college coursework while in high school; thus, when they entered college, they could immediately delve into more complex subject matter by receiving credit for introductory college courses (Santoli, 2002). This original reasoning for developing Advanced Placement is still the main benefit of the program, but other advantages both for the student and universities have also been identified in studies over the years. This includes (a) students who attended schools with extensive AP programs experienced more success in college than if they had attended a school without an AP program (Santoli; Willingham & Morris, 1986), (b) taking AP exams is a good indicator that a student will complete a college degree (Morgan & Ramist, 1998), and (c) that academic rigor of Advanced Placement in a high school curriculum improves college enrollment and the pursuit of higher education (Adelman, 1999; Camara, 2003; Horn & Kojaku, 2001). College Board President Gaston Capterton supports the previous research and claimed, after comparing students with similar academic and economic profiles, the studies in the *Report to the Nation* show that "the students who succeed on an AP exam are better prepared for the rigors of college, and more likely to obtain a bachelor's degree" (College Board, 2007c, ¶ 3).

Willingham and Morris (1986) studied the impact of Advanced Placement coursework on college success by comparing AP and non-AP students through 4 years of college. The longitudinal study included almost 5,000 college students and represented over 700 high school AP programs. Willingham and Morris found that the AP students performed better academically and generally took more advanced coursework in the subject areas in which they took examinations than the non-AP students.

A study conducted by Klopfenstein and Thomas (2004) analyzed the student records of 28,000 Texas high school students who graduated in 1999 and enrolled in Texas's 4-year universities that year. The researchers used the Texas Schools Microdata Panel to obtain the data and examined students' records who participated in AP courses in high school to determine if they had higher grades in their freshman year than their non-AP peers. Klopfenstein and Thomas reported that these students continued their education in greater numbers than their non-AP peers. The research findings indicated that mere participation in the AP exams did not allow the participants to perform better academically than their non-AP peers. The AP courses did not have any predictive power based on simply participating in AP in high school, but instead it was necessary to score well on the exam to indicate statistically predictive power of academic readiness. Geiser and Santelices (2004) also found that taking the AP examination alone did not predict college success, but those students who received qualifying scores on an AP examination generally had an advantage over non-AP students.

The increased participation of high schools across the United States in the Advanced Placement program has increased the use of AP scores as a decisive factor in the selection process for entry into university.

> AP courses no longer serve solely to judge whether a student can skip an introductory college course. Instead they have emerged as important selective mechanisms and are viewed by university admissions officers as measures of university preparedness—a measure that is more telling and precise than SAT or ACT scores. They serve the dual purpose of satisfying the national, state, and local government pressure to raise academic standards, while providing a

> common measure of academic achievement lacking in the decentralized US education system. (Isaacs, 2001, p. 405)

Originally the AP program was developed to offer select students the opportunity to enroll in introductory college courses while still in high school. These were the most capable students who were bored as college freshmen with the introductory college coursework. Taking the required introductory courses in high school would allow them to delve into more complex courses immediately upon entry into university (Isaacs, 2001). The College Board Advanced Placement program has expanded since its inception. More high schools are implementing AP programs, and the College Board is expanding the number of AP courses offered. The increased participation in the Advanced Placement program is well-recognized (College Board, 2007a; DiYanni, 2002; Hebel, 1999; Mathews, 2005; Santoli, 2002). The College Board is piloting an Advanced Placement Diploma which requires a student to have taken five AP courses and scored a 3 on each exam. Of the five courses, four core areas must be studied: mathematics, science, language arts, and history (Isaacs).

Gender Differences in Advanced Placement Participation and Success

Gender-related differences on cognitive tests have been well-documented and much has been reported on cognitive differences on aptitude and achievement tests through the research of Hakstian and Cattell, (1975), Hyde, Fennema, and Lamon (1990), Benbow and Stanley (1983), Benbow (1988, 1990), Feingold, (1993), Friedman (1989), and Stumpf and Stanley (1996). An area of standardized testing that has received less research is the Advanced Placement exam, particularly in the 2000s.

College Board (2007a) reported the number of males and females participating in the Advanced Placement exams each year. As College Board, with the assistance of the Educational Testing Service, develops and administers each AP question, the development team prepares a "careful analysis of test questions to see if there are any disadvantages to females or minorities" (Lively, 1993, p. 22). Even with the careful planning by the test development team, differences between male and female participation and scoring on some types of AP exams have occurred.

The lack of participation in the Advanced Placement exam for females in the mathematics and computer science courses explains the gender performance disparity on those exams. Hunter (1986), Honeywell (1987), and Stumpf and Stanley (1997) reported fewer females participating in math, science, or computer science Advanced Placement exams than males. Stumpf and Stanley (1996) explored gender-related differences in participation and success on the Advanced Placement exam and College Board's Achievement Examinations from 1982 through 1992. Male students had higher scores than females on physics, chemistry, and computer science exams, and females scored an advantage on some of the language exams. Much of the disparity reported was based on low participation of females in courses that require mathematics or programming skills. Stumpf and Stanley reported that larger participation of female students in some examinations does not decrease the performance rate relative to males. A 150% increase in participation on the SAT II Achievement test in Mathematics II occurred between 1982 and 1994, without appreciably affecting the overall performance in terms of scoring the highest or lowest scores on the exam (Stumpf & Stanley, 1998).

Implications of Gender Imbalance in Advanced Placement Participation and Success

The implications of gender imbalance specific to the Advanced Placement examination participation and success have not been documented. The significant increase of participation in the Advanced Placement examinations that occurred in the mid-1990s and has continued to date has not been studied with respect to gender differences; thus, no data are available regarding the implications of a disparity between males' and females' performance on the Advanced Placement exams.

Santoli (2002) reported Advanced Placement implications for college admission and economic implications. Santoli stated, "an obvious reason to take AP classes is the college factor—admission to college, or testing out of college courses" (p. 26). Multiple studies support that students applying to colleges with AP credits on their transcripts have an advantage over non-AP students in the college admissions process (Adelman, 1999; Camara, 2003; Isaacs, 2001; Lawrence, 1996; Lord, 2000; Willingham & Morris, 1986). No study found by the author reported gender differences in college enrollments due to Advanced Placement examination participation or scores.

Implications for Gender Differences in Advanced Placement Participation in Computer Science

The reduced number of females participating in Advanced Placement Computer Science has implications in college majors and the work force. The American Association of University Women (AAUW) reported that woman account for 17% of the high school students who took Advanced Placement exams in the early 1990s (as cited in De Palma, 2001), and that percentage has dropped over the past 12 years to 11.9% in 2007. This is a concern because when gender differences are examined, fewer females participate in high-technology learning environments, fewer females have enrolled in computer science programs and informational technology programs compared to their male peers, and females represent a small proportion of the high-technology workforce (Crombie, Abarbanel, & Anderson, 2001). The AAUW (1998) stated that the gender gap is increasing in computer science, as computer science becomes the new "boys club," and "the failure to include females in advanced level computer science courses threatens to make women bystanders in the technological 21st century" (p. 4). Yet, mathematics and computer science are the fastest growing and highest paying occupations, according to the U.S. Labor Department (2001). Only 28% of the undergraduate degrees were being awarded to females in the early 1990s (De Palma), so women are not entering a field that is growing fast and paying well.

According to Mason (2007), women comprise 51% of the U.S. population and they earn more bachelor-level degrees than their male counterparts each year, but of the computer science degrees, only 17% were awarded to women in 2004, which was down from 19% in 2000. Mason argued that the impact is not simply in the computer science field but in any career that women pursue because women who lack computer skills today will find themselves falling behind regardless of the career choice they make. Thus, another implication is that women will be at a disadvantage regardless of the career they pursue due to fewer women having advanced computer skills.

Because participating in AP exams is a good indicator that a student will complete a college degree (Morgan & Ramist, 1998), and participation in the academic rigor of Advanced Placement in a high school curriculum improves college enrollment and the pursuit of higher education (Adelman, 1999; Camara, 2003; Horn & Kojaku, 2001), females not participating in computer science, chemistry, and physics reduces the chances they will enter that major in college. The same is true of males entering fields of study in English literature or Spanish language majors. This was supported by Willingham and Cole (1997), who found females score higher than males on the AP foreign language tests.

Implications for Gender Differences in Scoring on Advanced Placement Exams

Foreign language tests represent the only subject area in which females outperformed males in successive years. The researcher did not find another study that compares gender in all of the Advanced Placement exams over several years, but multiple studies have found significant differences of Advanced Placement performance in specific subject areas (Ackerman, 2002; Ackerman, Bowen, Beier, & Kanfer, 2001; Halpern, 2002; Honeywell, 1987; Stumpf & Stanley, 1996, 1998; Zohar & Sela, 2003). The gender differences in scoring on the Advanced Placement tests have an impact on educational selection and placement at the postsecondary level. Although some variance occurs between universities, the most college credit, if given at all, is dependent on obtaining scores of 4 or 5, whereas scores of 1 or 2 are almost always denied college credit (College Board, 2000). Ackerman et al. reported a nearly 7% difference in rates of scores of 4 or 5 between males and females on Advanced Placement exams.

> With more than 1 million students tested each year, these differences translate into a substantial impact on larger numbers of women in college each year in terms of both their placement in courses and the number of on-campus courses that must be completed to obtain a baccalaureate degree. (Ackerman et al., p. 821)

Because Advanced Placement exam scores of 4 or 5 have significance for college placement and acceptance, males who have taken AP exams have an advantage when applying to universities because a significant number of males are passing, and in some areas significantly scoring the top scores, which provides the greatest amount of credit or access to the most prestigious universities.

Implications for Gender Differences in Advanced Placement Scoring in Mathematics, Computer Science, and Science Based on Current Research

If significantly more males than females score 5s on the Advanced Placement exams, such as has occurred on other standardized tests in mathematics, fewer females will pursue fields of study in those subject areas. Benbow (1992) studied the top 1% in the SAT-Mathematics exam and found males scored significantly higher than females. Benbow reported that when the top quarter of the top 1% of the SAT-Mathematics exam was analyzed, more males scored higher within the top 1% and within the top quarter of the 1%. More males score higher on many standardized tests such as the SAT Math tests (Hyde et al., 1990) and AP Calculus tests, which are used for selection of applicants at the postsecondary level (Halpern, 2002). While the SAT Verbal has not shown significant differences over the past 35 years, the SAT Math has revealed sex differences favoring males. Halpern et al. (2008) reported twice as many males than females with SAT Math scores of 500 out of 800, 4 times as many males with scores of 600 or higher, and 13 times more males than females with scores of 700 or higher. With AP programs and participation increasing across the United States, and use of these tests for college entry, the implication could mean that males have an advantage in scoring on the mathematics and science-based exams and thus have an advantage for entry into university, especially when the student is applying to a specific college within the university that emphasizes math or science. Because of Advanced Placement exam differences for males' and females' successful scores, fewer females enter specific math and science fields of study, resulting in women being under-represented in science and engineering. MIT cognitive psychologist Steven Pinker and Cambridge biologist Peter Lawrence argued that innate sex-based differences are found in men and women, which explains the disparity of women versus men in science and engineering (as cited in York & Clark, 2007).

Cognitive Ability Differences: An Explanation for Standardized Test Performance Differences

There are multiple explanations for differences in academic performance between males and females. The study of gender differences in mathematics and science performance has been compared on variables such as cognitive ability, attitudes and motivation, psychological preferences, differences in learning strategies, and the effect of stereotypes in society. Various hypotheses have been proposed to explain the differences in gender performance in mathematics, including genetic and biological factors (Halpern, 2000; Royer, Rath, Tronsky, Marchant, & Jackson, 2002), mathematics learning strategies (Carr & Jessup, 1997), and attitudes and personal preferences (Frost, Hyde, & Fennema, 1994; Tiedemann, 2000).

Several reports have suggested that there are cognitive ability differences between men and women (Goodhart, 1988; Halpern, 2000; McCrum, 1994; Pirie, 2001). The belief that genetic differences (Thomas, 1993) that cause hormonal differences (Kimura, 1992), which result in structural and activity differences in the cerebrum when performing the same tasks (Geary, 1996), has received notice. The structure that dictates function approach does not deny the impact of socialization on mathematics and science performance, but it implies that perhaps the differences may have significant impact regardless of nurture. These differences are based on genetic differences that predispose men to having a higher incidence on each end of the performance spectrum. In the context of academic achievement or in the context of higher education, this means that men are more likely to perform better than women in the top achievements, but are also more likely to be on the low end of achievement scores.

Gallagher, Levin, and Cahalan (2002) reported cognitive patterns of gender differences in solving mathematics problems on the Graduate Review Exam (GRE) using Halpern's cognitive-process taxonomy. The research found unusual male dominance on spatially based strategy problems, but not when the solution strategies were verbally based and similar to those found in mathematics textbooks. The similar male-favored significance was found in math problems that had multiple solution paths, but not on problems that had multiple steps and depended on working memory. Gallagher et al. concluded that the differences in math performance between males and females depended on the recognition and selection of solution strategies; thus, altering the way problems are presented would assist in reducing the difference in scoring between males and females on standardized tests like the GRE. Whether the differences in performance on standardized tests are due to cognitive ability differences, stereotype impact due to socialization, or differences in learning strategies, it is clear that differences in standardized test performance have occurred on scholastic achievement tests, Advanced Placement tests, and graduate review exams.

CHAPTER 3. METHODOLOGY

Introduction

A nonexperimental descriptive research design was utilized to investigate whether there is a significant difference between males' and females' Advanced Placement scores over a 12-year period. The independent variables were gender, type of Advanced Placement course, and examination year. The dependent variable was the examination rank score, ranging from 1 to 5.

The Advanced Placement scoring range is from 1 to 5. A score of 1 represents the individual achievement is not qualified for college credit; a score of 2 means the individual is possibly qualified for college credit; a score of 3 means the individual is qualified for college credit; a score of 4 means the individual is well-qualified for college credit; and a score of 5 means the individual is extremely qualified for college credit. College credit is typically not offered for a student scoring 1 or 2. Some colleges require a score of 4 or 5.

The study was conducted utilizing all Advanced Placement examination scores in the world from 1996 through 2007. These scores were obtained from the College Board, the organization responsible for the development and grading of Advanced Placement exams, with the assistance of the Educational Testing Service. Some of the 37 Advanced Placement courses have been developed within the past 12 years; thus, those courses had less data available.

Research Questions

The research study had two research questions:

Research Question 1: Is there a significant difference in participation on the Advanced Placement exams of the College Board between males and females from 1998 through 2007?

H_1: There is a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007.

H_0: There is not a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007.

Research Question 2: Is there a significant difference in successful scores on the Advanced Placement exams of the College Board between males and females from 1998 through 2007?

H_1: There is a significant difference between males' and females' successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

H_0: There is not a significant difference between males' and females' successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

The goal of the study was to determine if participation and achievement had significantly changed over the past 12 years between males' and females' Advanced Placement examination scores.

Research Design

It was impossible to compare all 37 Advanced Placement courses for all 12 years. Some Advanced Placement course programs were not available for all of the past 12 years. The AP Environmental Science course was developed in 1998 and the AP Chinese and Japanese Language courses were developed in 2006 (AP Central, 2007d). Also, most of the AP courses have had exam revisions at some time during the 12-year period. This means the exam scores have remained the same as has the method of grading the exam, but the exam itself may have been changed during the studied period. Courses like Advanced Placement Computer Science has experienced significant changes from using Pascal computer programming language in 1989, and using C++ in 1999, to using Java programming since 2004 (AP Central, 2007a). Furthermore, in the 2008 AP Computer Science exam, a GridWorld case study replaced the marine biology case study of the previous years (AP Central, 2007c). Changes such as these could have impacted gender differences of scoring, yet could not be isolated. Many of the Advanced Placement courses have had changes to the curriculum and exam during the past 12-year period. The College Board and the Educational Testing Service have tried to maintain consistency in the exam rigor and exam scoring to maintain scoring consistency from one year to the next despite the changes that occur within curriculum.

The first question examined the significant difference in participation on the Advanced Placement exams between males and females from 1996 through 2007. It was also determined if there was a significant difference in participation from one year to the next within individual courses. Lastly, the difference in participation in males and females in 1996 as compared to 2007 was analyzed to determine if there was a significant difference in the 2 years that had a 12-year gap.

The second goal was to explore the significant difference between the successful scores of males and females on all Advanced Placement exams given from 1996 through

2007. Thirty-five of the 37 Advanced Placement courses were compared between years to determine if males and females had any significant differences in success from one year to the next within a particular course. Some exams have fewer years of data available because the exam program for those courses was developed within the past 12 years. Courses with less than 12 years of data were included in the study, but 33 of the 37 courses had 12 years of data. Advanced Placement Chinese and Japanese Language were not included in the conclusions formed because there was only 1 year of data available.

Success was defined by examining three different sets of scores: passing scores of 3 and above, high-tailed scores of 5, and low-tailed scores of 1. The analysis included comparing males and females passing with a 3 or above in a particular course in separate years as well as all 12 years combined. Another analysis included comparing males and females scoring 5s in a particular course in separate years as well as all years combined. The final comparison included comparing males and females scoring 1s in a particular course.

Statistical Analysis

The research design was nonexperimental and descriptive, utilizing analysis of variance (ANOVA) factorial design as the primary statistical analysis to evaluate the differences in the means of Advanced Placement scores across 12 years between males and females for a specific course. ANOVA was also used to analyze the difference in means between males' and females' scores for a single year in the 37 Advanced Placement courses. Scores examined included percent means of students passing with a score of 3 out of a possible 5-point scale, percent means scoring 5s, and percent means scoring 1s. The independent nominal variables were gender, Advanced Placement subject, and examination year. The dependent variable was the examination score. The examination score was compared between the genders for a specific subject over 12 years. The examination score was compared between genders for total exams over 12 years.

The design of the proposed study differs from many ANOVA factorial designs by lacking a randomized population and by having unbalanced groups within the population sample. It also differed from most research studies by including the entire population of students who took Advanced Placement exams rather than a population sample.

In addition to ANOVA, a *z* test of inference was used to determine if the differences between the individual sample means and the population means are large enough to be statistically significant. Normally, a large simple random sample of the population would be utilized, but due to the nature of the study using standardized testing data provided by the College Board, the entire population was included. The *z* test determined if the Advanced Placement scores of a particular gender sample for a year or a course occurred by chance. If the scores were significantly different from the mean population score, the sample mean was unlikely to have happened by chance.

Comparisons between years was also analyzed using effect sizes reflecting differences in mean scores of the standard deviations between males' and females' AP scores for each course per year. Effect size "is standardized measure of mean differences" (Stumpf & Stanley, 1998, p. 193). AP examinations result in scores ranging from 1 to 5, with a score of 5 reflecting the student to be extremely well-qualified. The population sample for each year was divided into male and female groups, and within those groups the percent of students scoring a 5 and percent of students scoring a 1 was determined. The percent of males and females scoring a 5 was calculated, and these averages were the upper scale scores. The larger of the two scores was divided into the smaller one, forming a quotient called an upper scale ratio (USR). If the USR favors the female students, the percentage of female students scoring a 5 was larger than the percentage of male students scoring a 5 (Stumpf & Stanley, 1996). The same process was repeated with the percentage of students scoring a 1 on the exam, forming a lower scale ratio (LSR). The statistical significance of the effect size is significant above *ds* .50. According to Cohen (as cited in Stumpf & Stanley, 1998), effect size indices (*ds*) below .2 are considered negligible, and "*ds* of .20 through .49 are regarded as small; *ds* of .50 through .79 are considered to be of medium size; and *ds* of .80 or more can be regarded as large" (p. 193).

The proposed study also provided descriptive data about the differences in male and female participation and success on the Advanced Placement exam from 1996 through 2007. The percent scores and standard deviation of all sample groups who took an Advanced Placement exam during the years 1996 through 2007 were included in the study and compared by course, examination year, and gender.

Sample Selection

The Advanced Placement examination target population represents all high school students who have taken at least one Advanced Placement exam from 1996 through 2007 throughout the world. The largest sector of that population resides in the United States, the country in which the Advanced Placement program was developed and implemented starting in 1954. The size of the population participating in the Advanced Placement exam has increased from 537,428 in 1996 to 1,464,252 in 2007. The more than 1.4 million students in 2007 took over 2.5 million AP exams. All of the students' scores from around the world who took exams from 1996 through 2007 were included in this study. Students who live outside of the United States taking AP exams were included in the study even though they may have attended non-American curriculum-based schools and may not have been U.S. citizens. The population sample was not limited to students who took the AP exams in the United States.

Instrumentation

During 2 weeks in May, Advanced Placement examinations are administered at high schools and colleges across the world for each of the 37 subjects. The exams are shipped to the Educational Testing Service in the United States, and during the month of June the exams are scored using trained graders for each of the exams. The multiple-choice section is scored by using scantrons, and the free-response section is scored by multiple trained readers and is highly labor-intensive to ensure consistency and reliability between graders.

Approximately 6,000 readers meet together at designated AP reading sites at various locations in the United States to evaluate over 5 million free-response questions. Great attention is given to training each of the readers of the exams to ensure all papers are scored fairly, uniformly, and with equal standard from reader to reader (AP Central, 2007b). Each exam is graded by multiple graders with a chief grader responsible for differences that might occur between two graders. AP exams have multiple free-response questions, and no individual reader scores all the free responses for a single student. A reader typically scores one free response, so if a particular exam has four free responses, a table of readers is grading all four free responses with multiple readers for each question, but no individual reader scores all the free responses for one student. Furthermore, scores from one reader are not disclosed to other readers (College Board, 2007e). The College Board and the ETS have various checks and balances applied in the AP reading process to ensure that all exams are scored consistently and fairly within a specific year and from year to year.

The ETS analyzes the exam results and reports individual scores for each subject to the schools and districts in which the students reside. To obtain these scores, the researcher wrote the current Associate Director of International Services for College Board. He provided the researcher the raw data, which include the number of students scoring each possible score for each of the 37 courses for all 12 years. The raw data were provided by the College Board via written permission with the intention of using the data in the current research endeavor.

Data Collection Procedures

Advanced Placement examinations are taken at individual high schools with the exams secured and shipped to the Educational Testing Service after AP exams in May of each year. After being graded, the ETS provides a report to the College Board and statistically analyzes the data collected for each individual student, school, school district, and state. The data are provided to the authorities at the College Board. The data for this study were obtained from the College Board by the researcher writing Clay Hensley, the

Associated Director for International Services at the College Board. The College Board released to the researcher the unpublished data that provided the Advanced Placement score for each gender for each subject by year. Twelve years of data were given to the researcher.

Data Analysis Procedures

Two-way ANOVA was used to determine if gender, course, or examination year yield significantly different Advanced Placement scores. The independent variables examined were the Advanced Placement examination subject, gender, and the given year of the Advanced Placement exam. The dependent variable was the examination score.

In ANOVA research design, the independent variable is referred to as a factor, and because two or more factors are studied, how the variables interact and the effect that they have on the dependent variable is analyzed (Plonsky, 2006). A two-factor ANOVA was used in this study with two significance tests: a test of the main effects and a test of the interactions of the variables. ANOVA tables were utilized to display the results of significance with *z* scores computed to analyze the difference between the two means of groups. A *z* test was used instead of the *t* test due to the large population size, and a significance level of 0.01 was used.

Comparisons for each year and combined years were analyzed using effect sizes reflecting differences in mean scores of the standard deviations between males' and females' AP scores for each course per year. Effect size is a "standardized measure of mean differences" (Stumpf & Stanley, 1998, p. 193). AP examinations result in scores ranging from 1 to 5, with a score of 5 reflecting the student to be extremely well-qualified. The population sample for each year was divided into male and female groups, and within those groups the percent of students scoring a 5, percent of students scoring a 3, and the percent of students scoring a 1 was determined. The percent of males and females scoring a 5 was calculated, and these averages comprised the upper scale scores. The larger of the two scores was divided into the smaller one, forming a quotient called an upper scale ratio. If the USR favors the female students, the percentage of female students scoring a 5 is larger than the percentage of male students scoring a 5 (Stumpf & Stanley, 1996). The same process was repeated with the percentage of students scoring a 1 on the exam forming a lower scale ratio. Also, the process was repeated to show the percentage of students scoring a 3 or above. The statistical significance of the effect size is significant above *ds* .50. According to Cohen (as cited in Stumpf & Stanley, 1998), effect size indexes (*ds*) above .80 are considered large and statistically significant.

Because multiple comparisons were required in this research study, a Bonferroni adjustment was used to determine the statistical point of significance. The cutoff point of statistical significance was $p = 0.05 / 39 = 0.00128$. When multiple tests are being performed simultaneously, the Bonferroni correction allows corrections in the alpha value. Alpha values in individual tests may be appropriate without the Bonferroni correction, but when combined, as occurs with several years of data, this adjustment avoids positives that may occur due to a type I error. The alpha level represents the chance that a type I error could occur. A type I error occurs when a researcher incorrectly declares a significant difference to be true due to chance. Usually the alpha level is set at 0.05, which means that 1 out of 20 statistical tests will show something when there is actually nothing (Simple Interactive Statistical Analysis, 2008). Aickin and Gensler

(1996) reported that without adjusting the *p* value, the probability of declaring an effect or significance can be far higher than the nominal 0.5 alpha level when actually the results do not support the same conclusion when adjustments are made. Aickin and Gensler reported that when studying symptoms of a disease, the chances of forming a conclusion that some symptoms are related to a disease is higher if the alpha level is not adjusted, and symptoms unrelated to a disease may be considered related unless the Bonferroni correction is applied. The Bonferroni adjustment can be described as

> When the tests involve null hypotheses H_i (i = 1,,, , n), in order to maintain an overall type I error bound of α on all of them simultaneously, each of the corresponding *P* values F, is compared with α/n instead of α. The argument runs as follows. Assuming that *t* of the *n* hypotheses are true, a type I error can occur only if one of the events *P*, < *α*/*n* occurs for one of the true hypotheses. Since the Bonferroni inequality states that the probability of a union of events is less than or equal to the sum of the events' individual probabilities, the probability that any event *P*, < α/*n* occurs (for a true Hypothesis) is not greater than *tα/n*, which is less than or equal to α. The Bonferroni testing procedure is equivalent to an adjustment that replaces each *P*, with *nP*, (or 1, whichever is smaller) and compares these adjusted values with a. The values *nP*, can be considered "Bonferronied" *P* values, in the sense that *nP*, is the smallest overall significance level at which the individual hypotheses H_i would be rejected. (Aickin & Gensler, p. 1)

Conclusion

The nonexperimental descriptive research design examined the participation and success of males and females on Advanced Placement exams in 35 courses over a 12-year period. *Z* scores with a Bonferroni adjustment were used to determine the significance between participation, scores of 1, passing scores, and scores of 5. Some courses had less than 12 years of data but were still included in the study. Any significant differences between males and females were reported by year or by course.

CHAPTER 4. RESULTS

Introduction

This chapter presents the results of the analysis of data from 12 years of Advanced Placement exam scores in 37 different courses by comparing participation and success between males and females. The data were analyzed using two-way ANOVA and descriptive statistics. The data were first reviewed and examined to identify outliers or outcomes that might skew the results for unanticipated reasons, and none were found. Because the data were obtained from Advanced Placement Central, a division of College Board, outliers that could affect scoring were identified and eliminated by the Educational Testing Service and College Board prior to being provided to the researcher. Such outliers would include student scores that were invalidated for infractions occurring during the testing procedures, student scores that were based on taking the Advanced Placement exam at a different time than the rest of the population, and student scores in which gender was not identified on the exam registration form.

Characteristics of the Population

The population included students from secondary schools around the world who participated in Advanced Placement examinations from 1996 through 2007. Course exams that were developed within the 12 years were also examined, along with the courses that were developed by 1996. The entire population included more than 6.2 million females and more than 4.9 million male participants. The total population was over 11 million students participating in more than 18 million Advanced Placement examinations between 1996 and 2007. No sampling occurred because the scores of all 11 million students was provided and identified based on gender, year, and course.

Missing Data

Of the 37 courses developed by 1996, data were missing for the 2007 AP Studio Art and 1996 data for statistics. That data were not available from College Board. A few courses were not developed by 1996; thus, less than 12 years of data were available. Those courses include AP Chinese, Japanese, Environmental Science, World History, Human Geography, Italian Language, Music Listening and Literature, Studio Art 2-D, and Studio Art 3-D. Because AP Chinese and AP Japanese courses originated in 2007, no analysis occurred in those courses due to having only 1 year of data available. Thirty courses had 12 years of data. Those courses were American Government and Politics, Art History, Art Studio Drawing, Art Portfolio, Biology, Calculus AB, Calculus BC, Chemistry, Comparative Government and Politics, Computer Science A, Computer Science AB, English Language and Composition, English Literature and Composition, European History, French Language, French Literature, German Language, Latin: Vergil, Latin Literature, Macroeconomics, Microeconomics, Music Theory, Physics B, Physics C, Physics C, E and M, Psychology, Spanish Language, Spanish Literature, Statistics U.S. History, and World History. Thirty-seven courses were studied in the research, with 30 having 12 years of data. All 37 courses were analyzed, but AP Chinese and Japanese Language were not included in the analysis and conclusions because only 1 year of data were available for those two exams.

Data Analysis

For purposes of statistical analysis, the research hypotheses studied were null hypotheses. Hypotheses were tested using two-way ANOVA and descriptive statistics. One test was used to determine if participation in the Advanced Placement exams differed significantly between males and females over the years 1996 through 2007. Descriptive statistics were used to compare participation in each course between males and females over all 12 years collectively. Descriptive statistics were used to compare participation between males and females between years.

Besides participation, success on the Advanced Placement examinations was also studied. Two-way ANOVA was used to compare the significant difference between males' and females' passing score ranks for each course over the 12-year period. Two-way ANOVA was used to compare the significant difference between males' and females' highest and lowest score ranks for each course over the 12-year period. Scoring on the Advanced Placement exam is ranked from 1 to 5. College Board (2007a) defined the scores as 5 = *extremely well-qualified,* 4 = *well-qualified,* 3 = *qualified*, 2 = *possibly qualified*, 1 = *not qualified*. Scores examined in the data analysis included males and females scoring 5, 1, or above 3. A 3 score or above represents "passing" on the AP exam.

Research Question 1

Is there a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

$H_0$2: There is not a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007.

Procedures used for answering research question 1. To analyze and statistically determine if there were a significant difference in participation on Advanced Placement exams, the College Board was contacted with a request to receive all the Advanced Placement exam scores between 1996 and 2007 with scores and courses separated by gender. Dr. Clay Hensley was the contact person at College Board, but he directed the request to the research department at College Board, and the Assistant Director of Research and Analysis, Jean-Leger Sherby, provided the data via e-mail. The students per year and per course were totaled for each course over all the years and for each gender over all the courses throughout the 12-year period. The Statistical Package for Social Science (SPSS) software version 16 was utilized to determine the significant difference between males and females over all the years and within each course based on participation in the exam. The total number of students taking the exam who were male or female was compared over all the years for all courses and within each course using two-way ANOVA and SPSS.

SPSS is statistical software that provides broad-range capabilities to analyze data. Using the data generated from SPSS, users can generate data useful for making decisions, can understand and effectively present data in tables or graphical output, and share these results with others using various reporting methods (SPSS, 2008). SPSS version 16 was used to generate the data found in this research endeavor.

Findings for participation differences on Advanced Placement exams for 1996–2007.

Table 1. Two-Way ANOVA Tests for Proportion of Males and Females Participating Who Scored 3 or Above Over 1996–2007

	Proportion			
Test	Female	Male	*z*	*p* value
Art Studio 2-D Design	0.013	0.0074	26.328	< 0.0002
Art Studio 3-D Design	0.002	0.0016	5.81	< 0.0002
Art History	0.0152	0.01	21.855	< 0.0002
Art Studio - Drawing	0.0099	0.0068	15.954	< 0.0002
Art Studio - Portfolio	0.0098	0.0075	11.766	< 0.0002
Biology	0.1005	0.1018	–2.116	0.0348
Chemistry	0.0537	0.0836	–57.149	< 0.0002
Computer Science A	0.0041	0.0255	–88.481	< 0.0002
Computer Science AB	0.0012	0.0129	–70.139	< 0.0002
Microeconomics	0.0178	0.0316	–43.258	< 0.0002
Macroeconomics	0.0278	0.0447	–43.874	< 0.0002
English Lang & Comp	0.1862	0.1416	57.306	< 0.0002
English Lit & Comp	0.262	0.1913	80.208	< 0.0002
Environmental Science	0.029	0.029	0.021	0.9831
World History	0.0623	0.065	–5.258	< 0.0002
European History	0.068	0.078	–19.06	< 0.0002
U.S. History	0.2339	0.2667	–36.281	< 0.0002

Table 1. Two-Way ANOVA Tests for Proportion of Males and Females Participating Who Scored 3 or Above Over 1996–2007 (*continued*)

	Proportion			
Test	Female	Male	z	p value
French Language	0.0231	0.0127	36.721	< 0.0002
French Literature	0.0024	0.0012	12.559	< 0.0002
Human Geography	0.0134	0.0147	–5.171	< 0.0002
German Language	0.004	0.005	–6.795	< 0.0002
American Gov & Pol	0.0905	0.1052	–23.79	< 0.0002
Comp Gov & Pol	0.009	0.0131	–18.842	< 0.0002
International English	0.006	0.0052	5.395	< 0.0002
Italian Language	0.002	0.0014	6.544	< 0.0002
Latin: Vergil	0.0035	0.0048	–9.781	< 0.0002
Latin Literature	0.0026	0.0031	–4.521	< 0.0002
Calculus AB	0.1403	0.1976	–73.609	< 0.0002
Calculus BC	0.0308	0.0607	–69.705	< 0.0002
Music Theory	0.0063	0.0094	–16.654	< 0.0002
Physics B	0.0241	0.0577	–83.097	< 0.0002
Physics C: Mech	0.0093	0.0331	–81.96	< 0.0002
Physics C: E & M	0.0037	0.0163	–63.637	< 0.0002
Psychology	0.070	0.0481	44.658	< 0.0002
Spanish Language	0.0838	0.0603	42.927	< 0.0002
Spanish Literature	0.0133	0.0081	23.886	< 0.0002
Statistics	0.0487	0.0628	–29.141	< 0.0002

Table 1. Two-Way ANOVA Tests for Proportion of Males and Females Participating Who Scored 3 or Above Over 1996–2007 (*continued*)

	Proportion			
Test	Female	Male	*z*	*p* value
Chinese Language	0.0034	0.0036	–1.708	0.0778
Japanese Language	0.0017	0.0019	–2.013	0.0441

To address the first research hypothesis, the proportion of female and male participants (the average number of individuals who took a given test divided by the average population size of male and female students during the time period in question) was determined. An interactive program developed by Vassar College was used to obtain the *z* score and *p* values for the difference in the two proportions. This program provided the software to calculate the significant difference between two independent proportions. It calculated the *z* ratio for the significance of the difference between two independent proportions such as between the number of males and females participating in a given course over all 12 years. The software assumed two independent samples with *n*a and *n*b representing the total numbers of observations in two independent samples (sample a and b), and *k*a and *k*b representing the total number of observations within each sample, and *p*a and *p*b representing those proportions *k*a / *n*a and *k*b / *n*b, respectively (Lowry, 2008).

A Bonferroni adjustment was used to determine the cutoff point of statistical significance: $p = 0.05 / 39 = 0.00128$.

> The Bonferroni correction is a multiple-comparison correction used when several dependent or independent statistical tests are being performed simultaneously (since while a given alpha value may be appropriate for each individual

> comparison, it is not for the set of all comparisons). (Wolfram Research, 2008, ¶ 1)

This adjustment avoids positives that may occur when multiple comparisons are being statistically analyzed. This is the simplest and most conservative approach to address the alpha value. The Bonferroni correction

> Sets the alpha value for the entire *set* of n comparisons equal to α by taking the alpha value for *each* comparison equal to α/n. Explicitly, given n tests T_i for hypotheses H_i ($1 \leq i \leq n$) under the assumption H_0 that all hypotheses H_i are false, and if the individual test critical values are $\leq \alpha/n$, then the experiment-wide critical value is $\leq \alpha$. In equation form, if $P(T_i$ passes/ $H_0 < \alpha/n$ for $1 \leq i \leq n$, then P(some T_i passes/ $H_0) \leq \alpha$ which follows the Bonferroni inequalities. (Wolfram Research, 2008, ¶ 2)

Based on this criterion, the large majority of subject tests showed gender differences in the proportion of AP test-taking participants. The only tests that did not show any differences were Environmental Science, Biology, Chinese, and Japanese. Particularly significant differences were revealed in more male participants in Calculus AB, Calculus BC, Physics B, Physics C, Physics C, E and Mechanics, as well as Computer Science A and AB. More females participated in English Language, English Literature and Composition, Spanish, and French Language.

Descriptive statistics. The research sample included 18,770,181 tests from over 11 million students in 37 different Advanced Placement courses over a period of 12 years from 1996–2007. The following tables show frequencies and percents for gender for each AP course and for all courses combined.

The research showed that of the over 18.7 million exams taken over the past 12 years, more females have participated in Advanced Placement exams than males.

Table 2. Frequency and Percent of Males and Females Combined Over 12 Years of AP Exams

Gender	*f*	%
Male	8,565,225	45.63
Female	10,204,956	54.37

Over the past 12 years of Advanced Placement examinations, Computer Science has had the least percentage of females participating in the exam, with only 10.3% for the AB exam and 17.3% for the A exam. Other areas of low participation by females are AP Latin Literature and Physics. Low participation by males was observed in AP French Language, French Literature, and English Literature and Composition.

Table 3. Frequency of Males and Females for Each Course Over 12 Years of AP Exams

	Female		Male		
Test	*f*	%	*f*	%	Total *f*
Art: Studio 2-D Design	40,472	69.24	17,978	30.76	58,450
Art: Studio 3-D Design	6,767	51.35	6,411	48.65	13,178
Art: History	94,829	66.32	48,151	33.68	142,980
Art: Studio - Drawing	61,600	64.03	34,600	35.97	96,200
Art: Studio - Portfolio	30,593	39.71	46,449	60.29	77,042
Biology	687,011	58.33	490,884	41.67	1,177,895
Chemistry	335,246	46.21	390,297	53.79	725,543
Computer Science A	25,822	17.36	122,927	82.64	148,749

Table 3. Frequency of Males and Females for Each Course Over 12 Years of AP Exams (*continued*)

	Female		Male		
Test	*f*	%	*f*	%	Total *f*
Computer Science AB	7,595	10.31	66,055	89.69	73,650
Microeconomics	111,201	41.51	156,714	58.49	267,915
Macroeconomics	173,296	42.47	234,742	57.53	408,038
English Language & Composition	1,161,926	61.60	724,171	38.40	1,886,097
English Literature & Composition	1,634,937	65.08	877,126	34.92	2,512,063
Environmental Science	150,902	56.08	118,183	43.92	269,085
World History	194,334	51.90	180,071	48.10	374,405
History: European	423,947	49.57	431,235	50.43	855,182
History: U.S.	1,459,549	55.59	1,166,047	44.41	2,625,596
French Language	144,054	71.14	58,434	28.86	202,488
French Literature	14,777	72.62	5,572	27.38	20,349
Human Geography	48,721	52.90	43,381	47.10	92,102
German Language	25,074	35.80	44,973	64.20	70,047
Government & Politics: American	564,434	53.26	495,424	46.74	1,059,858
Gov. & Politics: Comparative	56,203	47.76	61,487	52.24	117,690
International English	18,811	61.95	11,553	38.05	30,364
Italian Language	2,078	43.63	2,685	56.37	4,763
Latin: Vergil	21,939	48.92	22,909	51.08	44,848
Latin: Literature	16,423	18.22	73,706	81.78	90,129
Calculus AB	875,458	48.74	920,543	51.26	1,796,001
Calculus BC	192,651	40.56	282,277	59.44	474,928
Music Theory	39,471	40.41	58,206	59.59	97,677

Table 3. Frequency of Males and Females for Each Course Over 12 Years of AP Exams (*continued*)

	Female		Male		
Test	*f*	%	*f*	%	Total *f*
Physics B	150,392	35.21	276,680	64.79	427,072
Physics C: Mechanics	57,730	26.82	157,559	73.18	215,289
Physics C: E & M	23,225	21.89	82,859	78.11	106,084
Psychology	425,141	64.23	236,779	35.77	661,920
Spanish Language	568,819	65.54	299,029	34.46	867,848
Spanish Literature	83,261	66.49	41,954	33.51	125,215
Statistics	276,267	49.92	277,174	50.08	553,441

Every year showed a significant difference at the 5% level between the number of males and females. Less than 12 years of data were available because the exam was implemented in 2002. More females participated in AP Studio: 2-D Design (see Table 4).

Table 4. Participation of Males and Females in Art: Studio 2-D Design

Year	% female	% male	*z*	*p*
2002	66.64	33.36	28.178	0.0000
2003	68.77	31.23	32.724	0.0000
2004	68.65	31.35	34.101	0.0000
2005	68.95	31.05	38.119	0.0000
2006	69.85	30.15	43.123	0.0000
2007	70.95	29.05	48.531	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. Less than 12 years of data were available because the exam was implemented in 2002. More females participated in AP Art Studio: 3-D Design (see Table 5).

Table 5. Participation of Males and Females in Art: Studio 3-D Design

Year	% female	% male	*z*	*p*
2002	62.52	37.48	9.226	0.0000
2003	61.90	38.10	9.194	0.0000
2004	61.22	38.78	9.270	0.0000
2005	62.81	37.19	11.080	0.0000
2006	63.35	36.65	11.996	0.0000
2007	64.53	35.47	13.993	0.0000

Every year showed a significant difference at the 5% level between the number of males and females. More females participated in AP Art History (see Table 6).

Every year revealed a significant difference at the 5% level between the number of males and females except 1996. More females participated in AP Studio Drawing, except in 1997 (see Table 7).

Every year revealed a significant difference at the 5% level between the number of males and females. The College Board did not provide all of the 12 years of data for AP Studio Portfolio. Only 6 years of data were available, and that data were recorded, indicating significant participation among females except in 1997 (see Table 8).

Table 6. Participation of Males and Females in Art History

Year	% female	% male	*z*	*p*
1996	64.24	35.76	22.366	0.0000
1997	73.86	26.14	36.583	0.0000
1998	63.61	36.39	23.310	0.0000
1999	63.94	36.06	26.507	0.0000
2000	65.31	34.69	30.194	0.0000
2001	64.88	35.12	31.274	0.0000
2002	66.08	33.92	36.288	0.0000
2003	65.58	34.42	36.489	0.0000
2004	66.44	33.56	38.568	0.0000
2005	67.54	32.46	45.455	0.0000
2006	67.40	32.60	46.652	0.0000
2007	66.73	33.27	45.918	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in Advanced Placement Biology (see Table 9).

Every year revealed a significant difference at the 5% level between the number of males and females. More males participated in Advanced Placement Chemistry (see Table 10).

Every year revealed a significant difference at the 5% level between the number of males and females. Significantly more males participated in AP Computer Science A (see Table 11).

Table 7. Participation of Males and Females in Art: Studio Drawing

Year	% female	% male	*z*	*p*
1996	50.28	49.72	0.288	0.7735
1997	36.31	63.69	–18.419	0.0000
1998	54.45	45.55	5.403	0.0000
1999	57.16	42.84	9.285	0.0000
2000	58.14	41.86	11.130	0.0000
2001	61.15	38.85	16.775	0.0000
2002	65.65	34.35	31.264	0.0000
2003	66.35	33.65	33.734	0.0000
2004	66.92	33.08	36.609	0.0000
2005	67.94	32.06	39.752	0.0000
2006	68.58	31.42	41.672	0.0000
2007	70.76	29.24	48.352	0.0000

Table 8. Participation of Males and Females in Art: Studio Portfolio

Year	% female	% male	*z*	*p*
1996	58.72	41.28	13.601	0.0000
1997	12.04	87.96	–142.504	0.0000
1998	62.37	37.63	22.253	0.0000
1999	62.36	37.64	23.141	0.0000
2000	63.58	36.42	26.021	0.0000
2001	66.34	33.66	32.173	0.0000

Table 9. Participation of Males and Females in Biology

Year	% female	% male	*z*	*p*
1996	55.51	44.49	28.274	0.0000
1997	62.23	37.77	61.901	0.0000
1998	56.98	43.02	38.329	0.0000
1999	57.45	42.55	42.799	0.0000
2000	57.87	42.13	46.392	0.0000
2001	58.58	41.42	52.118	0.0000
2002	58.99	41.01	56.238	0.0000
2003	58.56	41.44	55.173	0.0000
2004	58.45	41.55	56.324	0.0000
2005	58.72	41.28	60.782	0.0000
2006	58.33	41.67	60.462	0.0000
2007	58.15	41.85	62.026	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. Significantly more males participated in AP Computer Science AB (see Table 12).

Every year revealed a significant difference at the 5% level between the number of males and females. More males participated in Microeconomics (see Table 13).

Every year revealed a significant difference at the 5% level between the number of males and females. More males participated in Macroeconomics (see Table 14).

Table 10. Participation of Males and Females in Chemistry

Year	% female	% male	*z*	*p*
1996	41.70	58.30	–32.579	0.0000
1997	75.13	24.87	77.171	0.0000
1998	42.89	57.11	–30.130	0.0000
1999	43.06	56.94	–30.674	0.0000
2000	43.93	56.07	–27.900	0.0000
2001	44.38	55.62	–26.442	0.0000
2002	45.36	54.64	–23.009	0.0000
2003	45.61	54.39	–22.496	0.0000
2004	46.02	53.98	–21.246	0.0000
2005	46.46	53.54	–19.847	0.0000
2006	46.77	53.23	–19.101	0.0000
2007	46.73	53.27	–20.374	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. Significantly more females participated in AP English Language and Composition (see Table 15).

Every year showed a significant difference at the 5% level between the number of males and females. More females participated in AP English Literature and Composition (see Table 16).

Every year showed a significant difference at the 5% level between the number of males and females. More females participated in AP Environmental Science (see Table 17).

Table 11. Participation of Males and Females in Computer Science A

Year	% female	% male	*z*	*p*
1996	19.30	80.70	–50.792	0.0000
1997	26.71	73.29	–34.338	0.0000
1998	18.17	81.83	–51.239	0.0000
1999	16.48	83.52	–74.112	0.0000
2000	16.58	83.42	–78.089	0.0000
2001	17.06	82.94	–82.882	0.0000
2002	16.48	83.52	–83.890	0.0000
2003	15.80	84.20	–82.865	0.0000
2004	16.27	83.73	–80.769	0.0000
2005	16.56	83.44	–78.915	0.0000
2006	17.69	82.31	–78.241	0.0000
2007	18.39	81.61	–77.563	0.0000

Every year showed a significant difference at the 5% level between the number of males and females. More females participated in AP World History (see Table 18).

Every year showed a significant difference at the 5% level between the number of males and females. More females participated in AP European History (see Table 19).

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in AP U.S. History (see Table 20).

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in AP French Language (see Table 21).

Table 12. Participation of Males and Females in Computer Science AB

Year	% female	% male	*z*	*p*
1996	11.82	88.18	–52.476	0.0000
1997	7.03	92.97	–75.572	0.0000
1998	12.20	87.80	–48.152	0.0000
1999	9.40	90.60	–66.067	0.0000
2000	10.76	89.24	–65.073	0.0000
2001	10.94	89.06	–68.079	0.0000
2002	10.05	89.95	–70.557	0.0000
2003	10.47	89.53	–66.489	0.0000
2004	10.63	89.37	–61.381	0.0000
2005	10.10	89.90	–56.966	0.0000
2006	10.47	89.53	–55.565	0.0000
2007	11.91	88.09	–54.214	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in AP French Literature (ssee Table 22).

Every year showed a significant difference at the 5% level between the number of males and females except 2001. More females participated in AP Human Geography (see Table 23).

Every year showed a significant difference at the 5% level between the number of males and females except 2002, 2004, 2005, and 2006. German Language is the only AP course that has had a change in significance over the past 5 years. More males are participating in AP German language than in previous years (see Table 24).

Table 13. Participation of Males and Females in Microeconomics

Year	% female	% male	*z*	*p*
1996	40.05	59.95	–20.323	0.0000
1997	33.80	66.20	–38.245	0.0000
1998	41.88	58.12	–18.692	0.0000
1999	40.99	59.01	–21.972	0.0000
2000	41.66	58.34	–22.050	0.0000
2001	41.29	58.71	–23.827	0.0000
2002	42.57	57.43	–22.577	0.0000
2003	42.26	57.74	–24.799	0.0000
2004	42.05	57.95	–26.449	0.0000
2005	42.23	57.77	–27.968	0.0000
2006	41.55	58.45	–30.740	0.0000
2007	42.65	57.35	–28.410	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in AP American Government and Politics (see Table 25).

Every year showed a significant difference at the 5% level between the number of males and females. More males participated in AP Comparative Government and Politics (see Table 26).

Table 14. Participation of Males and Females in Macroeconomics

Year	% female	% male	*z*	*p*
1996	41.63	58.37	–19.598	0.0000
1997	20.30	79.70	–106.311	0.0000
1998	42.56	57.44	–19.771	0.0000
1999	42.80	57.20	–20.372	0.0000
2000	42.68	57.32	–22.557	0.0000
2001	43.62	56.38	–21.438	0.0000
2002	44.40	55.60	–20.078	0.0000
2003	44.98	55.02	–19.627	0.0000
2004	44.77	55.23	–21.261	0.0000
2005	45.27	54.73	–20.786	0.0000
2006	44.80	55.20	–23.846	0.0000
2007	45.22	54.78	–23.435	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. The College Board did not provide data for every year for this course. Only data for 1998 through 2002 were provided. More females participated in AP International English (see Table 27).

Every year revealed a significant difference at the 5% level between the number of males and females. The AP Italian Language course was implemented in 2006, so only 2 years of data were available. For the two years that AP Italian Language has been examined, more females participated than males (see Table 28).

Table 15. Participation of Males and Females in English Language & Composition

Year	% female	% male	*z*	*p*
1996	61.41	38.59	55.595	0.0000
1997	41.94	58.06	–50.894	0.0000
1998	61.92	38.08	67.416	0.0000
1999	62.24	37.76	76.387	0.0000
2000	62.39	37.61	83.713	0.0000
2001	62.86	37.14	94.673	0.0000
2002	62.92	37.08	102.110	0.0000
2003	62.56	37.44	105.357	0.0000
2004	62.83	37.17	114.317	0.0000
2005	63.02	36.98	125.064	0.0000
2006	62.73	37.27	128.958	0.0000
2007	63.00	37.00	138.126	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females except 1996, 1998, 2001, and 2005. More males participated in AP Latin: Vergil over the past 6 years (see Table 29).

Every year revealed a significant difference at the 5% level between the number of males and females except 1996, 1998, 1999, 2000, 2003, 2005, and 2006. More females participated in AP Latin: Literature (see Table 30).

Table 16. Participation of Males and Females in English Literature & Composition

Year	% female	% male	z	p
1996	63.29	36.71	103.430	0.0000
1998	63.61	36.39	111.315	0.0000
1999	63.58	36.42	114.008	0.0000
2000	63.80	36.20	120.526	0.0000
2001	63.52	36.48	121.350	0.0000
2002	63.84	36.16	128.484	0.0000
2003	63.60	36.40	130.257	0.0000
2004	63.58	36.42	132.946	0.0000
2005	63.67	36.33	139.617	0.0000
2006	63.50	36.50	143.193	0.0000
2007	63.78	36.22	150.568	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. More males participated in AP Calculus AB (see Table 31).

Every year revealed a significant difference at the 5% level between the number of males and females. More males participated in AP Calculus BC (see Table 32).

Every year revealed a significant difference at the 5% level between the number of males and females except 1996, 1998, and 2000. More males participated in AP Music Theory (see Table 33).

Table 17. Participation of Males and Females in Environmental Science

Year	% female	% male	*z*	*p*
1998	54.29	45.71	6.165	0.0000
1999	55.90	44.10	11.327	0.0000
2000	56.23	43.77	14.576	0.0000
2001	56.44	43.56	17.685	0.0000
2002	56.23	43.77	19.458	0.0000
2003	56.68	43.32	23.119	0.0000
2004	56.02	43.98	21.738	0.0000
2005	55.92	44.08	23.114	0.0000
2006	56.06	43.94	25.636	0.0000
2007	55.87	44.13	26.897	0.0000

Table 18. Participation of Males and Females in World History

Year	% female	% male	*z*	*p*
2002	54.01	45.99	11.599	0.0000
2003	54.26	45.74	15.791	0.0000
2004	54.76	45.24	20.763	0.0000
2005	55.00	45.00	25.332	0.0000
2006	55.62	44.38	32.581	0.0000
2007	55.17	44.83	33.015	0.0000

Table 19. Participation of Males and Females in European History

Year	% female	% male	*z*	*p*
1996	50.65	49.35	2.590	0.0096
1997	23.86	76.14	–158.391	0.0000
1998	51.16	48.84	5.114	0.0000
1999	52.24	47.76	10.491	0.0000
2000	51.70	48.30	8.291	0.0000
2001	52.21	47.79	11.331	0.0000
2002	52.69	47.31	14.098	0.0000
2003	52.64	47.36	14.330	0.0000
2004	53.27	46.73	18.413	0.0000
2005	53.29	46.71	19.204	0.0000
2006	53.51	46.49	21.165	0.0000
2007	53.55	46.45	22.124	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. Many more males participated in AP Physics B (see Table 34).

Every year revealed a significant difference at the 5% level between the number of males and females. Significantly more males participated in AP Physics C: Mechanics (see Table 35).

Every year revealed a significant difference at the 5% level between the number of males and females. Many more males participated in AP Physics C: E & M (see Table 36).

Table 20. Participation of Males and Females in U.S. History

Year	% female	% male	*z*	*p*
1996	53.27	46.73	24.634	0.0000
1997	95.03	4.97	262.062	0.0000
1998	53.72	46.28	29.943	0.0000
1999	53.56	46.44	29.977	0.0000
2000	53.70	46.30	32.286	0.0000
2001	53.73	46.27	33.908	0.0000
2002	54.14	45.86	39.492	0.0000
2003	54.52	45.48	44.513	0.0000
2004	54.59	45.41	47.119	0.0000
2005	55.04	44.96	53.898	0.0000
2006	54.77	45.23	53.182	0.0000
2007	54.56	45.44	52.676	0.0000

Every year revealed a significant difference at the 5% level between the number of males and females. More females participated in AP Psychology, and in the past 12 years, the *z* value has continued to increase even though the percent of students has remained relatively unchanged (see Table 37).

Every year showed a significant difference at the 5% level between the number of males and females. A much larger number of females participated in AP Spanish Language (see Table 38).

Table 21. Participation of Males and Females in French Language

Year	% female	% male	*z*	*p*
1996	69.41	30.59	45.056	0.0000
1997	95.45	4.55	90.175	0.0000
1998	69.27	30.73	45.152	0.0000
1999	69.60	30.40	48.067	0.0000
2000	68.94	31.06	47.152	0.0000
2001	70.82	29.18	53.531	0.0000
2002	70.11	29.89	53.019	0.0000
2003	70.08	29.92	54.618	0.0000
2004	69.84	30.16	54.721	0.0000
2005	69.72	30.28	56.114	0.0000
2006	70.69	29.31	60.787	0.0000
2007	69.90	30.10	58.633	0.0000

Every year showed a significant difference at the 5% level between the number of males and females except 1997. More females participated in AP Spanish Literature (see Table 39).

Every year showed a significant difference at the 5% level between the number of males and females except 2001, 2002, 2003, 2004, 2006, and 2007. In the past 6 years, there has not been a significant difference in the participation between males and females in AP Statistics (see Table 40).

Table 22. Participation of Males and Females in French Literature

Year	% female	% male	*z*	*p*
1996	70.48	29.52	15.833	0.0000
1998	72.00	28.00	17.701	0.0000
1999	70.07	29.93	15.789	0.0000
2000	70.76	29.24	16.887	0.0000
2001	70.80	29.20	16.993	0.0000
2002	72.89	27.11	18.862	0.0000
2003	68.47	31.53	15.944	0.0000
2004	70.73	29.27	17.693	0.0000
2005	71.88	28.12	18.746	0.0000
2006	71.88	28.12	18.746	0.0000
2007	71.28	28.72	19.351	0.0000

Table 23. Participation of Males and Females in Human Geography

Year	% female	% male	*z*	*p*
2001	48.50	51.50	–1.713	0.0867
2002	52.44	47.56	3.549	0.0004
2003	52.90	47.10	4.964	0.0000
2004	53.61	46.39	7.398	0.0000
2005	53.72	46.28	8.839	0.0000
2006	54.53	45.47	13.131	0.0000
2007	54.55	45.45	15.507	0.0000

Table 24. Participation of Males and Females in German Language

Year	% female	% male	*z*	*p*
1996	52.58	47.42	2.943	0.0032
1997	7.08	92.92	–133.013	0.0000
1998	52.02	47.98	2.386	0.0170
1999	52.23	47.77	2.673	0.0075
2000	52.46	47.54	3.024	0.0025
2001	51.34	48.66	1.715	0.0864
2002	50.54	49.46	0.697	0.4859
2003	51.60	48.40	2.015	0.0439
2004	51.04	48.96	1.401	0.1611
2005	49.47	50.53	–0.721	0.4710
2006	48.92	51.08	–1.548	0.1215
2007	48.53	51.47	–2.164	0.0304

The proportion tests that were used to create Tables 2–40 were repeated for each year during the period 1996–2007. Each year's data for each course were examined, and the data produced were similar to the data obtained when all 12 years of data were combined. The data for the period 1996 through 2007 were merged together for each course. To address the first research hypothesis, the average number of individuals who took a given test was divided by the average population size of male and female students during the time period analyzed. An interactive program developed by Vassar College was used to obtain the *z* score and *p* values for the difference in proportion of female and male participants.

Table 25. Participation of Males and Females in American Government & Politics

Year	% female	% male	*z*	*p*
1996	50.72	49.28	2.860	0.0042
1997	86.55	13.45	119.208	0.0000
1998	51.41	48.59	6.283	0.0000
1999	51.67	48.33	7.961	0.0000
2000	51.10	48.90	5.659	0.0000
2001	51.67	48.33	9.273	0.0000
2002	52.30	47.70	13.878	0.0000
2003	52.63	47.37	17.046	0.0000
2004	52.66	47.34	17.899	0.0000
2005	53.03	46.97	21.815	0.0000
2006	52.77	47.23	21.015	0.0000
2007	53.14	46.86	25.233	0.0000

An interactive program developed by Vassar College was used to obtain the *z* score and *p* values for the difference in the two proportions. As before, a Bonferroni adjustment was used to determine the cutoff point of statistical significance: $p = 0.05 / 39 = 0.00128$. Based on this criterion, the large majority of subject tests showed gender differences in the proportion of AP test-taking participants. The only tests that did not show any differences were AP Latin: Vergil for some years, AP German for the past 6 years, and AP Statistics. AP Japanese and AP Chinese were not included in the study because only 1 year of data were available as both were developed in 2006.

Table 26. Participation of Males and Females in Comparative Government & Politics

Year	% female	% male	*z*	*p*
1996	44.79	55.21	–7.976	0.0000
1997	72.83	27.17	29.236	0.0000
1998	45.69	54.31	–7.124	0.0000
1999	46.83	53.17	–5.475	0.0000
2000	45.71	54.29	–7.797	0.0000
2001	45.82	54.18	–8.012	0.0000
2002	45.79	54.21	–8.614	0.0000
2003	47.68	52.32	–5.084	0.0000
2004	47.70	52.30	–5.231	0.0000
2005	47.66	52.34	–5.616	0.0000
2006	47.32	52.68	–6.060	0.0000
2007	47.70	52.30	–5.312	0.0000

Table 27. Participation of Males and Females in International English

Year	% female	% male	*z*	*p*
1998	58.05	41.95	9.861	0.0000
1999	58.30	41.70	11.298	0.0000
2000	59.72	40.28	14.860	0.0000
2001	60.28	39.72	17.956	0.0000
2002	62.56	37.44	21.166	0.0000

Table 28. Participation of Males and Females in Italian Language

Year	% female	% male	z	p
2006	63.74	36.26	10.985	0.0000
2007	64.56	35.44	11.796	0.0000

Table 29. Participation of Males and Females in Latin: Vergil

Year	% female	% male	z	p
1996	48.13	51.87	–1.960	0.0500
1997	62.45	37.55	11.924	0.0000
1998	48.38	51.62	–1.860	0.0630
1999	47.19	52.81	–3.276	0.0011
2000	48.21	51.79	–2.097	0.0360
2001	50.20	49.80	0.244	0.8069
2002	48.29	51.71	–2.093	0.0363
2003	47.74	52.26	–2.835	0.0046
2004	48.24	51.76	–2.244	0.0248
2005	48.69	51.31	–1.726	0.0843
2006	47.50	52.50	–3.477	0.0005
2007	47.70	52.30	–3.233	0.0012

More AP examinations showed a significant difference in participation favoring females, but AP Physics, Chemistry, Computer Science, and Calculus indicate significant differences in participation favoring males.

Table 30. Participation of Males and Females in Latin: Literature

Year	% female	% male	*z*	*p*
1996	51.51	48.49	1.229	0.2189
1997	1.47	98.53	–237.991	0.0000
1998	50.95	49.05	0.860	0.3896
1999	50.54	49.46	0.510	0.6098
2000	51.17	48.83	1.136	0.2558
2001	52.91	47.09	2.867	0.0041
2002	52.19	47.81	2.339	0.0194
2003	51.42	48.58	1.481	0.1386
2004	52.33	47.67	2.609	0.0091
2005	50.91	49.09	1.077	0.2814
2006	51.67	48.33	1.923	0.0545
2007	53.17	46.83	3.892	0.0001

Summary of the research on Advanced Placement participation

More females took Advanced Placement exams than males from 1996 through 2007. Females tended to take more humanities and art classes (French Literature, Art: Drawing, English Language and Composition, etc.) while males were more weighted towards the physical sciences and mathematics (Physics, Computer Science, Chemistry, Calculus). The Advanced Placement exam with the highest proportion of females was AP French Literature (72.6%), and the highest proportion of males was found in AP Computer Science (89.7%).

Table 31. Participation of Males and Females in Calculus AB

Year	% female	% male	*z*	*p*
1996	46.72	53.28	–21.278	0.0000
1997	78.70	21.30	148.391	0.0000
1998	46.87	53.13	–21.453	0.0000
1999	46.97	53.03	–21.644	0.0000
2000	47.10	52.90	–21.495	0.0000
2001	47.31	52.69	–20.613	0.0000
2002	47.74	52.26	–17.970	0.0000
2003	47.36	52.64	–21.528	0.0000
2004	47.73	52.27	–18.989	0.0000
2005	47.77	52.23	–19.213	0.0000
2006	48.24	51.76	–15.604	0.0000
2007	48.47	51.53	–14.121	0.0000

Advanced Placement U.S. History was taken the most frequently, with 2,625,596 exams taken over the 12-year period, and AP Italian Language, which has only been implemented in the last 2 years, had 4,763 exams taken.

Research Question 2

Is there a significant difference in successful scores on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

$H_0$1: There is not a significant difference between males and females successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

Table 32. Participation of Males and Females in Calculus BC

Year	% female	% male	*z*	*p*
1996	37.43	62.57	–36.605	0.0000
1998	38.40	61.60	–38.193	0.0000
1999	38.01	61.99	–42.046	0.0000
2000	38.27	61.73	–43.350	0.0000
2001	38.55	61.45	–44.705	0.0000
2002	39.12	60.88	–44.483	0.0000
2003	39.57	60.43	–44.713	0.0000
2004	39.99	60.01	–44.840	0.0000
2005	40.62	59.38	–43.748	0.0000
2006	40.05	59.95	–48.186	0.0000
2007	40.87	59.13	–46.314	0.0000

Procedures used for answering research question 2. To analyze and statistically determine if there is a significant difference in successful scores on Advanced Placement exams, the College Board was contacted with a request to receive all the Advanced Placement exam scores between 1996 and 2007 with scores and courses separated by gender. Dr. Clay Hensley was the contact person at College Board, but he directed the request to the research department at College Board, and the Assistant Director of Research and Analysis, Jean-Leger Sherby, provided the data via e-mail. The students per year and per course were totaled for each course over all the years and for each gender over all the courses throughout the 12-year period.

Table 33. Participation of Males and Females in Music Theory

Year	% female	% male	*z*	*p*
1996	50.53	49.47	0.566	0.5712
1997	10.49	89.51	–99.356	0.0000
1998	49.09	50.91	–1.158	0.2469
1999	47.86	52.14	–2.967	0.0030
2000	49.15	50.85	–1.236	0.2165
2001	48.44	51.56	–2.439	0.0147
2002	48.08	51.92	–3.176	0.0015
2003	46.81	53.19	–5.673	0.0000
2004	45.87	54.13	–7.862	0.0000
2005	45.28	54.72	–9.383	0.0000
2006	43.89	56.11	–13.279	0.0000
2007	43.10	56.90	–15.845	0.0000

SPSS software version 16 was utilized to determine the significant difference between males and females over all the years and within each course based on passing scores and the upper- and lower-tailed scores, which are 5 and 1.

A successful score occurs when a student scores at least a 3 on the AP exam. Table 42 reveals the *t* test and *p* value for all the AP exams over the 12-year study. The average number of individuals who achieved a successful score was calculated for males and females over all the years for each course. A two-way sample *t* test was used to determine potential significant differences in successful scores, which represents a score of at least 3. This difference was calculated using SPSS software (v. 16).

Table 34. Participation of Males and Females in Physics B

Year	% female	% male	*z*	*p*
1996	34.36	65.64	–43.640	0.0000
1997	45.85	54.15	–10.547	0.0000
1998	34.30	65.70	–48.932	0.0000
1999	34.75	65.25	–50.755	0.0000
2000	35.07	64.93	–52.559	0.0000
2001	34.82	65.18	–55.994	0.0000
2002	34.64	65.36	–59.464	0.0000
2003	34.16	65.84	–64.082	0.0000
2004	34.84	65.16	–63.078	0.0000
2005	35.32	64.68	–63.651	0.0000
2006	35.00	65.00	–67.727	0.0000
2007	34.94	65.06	–70.563	0.0000

There was inadequate data to perform this test on Chinese or Japanese because there is only 1 year's worth of data (2007) for that test. The significance level of 0.05 was used since there are multiple comparisons informed. In particular, there were 37 tests, so 0.05 / 37 = 0.00135 was the cutoff significance level. The significance level of 0.05 was used because the Bonferroni correction is used to adjust for multiple comparisons when research involves multiple comparisons on the same data (Simon, 2008).

Based on the data, there appear to be strong differences between genders in successful performance. This is consistent with some stereotypes; females showed a particular aptitude in the arts, languages, and literature, as revealed by many of those subject tests having significance in passing scores. In comparison, males showed more aptitude than females in Computer Science and Physics. While Calculus had significance in participation between males and females with far more males participating, there was no significance in successful scores between males and females in Calculus AB or BC when examining scores of 3 and above.

Table 35. Participation of Males and Females in Physics C: Mechanics

Year	% female	% male	*z*	*p*
1996	26.22	73.78	–50.462	0.0000
1997	41.43	58.57	–15.041	0.0000
1998	26.50	73.50	–53.459	0.0000
1999	26.15	73.85	–57.287	0.0000
2000	25.60	74.40	–61.022	0.0000
2001	26.63	73.37	–61.646	0.0000
2002	26.33	73.67	–65.686	0.0000
2003	26.24	73.76	–68.035	0.0000
2004	25.72	74.28	–71.860	0.0000
2005	26.73	73.27	–71.351	0.0000
2006	26.02	73.98	–75.035	0.0000
2007	26.69	73.31	–75.628	0.0000

Table 36. Participation of Males and Females in Physics C: E & M

Year	% female	% male	*z*	*p*
1996	22.34	77.66	–42.078	0.0000
1997	16.98	83.02	–58.594	0.0000
1998	22.34	77.66	–44.311	0.0000
1999	21.54	78.46	–47.963	0.0000
2000	21.47	78.53	–49.294	0.0000
2001	22.33	77.67	–50.610	0.0000
2002	21.73	78.27	–54.933	0.0000
2003	23.06	76.94	–53.939	0.0000
2004	22.08	77.92	–57.964	0.0000
2005	23.23	76.77	–56.611	0.0000
2006	22.07	77.93	–57.191	0.0000
2007	22.46	77.54	–58.265	0.0000

Descriptive statistics. The highest percentage of 1 scores was found in AP Computer Science A (41%) by females, and the highest percentage of 5 scores was found in AP Computer Science AB (27%) and Spanish Language (29.7%). The lowest percentage of 1 scores by females occurred in AP Art Studio courses (4–5%), and the lowest percentage of 5 scores by females occurred in AP American Government and Politics (5.7%).

Table 37. Participation of Males and Females in Psychology

Year	% female	% male	z	p
1996	65.00	35.00	36.288	0.0000
1997	42.17	57.83	–26.510	0.0000
1998	65.19	34.81	45.023	0.0000
1999	66.54	33.46	55.642	0.0000
2000	65.53	34.47	57.311	0.0000
2001	65.92	34.08	66.007	0.0000
2002	65.73	34.27	71.636	0.0000
2003	65.84	34.16	79.327	0.0000
2004	65.63	34.37	84.054	0.0000
2005	65.05	34.95	88.860	0.0000
2006	64.26	35.74	90.765	0.0000
2007	64.76	35.24	100.618	0.0000

When combining 1 scores with 2 scores, the difference between males and females in AP Computer Science A was 39% for males and 51% for females. Another large difference in 1 scores when combined with 2 scores was found in Chemistry. Forty-nine percent of the females scored 1 or 2, but 37% of the males scored 1 or 2.

The highest percentage of 1 scores by males occurred in AP Computer Science A (29.5%) while the highest percentage of 5 scores by males occurred in AP Calculus BC (44.5%) and AP Physics C (28–30%). The lowest percentage of 1 scores by males occurred in AP Studio Drawing (6.9%) while the lowest percentage of 5 scores by males occurred in AP English Literature and Composition (8.61%) and American Politics and Government (8.7%).

Table 38. Participation of Males and Females in Spanish Language

Year	% female	% male	*z*	*p*
1996	64.01	35.99	57.165	0.0000
1997	93.76	6.24	154.928	0.0000
1998	63.94	36.06	63.210	0.0000
1999	64.12	35.88	68.213	0.0000
2000	64.46	35.54	73.400	0.0000
2001	64.51	35.49	77.274	0.0000
2002	64.83	35.17	80.809	0.0000
2003	64.71	35.29	85.191	0.0000
2004	64.84	35.16	89.469	0.0000
2005	64.70	35.30	92.148	0.0000
2006	64.43	35.57	91.945	0.0000
2007	64.26	35.74	90.740	0.0000

The mean score for all the Advanced Placement exams was close to 3, but varied from one course to another between 2.5 to 3.79. The lowest mean score was achieved by females in AP Computer Science A (2.5), and the highest mean score was achieved by males in AP Calculus BC (3.79). The average score for both males and females for all courses was around 3 with a standard deviation near 1 (see Table 45).

Table 39. Participation of Males and Females in Spanish Literature

Year	% female	% male	*z*	*p*
1996	67.85	32.15	26.831	0.0000
1997	49.70	50.30	–0.545	0.5855
1998	66.70	33.30	27.887	0.0000
1999	67.40	32.60	31.130	0.0000
2000	68.14	31.86	34.088	0.0000
2001	68.76	31.24	37.495	0.0000
2002	68.92	31.08	39.500	0.0000
2003	68.66	31.34	38.866	0.0000
2004	68.14	31.86	40.237	0.0000
2005	67.86	32.14	41.828	0.0000
2006	66.18	33.82	38.677	0.0000
2007	66.71	33.29	41.372	0.0000

All of the courses showed a significant difference at the 5% level between males and females who scored a 1 except 3-D studio art design, German language, International English, and Vergil Latin. The greatest differences result in more females scoring ones than males in statistics, physics, calculus, American government and politics, U.S. history, macroeconomics, biology, chemistry, microeconomics, world history, and European history. While far more males participated in AP computer science A and AB, and more females scored 1 than males, there are less females scoring 1 proportionally as compared to other previously mentioned courses (see Table 46).

Table 40. Participation of Males and Females in Statistics

Year	% female	% male	z	p
1998	47.64	52.36	–5.882	0.0000
1999	48.68	51.32	–4.179	0.0000
2000	48.93	51.07	–3.963	0.0001
2001	49.91	50.09	–0.368	0.7131
2002	49.90	50.10	–0.439	0.6606
2003	50.06	49.94	0.307	0.7591
2004	49.96	50.04	–0.187	0.8517
2005	50.46	49.54	2.526	0.0115
2006	50.19	49.81	1.155	0.2482
2007	50.17	49.83	1.038	0.2993

Table 41. Participation of Males and Females in Individual Courses for 12 Years: 1996–2007

Course	Female %	Male %	z	p
Art: Studio 2-D Design	69.24	30.76	93.041	0.0000
Art: Studio 3-D Design	51.35	48.65	3.101	0.0019
Art: History	66.32	33.68	123.445	0.0000
Art: Studio - Drawing	64.03	35.97	87.051	0.0000
Art: Studio - Portfolio	39.71	60.29	–57.125	0.0000
Biology	58.33	41.67	180.711	0.0000
Chemistry	46.21	53.79	–64.630	0.0000
Computer Science A	17.36	82.64	–251.776	0.0000
Computer Science AB	10.31	89.69	–215.413	0.0000

Table 41. Participation of Males and Females in Individual Courses for 12 Years: 1996–2007 (*continued*)

Course	Female %	Male %	*z*	*p*
Microeconomics	41.51	58.49	–87.930	0.0000
Macroeconomics	42.47	57.53	–96.193	0.0000
English Language & Composition	61.60	38.40	318.749	0.0000
English Literature & Composition	65.08	34.92	478.130	0.0000
Environmental Science	56.08	43.92	63.075	0.0000
World History	51.90	48.10	23.310	0.0000
History: European	49.57	50.43	–7.881	0.0000
History: U.S.	55.59	44.41	181.133	0.0000
French Language	71.14	28.86	190.272	0.0000
French Literature	72.62	27.38	64.529	0.0000
Human Geography	52.90	47.10	17.596	0.0000
German Language	35.80	64.20	–75.186	0.0000
Government & Politics: American	53.26	46.74	67.033	0.0000
Government & Politics: Comparative	47.76	52.24	–15.403	0.0000
International English	61.95	38.05	41.652	0.0000
Italian Language	43.63	56.37	–8.795	0.0000
Latin: Vergil	48.92	51.08	–4.580	0.0000
Latin: Literature	18.22	81.78	–190.807	0.0000
Calculus AB	48.74	51.26	–33.642	0.0000
Calculus BC	40.56	59.44	–130.053	0.0000
Music Theory	40.41	59.59	–59.946	0.0000
Physics B	35.21	64.79	–193.246	0.0000
Physics C: Mechanics	26.82	73.18	–215.152	0.0000
Physics C: E & M	21.89	78.11	–183.092	0.0000

Table 41. Participation of Males and Females in Individual Courses for 12 Years: 1996–2007 (*continued*)

Course	Female %	Male %	*z*	*p*
Psychology	64.23	35.77	231.521	0.0000
Spanish Language	65.54	34.46	289.604	0.0000
Spanish Literature	66.49	33.51	116.733	0.0000
Statistics	49.92	50.08	–1.219	0.2228

Table 42. Two-Sample *T* Tests for Mean Number of Successful AP Test Scores by Gender (1996–2007; Scores of 3, 4, and 5)

Test	Gender	*M*	*SD*	*t*	*p* value
Art Studio 2-D Design	Female	1,473.60	435.618	4.364	0.001*
	Male	656.56	143.467		
Art Studio 3-D Design	Female	236.06	52.872	3.794	0.004
	Male	146.83	22.802		
Art History	Female	1,812.60	574.405	4.998	< 0.0001*
	Male	909.56	248.510		
Art Studio - Drawing	Female	1,209.40	206.143	2.745	0.012
	Male	617.03	63.902		
Art Studio - Portfolio	Female	1,065.20	137.755	7.086	< 0.0001*
	Male	641.61	49.623		
Biology	Female	11,002.00	775.531	1.618	0.12
	Male	9,422.30	593.331		
Chemistry	Female	4,717.00	1,555.011	–3.378	0.003
	Male	7,102.40	1,888.045		
Computer Science A	Female	343.81	116.780	–8.31	< 0.0001*
	Male	2,070.10	710.105		
Computer Science AB	Female	148.53	32.071	–11.92	< 0.0001*
	Male	1,249.90	318.569		

Table 42. Two-Sample *T* Tests for Mean Number of Successful AP Test Scores by Gender (1996–2007; Scores of 3, 4, and 5) (*continued*)

Test	Gender	*M*	*SD*	*t*	*p* value
Microeconomics	Female	1,723.40	718.862	–2.88	0.009
	Male	2,879.10	1,189.328		
Macroeconomics	Female	2,400.20	1,110.579	–2.52	0.019
	Male	3,837.70	1,633.258		
English Lang & Comp	Female	18,581.00	8,309.601	2.45	0.023
	Male	11,691.00	5,094.392		
English Lit & Comp	Female	29,405.00	5,588.693	6.83	< 0.0001*
	Male	16,748.00	3,157.060		
Environmental Science	Female	23,238.00	1,267.123	–0.065	0.949
	Male	23,611.00	1,308.231		
World History	Female	5,176.80	2,608.401	–0.104	0.919
	Male	5,335.70	2,683.945		
European History	Female	7,746.70	2,093.307	–0.34	0.973
	Male	7,774.60	1,939..491		
U.S. History	Female	19,958.00	5876.521	0.091	0.929
	Male	19,751.00	5304.945		
French Language	Female	2248.90	418.143	10.11	< 0.0001*
	Male	1029.90	171.400		
French Literature	Female	296.08	29.757	20.13	< 0.0001*
	Male	112.72	10.571		
Human Geography	Female	1,212.40	793.186	–0.105	0.918
	Male	1,256.30	771.962		
German Language	Female	475.96	78.665.000	1.24	0.23
	Male	430.75	97.973.000		
American Gov & Pol	Female	7,864.90	3,126.731	–0.70	0.49
	Male	8,785.40	3,357.621		
Comp Gov & Pol	Female	884.69	280.657	–2.257	0.034
	Male	1,170.70	337.451		
International English	Female	860.83	348.946	1.617	0.14
	Male	597.22	194.228		
Italian Language	Female	181.50	6.364	18.34	0.003
	Male	98.33	0.471		

Table 42. Two-Sample *T* Tests for Mean Number of Successful AP Test Scores by Gender (1996–2007; Scores of 3, 4, and 5) (*continued*)

Test	Gender	*M*	*SD*	*t*	*p* value
Latin: Vergil	Female	389.06	65.871	–1.026	0.32
	Male	418.42	74.128		
Latin Literature	Female	279.89	72.354.000	1.185	0.25
	Male	247.39	61.604.000		
Calculus AB	Female	14,134.00	3,189.135	–2.554	0.018
	Male	17,636.00	3,519.417		
Calculus BC	Female	4,092.90	1,589.221	–3.351	0.003
	Male	6,786.30	2,286.220		
Music Theory	Female	717.64	269.807	–1.030	0.31
	Male	863.94	411.247		
Physics B	Female	2,131.30	674.670	–6.067	< 0.0001*
	Male	5,131.50	1,574.568		
Physics C Mech	Female	956.94	297.711	–8.804	< 0.0001*
	Male	3,320.4	927.566		
Physics C: E & M	Female	392.33	110.056	–9.528	< 0.0001*
	Male	1,541.2	402.934		
Psychology	Female	8,288.8	4,921.887	2.225	0.037
	Male	4,649.8	2,608.455		
Spanish Language	Female	11,080	4,655.434	3.355	0.003
	Male	6,096.5	2,190.174		
Spanish Literature	Female	1,617.8	589.055	7.349	< 0.0001*
	Male	708.39	179.936		
Statistics	Female	4,573.8	2,769.976	–0.739	0.47
	Male	5,510.8	3,166.51		

Table 43. Frequency and Percentage of Females Scoring 1 Through 5 on AP Examinations From 1996–2007

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Art: Studio 2-D Design	2,559	6.32	11,388	28.14	15,366	37.97	7,677	18.97	34,82	8.60
Art: Studio 3-D Design	544	8.04	1,974	29.17	2,655	39.23	1,008	14.90	586	8.66
Art: History	13,370	14.10	16,207	17.09	28,621	30.18	23,850	25.15	12,781	13.48
Art: Studio - Drawing	2,690	4.37	15,370	24.95	22,786	36.99	12,826	20.82	7,928	12.87
Art: Studio - Portfolio	1,668	5.45	9,752	31.88	9,596	31.37	5,648	18.46	3,929	12.84
Biology	116,906	17.02	174,024	25.33	156,788	22.82	130,306	18.97	108,987	15.86
Chemistry	93,197	27.80	72,227	21.54	82,194	24.52	494,22	14.74	38,206	11.40
Computer Science A	10,636	41.19	2,809	10.88	4,157	16.10	4,994	19.34	3,226	12.49
Computer Science AB	1,357	17.87	891	11.73	2,022	26.62	1,253	16.50	2,072	27.28
Microeconomics	25,967	23.35	23,191	20.86	24,428	21.97	26,155	23.52	11,460	10.31
Macroeconomics	45,167	26.06	41,723	24.08	29,666	17.12	39,474	22.78	17,266	9.96
English Language & Composition	107,462	9.25	385,554	33.18	376,185	32.38	203,598	17.52	89,127	7.67
English Literature & Composition	109,426	6.69	466,935	28.56	563,551	34.47	348,189	21.30	146,836	8.98

Table 43. Frequency and Percentage of Females Scoring 1 Through 5 on AP Examinations From 1996–2007 (*continued*)

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Environmental Science	52,433	34.75	28,756	19.06	28,059	18.59	30,780	20.40	10,874	7.2
World History	51,213	26.35	49,938	25.70	48,619	25.02	28,147	14.48	16,417	8.45
History: European	68,591	16.18	76,476	18.04	159,752	37.68	78,044	18.41	41,084	9.69
History: U.S.	276,821	18.97	464,246	31.81	324,370	22.22	264,060	18.09	130,052	8.91
French Language	29,150	20.24	30,343	21.06	42,557	29.54	23,312	16.18	18,692	12.98
French Literature	1,748	11.83	2,370	16.04	3,188	21.57	3,805	25.75	3,666	24.81
Human Geography	14,915	30.61	8,345	17.13	10,805	22.18	8,818	18.10	5,838	11.98
German Language	2,585	10.31	5,364	21.39	5,908	23.56	4,863	19.39	6,354	25.34
Government & Politics: American	93,730	16.61	187,566	33.23	158,026	28.00	92,799	16.44	32,313	5.72
Government & Politics: Comparative	10,283	18.30	14,071	25.04	17,500	31.14	7,586	13.50	6,763	12.03
International English	957	5.09	2,359	12.54	5,436	28.90	5,746	30.55	4,313	22.93
Italian Language	537	25.84	452	21.75	499	24.01	276	13.28	314	15.11
Latin: Vergil	3,996	18.21	3,937	17.95	5,939	27.07	4,137	18.86	3,930	17.91

Table 43. Frequency and Percentage of Females Scoring 1 Through 5 on AP Examinations From 1996–2007 (*continued*)

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Latin: Literature	3,763	22.91	2,584	15.73	4,330	26.37	3,006	18.30	2,740	16.68
Calculus AB	203,361	23.23	163,263	18.65	202,306	23.11	177,254	20.25	129,274	14.77
Calculus BC	27,806	14.43	17,501	9.08	45,941	23.85	35,881	18.62	65,522	34.01
Music Theory	3,913	9.91	9,723	24.63	11,303	28.64	8,011	20.30	6,521	16.52
Physics B	46,734	31.07	26,930	17.91	42,858	28.50	21,406	14.23	12,464	8.29
Physics C: Mechanics	12,428	21.53	10,852	18.80	13,138	22.76	12,164	21.07	9,148	15.85
Physics C: E & M	4,161	17.92	4,940	21.27	3,464	14.91	5,570	23.98	5,090	21.92
Psychology	69,502	16.35	70,059	16.48	95,563	22.48	109,171	25.68	80,846	19.02
Spanish Language	53,974	9.49	79,987	14.06	129,046	22.69	136,508	24.00	169,304	29.76
Spanish Literature	12,072	14.50	12,949	15.55	28,798	34.59	19,865	23.86	9,577	11.50
Statistics	69,924	25.31	57,201	20.70	70,235	25.42	54,587	19.76	24,320	8.80

Table 44. Frequency and Percentage of Males Scoring 1 Through 5 on AP Examinations From 1996–2007

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Art: Studio 2-D Design	1,398	7.78	4,762	26.49	6,520	36.27	3,424	19.05	1,874	10.42
Art: Studio 3-D Design	552	8.61	1,465	22.85	2,141	33.40	1,354	21.12	899	14.02
Art: History	7,568	15.72	8,541	17.74	14,694	30.52	11,472	23.83	5,876	12.20
Art: Studio - Drawing	2,385	6.89	8,879	25.66	12,249	35.40	6,672	19.28	4,415	12.76
Art: Studio - Portfolio	3,870	8.33	10,403	22.40	12,151	26.16	10,282	22.14	9,743	20.98
Biology	57,632	11.74	101,500	20.68	113,029	23.03	108,218	22.05	110,505	22.51
Chemistry	75,498	19.34	71,525	18.33	96,098	24.62	71,654	18.36	75,522	19.35
Computer Science A	36,237	29.48	12,250	9.97	22,093	17.97	29,448	23.96	22,899	18.63
Computer Science AB	10,981	16.62	8,188	12.40	15,273	23.12	10,911	16.52	20,702	31.34
Microeconomics	23,449	14.96	28,272	18.04	33,433	21.33	45,116	28.79	26,444	16.87
Macroeconomics	35,265	15.02	50,488	21.51	46,351	19.75	65,155	27.76	37,483	15.97
English Language & Composition	64,562	8.92	215,704	29.79	236,774	32.70	141,798	19.58	65,333	9.02

Table 44. Frequency and Percentage of Males Scoring 1 Through 5 on AP Examinations From 1996–2007 (*continued*)

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
English Literature & Composition	66,506	7.58	247,646	28.23	301,368	34.36	186,127	21.22	75,479	8.61
Environmental Science	28,011	23.70	19,340	16.36	23,482	19.87	32,355	27.38	14,995	12.69
World History	29,899	16.60	37,811	21.00	52,317	29.05	35,414	19.67	24,630	13.68
History: European	50,566	11.73	75,904	17.60	152,320	35.32	94,260	21.86	58,185	13.49
History: U.S.	156,249	13.40	337,501	28.94	282,083	24.19	253,907	21.78	136,307	11.69
French Language	12,322	21.09	11,213	19.19	16,414	28.09	9,635	16.49	8,850	15.15
French Literature	881	15.81	919	16.49	1,255	22.52	1,332	23.91	1,185	21.27
Human Geography	9,221	21.26	6,805	15.69	10,043	23.15	9,362	21.58	7,950	18.33
German Language	4,793	10.66	10,254	22.80	12,969	28.84	9,202	20.46	7,755	17.24
Government & Politics: American	52,650	10.63	139,582	28.17	152,303	30.74	107,489	21.70	43,400	8.76
Government & Politics: Comparative	7,976	12.97	12,690	20.64	19,656	31.97	10,381	16.88	10,784	17.54
International English	535	4.63	1,254	10.85	3,081	26.67	3,674	31.80	3,009	26.05

Table 44. Frequency and Percentage of Males Scoring 1 Through 5 on AP Examinations From 1996–2007 (*continued*)

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Italian Language	574	21.38	487	18.14	730	27.19	432	16.09	462	17.21
Latin: Vergil	4,202	18.34	4,180	18.25	6,263	27.34	4,339	18.94	3,925	17.13
Latin: Literature	14,369	19.50	13,323	18.08	19,923	27.03	15,360	20.84	10,731	14.56
Calculus AB	164,777	17.90	146,929	15.96	201,455	21.88	205,435	22.32	201,947	21.94
Calculus BC	29,254	10.36	20,263	7.18	56,712	20.09	49,916	17.68	126,132	44.68
Music Theory	7,094	12.19	11,900	20.44	16,379	28.14	11,474	19.71	11,359	19.52
Physics B	54,131	19.56	40,508	14.64	81,192	29.35	54,708	19.77	46,141	16.68
Physics C: Mechanics	19,168	12.17	22,375	14.20	32,465	20.60	39,286	24.93	44,265	28.09
Physics C: E & M	10,943	13.21	14,680	17.72	11,953	14.43	19,839	23.94	25,444	30.71
Psychology	32,378	13.67	35,888	15.16	54,423	22.98	64,084	27.06	50,006	21.12
Spanish Language	31,707	10.60	44,179	14.77	71,942	24.06	72,318	24.18	78,883	26.38

Table 44. Frequency and Percentage of Males Scoring 1 Through 5 on AP Examinations From 1996–2007 (*continued*)

	Score									
	1		2		3		4		5	
AP examination	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Spanish Literature	8,041	19.17	6,842	16.31	13,369	31.87	8,937	21.30	4,765	11.36
Statistics	50,802	18.33	47,496	17.14	68,387	24.67	67,764	24.45	42,725	15.41

Table 45. Mean and Standard Deviation of Genders' Scores

	M		*SD*	
Course	Female	Male	Female	Male
Art: Studio 2-D Design	2.954	2.979	1.032	1.088
Art: Studio 3-D Design	2.870	3.091	1.045	1.156
Art: History	3.068	2.991	1.233	1.238
Art: Studio - Drawing	3.129	3.054	1.063	1.110
Art: Studio - Portfolio	3.014	3.250	1.111	1.247
Biology	2.913	3.229	1.323	1.321
Chemistry	2.604	3.000	1.332	1.384
Computer Science A	2.511	2.923	1.487	1.503
Computer Science AB	3.236	3.336	1.426	1.447
Microeconomics	2.766	3.146	1.317	1.312
Macroeconomics	2.665	3.081	1.341	1.314
English Language & Composition	2.812	2.900	1.072	1.096
English Literature & Composition	2.973	2.950	1.061	1.068
Environmental Science	2.463	2.890	1.336	1.371
World History	2.530	2.928	1.254	1.270
History: European	2.874	3.078	1.176	1.182
History: U.S.	2.662	2.894	1.225	1.225
French Language	2.806	2.854	1.290	1.336
French Literature	3.357	3.183	1.325	1.361
Human Geography	2.637	3.000	1.387	1.399
German Language	3.281	3.108	1.325	1.240
Government & Politics: American	2.614	2.898	1.114	1.124
Government & Politics: Comparative	2.759	3.054	1.241	1.262

Table 45. Mean and Standard Deviation of Genders' Scores (*continued*)

	M		*SD*	
Course	Female	Male	Female	Male
International English	3.537	3.638	1.124	1.117
Italian Language	2.701	2.896	1.378	1.369
Latin: Vergil	3.003	2.983	1.347	1.338
Latin: Literature	2.901	2.929	1.384	1.321
Calculus AB	2.847	3.144	1.373	1.398
Calculus BC	3.487	3.791	1.406	1.351
Music Theory	3.089	3.139	1.224	1.285
Physics B	2.508	2.994	1.286	1.339
Physics C: Mechanics	2.909	3.426	1.373	1.349
Physics C: E & M	3.107	3.412	1.426	1.415
Psychology	3.145	3.268	1.347	1.320
Spanish Language	3.505	3.410	1.302	1.304
Spanish Literature	3.023	2.894	1.197	1.259
Statistics	2.660	3.015	1.286	1.329

Table 46. Proportions of Males and Females Who Scored a 1 From 1996 Through 2007

Course	Female %	Male %	*z* score	*p* value
Art: Studio 2-D Design	6.32	7.78	–6.224	0.0000
Art: Studio 3-D Design	8.04	8.61	–1.186	0.2357
Art: History	14.10	15.72	–8.062	0.0000
Art: Studio - Drawing	4.37	6.89	–15.873	0.0000

Table 46. Proportions of Males and Females Who Scored a 1 From 1996 Through 2007 (*continued*)

Course	Female %	Male %	*z* score	*p* value
Art: Studio - Portfolio	5.45	8.33	–15.781	0.0000
Biology	17.02	11.74	81.741	0.0000
Chemistry	27.80	19.34	84.624	0.0000
Computer Science A	41.19	29.48	35.195	0.0000
Computer Science AB	17.87	16.62	2.686	0.0072
Microeconomics	23.35	14.96	53.907	0.0000
Macroeconomics	26.06	15.02	85.800	0.0000
English Language & Composition	9.25	8.92	7.763	0.0000
English Literature & Composition	6.69	7.58	–25.878	0.0000
Environmental Science	34.75	23.70	63.424	0.0000
World History	26.35	16.60	73.327	0.0000
History: European	16.18	11.73	59.514	0.0000
History: U.S.	18.97	13.40	122.994	0.0000
French Language	20.24	21.09	–4.275	0.0000
French Literature	11.83	15.81	–7.158	0.0000
Human Geography	30.61	21.26	32.641	0.0000
German Language	10.31	10.66	–1.444	0.1486
Government & Politics: American	16.61	10.63	90.436	0.0000
Government & Politics: Comparative	18.30	12.97	25.111	0.0000
International English	5.09	4.63	1.806	0.0709
Italian Language	25.84	21.38	3.588	0.0003
Latin: Vergil	18.21	18.34	–0.351	0.7259
Latin: Literature	22.91	19.50	9.522	0.0000
Calculus AB	23.23	17.90	88.409	0.0000

Table 46. Proportions of Males and Females Who Scored a 1 From 1996 Through 2007 (*continued*)

Course	Female %	Male %	*z* score	*p* value
Calculus BC	14.43	10.36	41.319	0.0000
Music Theory	9.91	12.19	–11.229	0.0000
Physics B	31.07	19.56	81.534	0.0000
Physics C: Mechanics	21.53	12.17	49.313	0.0000
Physics C: E & M	17.92	13.21	16.954	0.0000
Psychology	16.35	13.67	29.522	0.0000
Spanish Language	9.49	10.60	–16.292	0.0000
Spanish Literature	14.50	19.17	–20.503	0.0000
Statistics	25.31	18.33	63.098	0.0000

Table 47 uses the same approach as that for Table 46. Some of the tests results among those who passed, for example, physics B and English literature and composition, showed a highly significant gender effect, but there was no significant gender effect when looking at those who had received a score of 1 when mean number of students scoring 1 was compared. The data represent those courses with the greatest differences in mean numbers of students scoring 1. While none of the AP tests showed significant differences in scoring a 1, the exams with the greatest differences are reported in Table 47.

Table 47. Two-Sample *T* Tests for Mean Number of AP Test Scores of 1 by Gender (1996–2007)

Test	Gender	*M*	*SD*	*t* test	*p* value
Art History	Female	1114.170	779.450	1.858	0.077
	Male	643.500	403.178		
Chemistry	Female	7766.420	3249.125	1.134	0.269
	Male	6460.420	2317.146		
Microeconomics	Female	2163.920	1251.657	0.483	0.634
	Male	1937.250	1035.716		
English Lit & Comp	Female	3634.790	1049.273	2.611	0.016
	Male	2419.356	698.408		
U.S. History	Female	23,100.000	12413.092	2.277	0.033
	Male	13,500.000	7496.067		
American Gov & Pol	Female	7,810.830	4693.127	2.138	0.044
	Male	4494.670	2613.791		
Italian Lang	Female	268.500	26.163	4.183	0.053
	Male	181.500	13.435		
Latin Literature	Female	313.580	116.777	–0.432	0.670
	Male	333.170	104.883		
Physics B	Female	3894.500	1415.674	–1.216	0.237
	Male	4661.580	1665.213		
Spanish Literature	Female	1006.000	886.891	1.242	0.227
	Male	639.670	507.549		

All of the courses showed a significant difference at the 5% level between males and females who scored a 5 except Drawing (Art Studio), Italian Language, and Spanish Literature. Courses with the most significant difference of males scoring 5s occurred in Statistics, Physics B, Physics C, Calculus AB, Calculus BC, Biology, Chemistry, American Government and Politics, and U.S. History.

Table 48. Proportions of Males and Females Who Scored a 5 From 1996 Through 2007

Course	Female %	Male %	*z* score	*p* value
Art: Studio 2-D Design	8.60	10.42	–6.814	0.0000
Art: Studio 3-D Design	8.66	14.02	–9.712	0.0000
Art: History	13.48	12.20	6.858	0.0000
Art: Studio - Drawing	12.87	12.76	0.490	0.6240
Art: Studio - Portfolio	12.84	20.98	–30.252	0.0000
Biology	15.86	22.51	–89.664	0.0000
Chemistry	11.40	19.35	–94.991	0.0000
Computer Science A	12.49	18.63	–26.239	0.0000
Computer Science AB	27.28	31.34	–7.490	0.0000
Microeconomics	10.31	16.87	–49.992	0.0000
Macroeconomics	9.96	15.97	–57.532	0.0000
English Language & Composition	7.67	9.02	–32.364	0.0000
English Literature & Composition	8.98	8.61	10.058	0.0000
Environmental Science	7.21	12.69	–46.657	0.0000
World History	8.45	13.68	–50.952	0.0000
History: European	9.69	13.49	–55.041	0.0000
History: U.S.	8.91	11.69	–73.204	0.0000
French Language	12.98	15.15	–12.561	0.0000
French Literature	24.81	21.27	5.422	0.0000
Human Geography	11.98	18.33	–26.770	0.0000
German Language	25.34	17.24	24.733	0.0000
Government & Politics: American	5.72	8.76	–59.880	0.0000
Government & Politics: Comparative	12.03	17.54	–26.751	0.0000
International English	22.93	26.05	–6.105	0.0000

Table 48. Proportions of Males and Females Who Scored a 5 From 1996 Through 2007 (*continued*)

Course	Female %	Male %	*z* score	*p* value
Italian Language	15.11	17.21	–1.956	0.0504
Latin: Vergil	17.91	17.13	2.173	0.0298
Latin: Literature	16.68	14.56	6.669	0.0000
Calculus AB	14.77	21.94	–124.87	0.0000
Calculus BC	34.01	44.68	–74.715	0.0000
Music Theory	16.52	19.52	–12.032	0.0000
Physics B	8.29	16.68	–83.572	0.0000
Physics C: Mechanics	15.85	28.09	–64.624	0.0000
Physics C: E & M	21.92	30.71	–27.890	0.0000
Psychology	19.02	21.12	–20.370	0.0000
Spanish Language	29.76	26.38	33.560	0.0000
Spanish Literature	11.50	11.36	0.760	0.4471
Statistics	8.80	15.41	–75.788	0.0000

All of the courses showed a significant difference at the 5% level between males and females who passed except 2-D Art Studio Design, Computer Science AB, and Vergil Latin.

Table 49. Proportions of Males and Females Scoring 3 or Above

Course	Female %	Male %	*z* score	*p* value
Art: Studio 2-D Design	65.54	65.74	–0.462	0.6438
Art: Studio 3-D Design	62.79	68.54	–6.963	0.0000
Art: History	68.81	66.54	8.632	0.0000
Art: Studio - Drawing	70.68	67.45	10.387	0.0000
Art: Studio - Portfolio	62.67	69.27	–18.874	0.0000
Biology	57.65	67.58	–110.90	0.0000
Chemistry	50.66	62.33	–100.58	0.0000
Computer Science A	47.93	60.56	–37.053	0.0000
Computer Science AB	70.40	70.98	–1.047	0.2952
Microeconomics	55.79	67.00	–58.809	0.0000
Macroeconomics	49.86	63.47	–87.295	0.0000
English Language & Composition	57.57	61.30	–50.852	0.0000
English Literature & Composition	64.75	64.18	8.887	0.0000
Environmental Science	46.20	59.93	–71.617	0.0000
World History	47.95	62.40	–89.825	0.0000
History: European	65.78	70.67	–48.627	0.0000
History: U.S.	49.23	57.66	–136.63	0.0000
French Language	58.70	59.72	–4.248	0.0000
French Literature	72.13	67.70	6.103	0.0000
Human Geography	52.26	63.06	–33.341	0.0000
German Language	68.30	66.54	4.763	0.0000
Government & Politics: American	50.16	61.20	–114.91	0.0000
Government & Politics: Comparative	56.67	66.39	–34.376	0.0000
International English	82.37	84.51	–4.910	0.0000

Table 49. Proportions of Males and Females Scoring 3 or Above (*continued*)

Course	Female %	Male %	*z* score	*p* value
Italian Language	52.41	60.48	–5.587	0.0000
Latin: Vergil	63.84	63.41	0.944	0.3453
Latin: Literature	61.35	62.43	–2.564	0.0104
Calculus AB	58.12	66.14	–111.03	0.0000
Calculus BC	76.48	82.46	–49.692	0.0000
Music Theory	65.45	67.37	–6.210	0.0000
Physics B	51.02	65.79	–93.922	0.0000
Physics C: Mechanics	59.67	73.63	–60.067	0.0000
Physics C: E & M	60.81	69.08	–23.060	0.0000
Psychology	67.17	71.17	–33.951	0.0000
Spanish Language	76.45	74.62	18.744	0.0000
Spanish Literature	69.95	64.53	19.197	0.0000
Statistics	53.98	64.54	–80.335	0.0000

When all the test data were combined for participants who had passed, another *t* test was used to see if there were significant differences by gender between aggregate means. Based on this result, there were significantly more females than males who had passed ($p = 0.022$) at the 5% level of significance. From this, an effect size measurement can be calculated. The Cohen *d* was used: This is (Mean*F* – Mean*M*) / Sp, where Sp is the common standard deviation (i.e., Sp = sqrt($Sf^2 + Sm^2$) = sqrt($21{,}692.274^2 + 16{,}746.079^2$) = 27,404.12. Thus, Cohen's *d* is (15,046 – 13,970) / 27,404.12 = 0.039. Cohen (1988) defined effect sizes as "small, *d* = .2 . . . medium, *d* = .5 . . . and "large, *d* =

.8" (p. 25). An effect size of 0.039 is small and, as such, insignificant. While significant differences occurred for passing specific exams, no significant difference was found when all exams for all years were combined. Males and females passed Advanced Placement exams overall with insignificant differences in passing scores.

Table 50. Two-Way ANOVA Test for All Exams Combined for Mean Number of Successful Scores by Gender From 1996 Through 2007

Test	Gender	*M*	*SD*	*t* test	*p* value
Combined	Female Male	15,046 13,920	21,692.274 16,746.079	0.78	0.022*

As presented in Table 51, the data set was restricted to the first and last years of data collection and all intervening data were discarded. There were no significant differences in the mean number of passing tests between genders ($p = 0.745$). This indicates that in the year 1996 there was no significant difference in passing from 2007. By examining the two perimeter years, any deviations that may have occurred slowly over time could be seen through this comparison. No significant difference in scoring between males and females over all the exams occurred when comparing those two years.

Finally, an analysis of variance was run on the number of passing scores against both gender and time (measured in years). Based on this method, the following tests were shown to have simultaneously significant gender and time effects doing the Bonferroni adjustment method mentioned previously: Biology, Chemistry, Microeconomics, Macroeconomics, English Language and Composition, English Literature and

Composition, World History, German Language, American Government and Politics, Comparative Government and Politics, Latin Literature, Calculus AB, and Calculus BC.

Table 51. Two-Way ANOVA Test for All Exams Combined for Mean Number of Successful Scores by Gender With the Years 1996 and 2007 Only

Test	Gender	*M*	*SD*	*t* test	*p* value
Combined	Female	16,072	24,586.495	0.326	0.745
	Male	14,825	18,974.348		

Summary

Examining the raw data and determining the percent of students who scored high or low on a particular exam yielded data also relevant to the study. Approximately 100,000 more AP tests annually were taken by females than males in 2000, yet more scores of 4 or 5 were obtained by males (Ackerman, 2002), and more females have taken AP tests every year for the past 12 years (College Board, 2007b), yet in 2007, more females scored 1s than males. In some AP tests, the difference of scoring 1 (the lowest score possible) was as much as 4 times higher in females than males. The Advanced Placement Biology exam had no significant difference in passing the exam, but 15,580 females scored a 1 as compared to 7,469 males scoring 1 in 2007 (College Board), and significantly more males scored 5, the highest score possible. For every male that scored a 1, there were 2.5 females scoring a 1 in 2001 and 2003 on the AP Biology exam (College Board).

This significantly higher number of 1s in AP Biology was also found to occur in the similar course, AP Environmental Science. Almost twice as many females score 1 in AP Environmental Science as males, yet more males score 5s than females every year since 1998, the year the course was designed and implemented.

The difference in scoring on the mathematics-based courses such as Calculus and Physics are not particularly significant on the 1 score, but the difference in scoring can be seen on the 5 score. Close to twice as many males score 5s in Calculus and 3 times as many males scored 5s in Physics B (College Board, 2007b). On the AP Physics C: E & M in 2006, males scored 5s five times more frequently than females, and almost five times as many males scored 5s on the same exam in 2007 (College Board). This same trend occurred over the past 12 years. Males continually scored more 5s in Calculus and Physics courses over the past 12 years of the Advanced Placement exams for those subject areas. This same trend can be seen in AP Statistics, Microeconomics, Macroeconomics, and Chemistry. To a lesser degree, it can also be seen in social studies courses such as AP World History, European History, and Human Geography.

The difference in scoring becomes even greater when examining the scores of the AP Computer Science exam for 2007. More than 7 times as many males took the AP Computer AB exam, and of the 5,064 students taking the exam, 1,682 scored a 5 on the exam, and of those, only 182 were females. Only 10.8% of the 5 scores on the 2007 AP Computer Science AB exam were females. This trend is similar regardless of the year examined over the past decade. In 1996, only 9% of the 5 scores were made by females, and by 2000, the percentage was still 9%, so the trend has not changed much over the 12-

year period. Females still score significantly lower top scores than males on the Advanced Placement Computer Science A and AB exams.

The difference in scoring favoring females can be seen in the foreign language courses. The difference in scoring is less significant than the difference in participation. More females participated in French Literature, French Language, Italian Language, Spanish Language, and Spanish Literature, but not all of the language courses favored female participation. The AP German Language, Japanese Language and Culture, Latin Literature, and Latin: Vergil all had very similar results in participation and scoring for both males and females. The differences in scoring and participation were less obvious in the languages favoring females, as the differences in scoring and participation were for males in the math and sciences.

CHAPTER 5. SUMMARY AND CONCLUSIONS

Restatement of the Problem

Over the past 5 years, there has been an increase in student participation in the Advanced Placement program (Lichten, 2000; Samuels, 2005; Viadero, 2001; Wasley, 2007) However, there has not been current research on gender differences in participation and achievement on the Advanced Placement exam for most courses. This research studied the significance of difference in participation between males and females on 33 different exams over a 12-year period. It also studied the significant difference in passing scores, scores of 5, and scores of 1 between males and females over 12 years for each course. Lastly, it examined differences in scoring of all AP exams combined over a 12-year period and the difference in passing scores of males and females in the two extreme years: 1996 and 2007. Of the 37 courses, some courses had been developed within the 12-year period. For those courses, the study included the course from the first year of its development until 2007.

Discussion of Differences in Males and Females in Participation on Advanced Placement Exams

Research Question 1

Is there a significant difference in participation on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

H_02: There is not a significant difference in participation on the Advanced Placement exams of The College Board between males and females from 1996 through 2007.

Summary of research question 1. The null hypothesis was not rejected on the difference in participation on the Advanced Placement exams of the College Board in Advanced Placement statistics over the 12-year period, and Japanese and Chinese for the past year. Advanced Placement Japanese and Chinese only had 1 year of data; thus, the conclusions formed excluded those 2 exams.

The null hypothesis was rejected for all other Advanced Placement exams as all had a significant difference in participation between males and females. Most AP exams revealed a significantly higher female participation in language courses and significantly more males participated in mathematics, social studies, and some science courses. Advanced Placement Biology and Environmental Science had more females participate, whereas Advanced Placement Chemistry and Physics had more males participate.

The most significant differences favoring male participation occurred in Computer Science A, Computer Science AB, Chemistry, Calculus AB, Calculus BC, Microeconomics, Macroeconomics and all three AP Physics exams. Females participated significantly more in Psychology, Spanish Language, English Language and Composition, and English Literature. Of these, AP Computer Science A, Computer Science AB, and Physics had the highest differences in participation favoring males. English Literature had the highest differences in participation favoring females.

The research findings are supported by Zohar and Sela (2003), who reported more males participated and were successful in Advanced Placement Physics. Stumpf and

Stanley (1996) explored gender-related differences in participation and scoring on the Advanced Placement exams from 1982 through 1996. Their research examined gender differences in all the Advanced Placement exams available at that time. Like this research, Stumpf and Stanley found Spanish examinations attracted more females, whereas more males participated in AP Physics, Chemistry, and Computer Science examinations. Unlike the findings of this research, Stumpf and Stanley reported that in some cases gender differences narrowed between 1982 and 1996 in science and computer science subject areas. Twelve years after Stumpf and Stanley's research, males still participated more in Physics, Calculus, Chemistry, and Computer Science AP examinations. Multiple studies support higher male participation in Advanced Placement Computer Science (Bombardieri, 2005; De Palma, 2001; Gilbert, 2002; Honeywell, 1987; Hunter, 1986; Stumpf & Stanley, 1997), Calculus (Sanders & Nelson, 2004; Stumpf & Stanley, 1996), and Physics (Campbell & Clewell, 1999; Sanders & Nelson; Zohar & Bronshtein, 2005).

Implications of differences in participation in Advanced Placement exams. The implications of the difference in participation in Advanced Placement exams are best addressed by examining benefits that are lost by not participating in the program. Horn and Kojaku (2001) and Morgan and Maneckshana (2000) reported that students who participated in the Advanced Placement program at their high school were more likely to have completed a bachelor's degree and continued at their initial college of enrollment. Morgan and Maneckshana further stated that AP students were more likely to obtain a college degree within 4 years, and the majority of these students graduated with a 3.0 GPA or higher. Lichten (2000) reported that students who took AP calculus and passed the AP exam were more likely to take calculus in college than non-AP peers. Eykamp (2006) reported that about one third of University of California students received credit for their AP coursework and made use of those credits. Some students take an easier course load as a result. They still graduate within the same time frame as other non-AP students, but their course load initially was lighter, providing them an easier transition into college.

Another benefit of taking Advanced Placement is that it increases academic confidence, allowing students to enter college with mental assurance, and the students are more likely to pursue more courses in college in the fields in which their Advanced Placement scores were successful (Willingham & Morris, 1986).

Santoli (2002) stated that besides the obvious reason to receive college credit or increasing college admission, taking more challenging classes better prepared them for college and often they had better teachers. Still, one of the most common reasons for taking AP courses even if college credit is not awarded is that adding Advanced Placement courses to one's transcript strengthens one's college admission application (Lawrence, 1996; Oxtoby, 2007; Willingham & Morris, 1986).

Conclusion based on the implications. The implications are that if females are taking few Advanced Placement courses in the math and science fields, they are less likely to pursue that field as a career, less likely to take advanced coursework in a field in which they have not taken an AP course exam, less likely to complete that degree in 4 years, and may not take a lighter course load. Furthermore, they may not have the AP advantage for college admission. Any one of these reasons is sufficient to motivate both males and females to pursue more Advanced Placement coursework in a variety of areas.

If participating in Advanced Placement provides exposure for students to coursework to which they were not otherwise exposed prior to university experiences, the lack of Advanced Placement exposure in the mathematics and science fields could explain why fewer women are entering college majors requiring advanced work in these areas. This study cannot confirm that the lack of participation in particular coursework is the direct cause of fewer females entering mathematics, physics, and computer-based fields of study, but there is a correlation between reduced Advanced Placement participation and success in math and sciences and the pursuit of those fields in college by females. Whether fewer females taking Advanced Placement Calculus, Chemistry, Computer Science, Physics, and Economics causes fewer young women to enter careers such as engineering, computer programming, professors of math and science, and many other careers that depend heavily on these fields of study should be determined by future studies.

Research Question 2

Is there a significant difference in successful scores on the Advanced Placement exams of College Board between males and females from 1996 through 2007?

$H_0$1: There is not a significant difference between males and females successful scores on the Advanced Placement exams of College Board from 1996 through 2007.

Discussion on the differences in scoring on AP exams between males and females. Significant differences were found on most of the Advanced Placement exams for almost every year over the 12-year period studied. The null hypothesis was rejected for Advanced Placement Art Studio, Art History, Chemistry, Computer Science, Microeconomics, Macroeconomics, French Language, French Literature, Comparative

Government and Politics, Italian Language, Calculus AB, Calculus BC, Physics, Psychology, Spanish Language, and Spanish Literature. Overall there seems to be significant difference in scoring on the Advanced Placement exams with most exams favoring males, and only certain foreign language subject areas favoring females.

The greatest differences favoring females occurred in AP English Literature and Composition, Italian Language, French Literature, and French Language, whereas the greatest differences favoring males occurred in Computer Science A, Computer Science AB, Physics, and Calculus. The research of this study indicated that while participation in the Advanced Placement exams has increased, males have continued to score higher in math and some science fields, while females continued to score higher in the language courses. Most of the research prior to this study examined only specific subject areas of the Advanced Placement exam scoring and participation, but their findings (Ackerman, 2002; Ackerman et al., 2001; Halpern, 2002; Honeywell, 1987; Stumpf & Stanley, 1996, 1998; Zohar & Sela, 2003) agree with those of this study.

Significant differences in scoring 5 on the Advanced Placement exam from 1996 through 2007. All advanced placement exams had a significant difference at the 5% level between males and females except AP Art Studio: Drawing, Italian Language, and Spanish Literature. AP Art History, English and Composition, French Literature, German Language, Latin: Vergil, Latin Literature, and Spanish Language favored females, and in all other AP courses males scored 5 significantly more than females. Clearly, the language courses favor females in the highest scores of the AP exam, while other courses such as Computer Science, Sciences, Social Studies, and Mathematics favor males. Little has changed since Stumpf and Stanley (1996) studied the difference in participation and scoring on the Advanced Placement exams.

Significant differences in scoring 1 on the Advanced Placement exam from 1996 through 2007. Only 3-D Studio Art Design, German Language, International English, and Vergil Latin did not show a significant difference in 1 scores on the AP exams between males and females. The greatest differences resulted in more females scoring 1s than males in Statistics, Physics, Calculus, American Government and Politics, U.S. History, Macroeconomics, Biology, Chemistry, Microeconomics, World History, and European History. Many of the same courses that had the highest number of females scoring 1 on the AP exams also had the highest number of males scoring 5. Courses such as AP Physics, Calculus, Macroeconomics, Microeconomics, American Government and Politics favor the males in participation, scoring 5, and have a significant number of females scoring 1. Advanced Placement Biology favored males in scoring but had more females participate in the course and exam. Advanced Placement Chemistry had significantly more males participating and scoring the highest scores. Computer Science, which had the highest male participation and significant differences in males scoring 5, did not have as significant of a difference in females scoring 1. Because 5 times more males took Computer Science, the females that were involved did not necessarily represent the average female attitude or ability toward computer science.

Combined exams' difference in scoring between males and females 1996 through 2007. No significant difference in scoring was observed between males and females when all exams for all years were combined. Even though the percentage of females participating was higher than males, and for most courses more males had a significantly higher rate of passing and scoring 5 on most of the Advanced Placement exams, when a Cohen *d* for effect size was applied, no significant difference was found between males and females when all Advanced Placement exams were combined.

Comparison of differences in males and females on all exams in 1996 and 2007 only. Because a great deal of gradual change can occur over a 12-year period, comparisons of difference between males and females on the exams given in 1996 were compared to exams given in 2007. While over the past 12 years participation has continued to increase, the difference in scoring on all exams in 1996 did not differ significantly from passing exams in 2007, revealing consistency between the two years of data. Differences in male and female scoring and participation that occurred in the 1996 exams also occurred in the 2007 exams. No significant differences were found between the two years' exams, but males continued to score significantly higher than females on most exams except in the language courses.

Conclusions

Does it matter that more females participated in many Advanced Placement exams, significantly more males passed Advanced Placement exams, and that in mathematics, computer science, and science significantly more males scored the highest scores on the Advanced Placement exams? Before addressing that question, it will be necessary to consider other research. Research from the U.S. Department of Education and the *Trends in International Math and Science Study* supported the need to increase rigorous mathematics and science curriculums in high schools. Campbell and Clewell (1999) stated that the *Third International Mathematics and Science Study*, now known as the *Trends in International Math and Science Study*, raised U.S. awareness of the country's comparative stance with other nations. Raymond Simon, U.S. Secretary of the Department of Education, has acknowledged that compared to international test scores, the United States trails far behind other countries in math and science, declaring adjustments are taking place and will continue (as cited in Mohr, 2007). Some of these adjustments include increasing the amount of Advanced Placement courses offered in U.S. public schools. The U.S. Department of Education (2006) reported that expanding access to Advanced Placement programs is an attempt to reduce the deficit in math, science, and languages. The U.S. Department of Education further reported that U.S. high schools must offer more rigorous coursework such as Advanced Placement courses in order for graduates to compete and succeed in the workforce and in higher education. When considering the research findings in this report, one can deduce that the United States, which trails far behind other countries in math and science, could have fewer females in math and science careers competing in the global market.

The research of this study indicates that females participated significantly less in Advanced Placement mathematics, some sciences, and computer science than males. Campbell and Clewell (1999) reported that besides not having women in some of these prestigious and highly paid careers, the loss of women's perspectives in those disciplines is also a negative impact for the enrichment and expansion of those disciplines. The establishment of the Commission on the Advancement of Women in Science, Engineering, and Technology Development is expected to address possible solutions for increasing women's pursuits in the labor force as the economy continues to push forward in technology (Campbell & Clewell).

Research supports that students who attend schools with extensive AP programs experience more success in college than if they attend a school without an AP program (Santoli, 2002; Willingham & Morris, 1986). Furthermore, taking AP exams is a good indicator that a student will complete a college degree (Morgan & Ramist, 1998), and that academic rigor of Advanced Placement in a high school curriculum improves college enrollment and the pursuit of higher education (Adelman, 1999; Camara, 2003; Horn & Kojaku, 2001). Some colleges, such as the University of Alberta, provide entrance scholarships and academic excellence and leadership awards for students completing Advanced Placement coursework (The University of Alberta, 2008). Finally, Curry, MacDonald, and Morgan (1999) reported that students who took Advanced Placement courses and passed the exam resulted in the majority of the students in the study graduating from college with a 3.0 or higher GPA. All of these are valid reasons for students to participate and be successful in Advanced Placement exams. The answer to the initial question is yes, it does matter that more females participated in many Advanced Placement, yet significantly more males passed a majority of the Advanced Placement exams, and significantly more males scored the highest scores in mathematics and some sciences. The implications for not addressing this difference are the possible continued lag of American students behind other country's students in math and science, and the reduction of women in specific fields of study and certain careers. When males or females are not participating or being successful in AP subject areas such as, collectively, language courses, or mathematics and science courses, not only is a large group of the population at a disadvantage, the entire nation is disadvantaged by eliminating large numbers of the population from contributing to the field of study, the careers associated with those fields of study, and the eventual economic opportunities that are limited by a lack of exposure to advanced coursework.

Limitations of the Study

One limitation of this study was based on the amount of data available for some of the courses. AP Japanese and Chinese had only 1 year of data, and thus were not included in the study. Other subject areas such as AP Human Geography, World History, Studio 2-D Design, Studio 3-D Design, Environmental Science, French Literature, Italian Language, and International English did not have 12 years of data. In some cases, the College Board did not provide a specific year of data, and stated it was unavailable or, in most cases, the course was designed and implemented within the last 12 years so less data were available for some courses.

The study was limited to examining participation and scoring on the Advanced Placement examinations for males and females; yet the differences in participation and scoring of different age groups, ethnicity, or type of school that students attended was not considered. Several teachers at the researcher's workplace asked if students attending international schools were being compared to those attending U.S. schools, but such comparison did not occur. The study utilized all students worldwide and did not separate them into any group except males and females. A rich text of data is available in the other areas not researched.

Recommendations for Future Research

While the implications of not intervening and encouraging more females to participate in Advanced Placement Math, Science, and Computer Science, and males to participate in language courses have been outlined in this study, the methods of intervention were not studied. The results of including more females in mathematics and science and more males in foreign language were not studied. The best practices to improve male and female differences in AP participation and success were not studied, yet such models could increase female participation and success in Advanced Placement exams. It is recommended that models be developed and studied to determine the best practices that encourage more males to participate in foreign language and more females to participate in mathematics, science, and social studies AP coursework with success on the exams.

Whether there are significantly larger differences in participation and scoring for males and females of different nationalities was not studied, but it is recommended for future studies to determine if Advanced Placement scoring differences are similar for males and females in all racial groups.

It is further recommended that this study be repeated and data compared based on public and private schools, international and U.S. exam results, and teacher experience and expertise in the courses taught. Other variables that could be examined include the impact of Advanced Placement in successfully acquiring college credit, the difference in participating in one versus three or more Advanced Placement exams, and the difference in GPAs of freshmen who have taken three or more AP courses compared to college freshmen who have not taken any AP courses in high school.

Finally, it is recommended that this study be examined at a later date to determine if the Advanced Placement Japanese and Chinese Language courses have similar results to other language results. At the time of this study, there was only 1 year of data released, which was insufficient to form any conclusions about gender differences within those particular language courses.

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