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The Effect of Enrollment in Middle School Challenge Courses on Advanced Placement Exams in Social Studies and Science

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on Advanced Placement Exams

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by

Katherine Glaude-Bolte

A Dissertation submitted to the Education Faculty of Lindenwood University

In partial fulfillment of the requirements for the

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At Lindenwood University by the School of Education

______________________________ 11/12/10
Dr. Vicki Hedges-Oldani, Dissertation Chair — Date

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Dr. John Oldani, Committee Member — Date

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Dr. Karen Seiber, Committee Member — Date

Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

Katherine Glaude-Bolte

Signature: Kat Glaude-Bolte Date: 11/12/10

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Abstract

Educators seek to guide students through appropriate programs and courses that prepare them for future success, in more advanced coursework and in other challenges of life. Some middle schools offer Challenge, or honors, courses for students who have demonstrated high ability. High schools often offer Advanced Placement (AP) courses, which are taught at the college level. This study examined the correlation between enrollment in middle school Challenge courses and subsequent AP exam category scores in social studies and science in a suburban school district. The independent variables were the number of years of enrollment in middle school social studies or science Challenge courses. The dependent variables were the AP exam category scores in the eight social studies AP courses or the six science AP courses. The sample sizes were limited to the number of students who took an AP social studies or science exam and also attended the middle school of study. The null hypothesis was that there was no relationship between the two variables. This study included eight social studies AP courses and six science AP courses. A significant positive correlation was indicated in only two of the courses, U.S. Government and Comparative Government, supporting the claim that enrollment in middle school Challenge social studies was correlated with success, at least on these two AP exams. In the remaining 12 courses, there was not enough evidence to reject the null hypothesis. Therefore, enrollment in middle school Challenge science and social studies courses generally did not seem to correlate with AP exam category scores. Results of this study call into question the validity of the claim by the district that enrollment in Challenge courses helps prepare students for rigorous coursework in high school. Several factors, including student readiness, teacher training,

familiarity with course content, and previous AP experience may contribute more to a student's AP exam category score. Results also suggest that the district may need to revisit the effectiveness of the Challenge curriculum and the policy of limiting enrollment in Challenge courses.

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Background

In Plato's plan for the ideal society, he said, "education must be the chief concern of the guardians," because "a good beginning will lead to a good end" (Sterling & Scott, 1985, pp. 120, 121). The American Recovery and Reinvestment Act of 2009 "invested heavily in education both as a way to provide jobs now and lay the foundation for long-term prosperity" (White House, 2009, para. 1). An important goal of education was, and still is, to prepare students for their future lives. Even in the early days of philosophy and education, people of wisdom recognized that one phase of education affects the next. Educators benefit from knowing what best prepares students to progress through the levels of schooling. At each level different students have different individual needs, academically, developmentally, and emotionally. School districts attempt to meet these needs with programs tailored for certain students. Elementary and middle school curricula have served high-achieving and gifted students by offering opportunities for increased rigor. Challenge courses, otherwise known as honors courses, at the middle school are purported to prepare students for high-level high school courses, which in turn are said to prepare them for college and the workplace.

This study took place in a suburban school district in St. Louis County, Missouri, which serves 23,000 students, 14% of whom represent minority populations. In this district 6th, 7th, and 8th graders attend six middle schools, while 9th, 10th, 11th, and 12th graders attend four high schools. The high schools offer courses at regular, honors, and college levels. As in many high schools across the nation, college-level courses in this district include Advanced Placement (AP) courses. Although there are recommended prerequisites for the honors and college-level courses, enrollment is open to any interested, motivated student. The middle schools offer courses at remedial, regular, and Challenge levels. Until 1998 enrollment in Challenge courses in middle school was restricted to those who qualified for the gifted program.

In 1998 the board of education of this district approved the Middle School Challenge Program Eligibility Criteria. The criteria, which are still district policy at the time of this writing, serve as the guideline for determining which students are eligible to enroll in a Challenge-level course in one or more of the core subject areas: language arts, math, social studies, and science. The Challenge program includes courses in these core subject areas that offer similar content as in the regular course, but the content is to be enriched, compacted, and/or accelerated in order to meet the needs of the high-ability student. The advanced academic rigor of Challenge courses serve to offer differentiated instruction with opportunities for individual and collaborative projects, which facilitate the development of higher-level thinking skills. These thinking skills, which include inquiry, research, analysis, synthesis, and production, are skills in the two highest levels of Depth of Knowledge: strategic thinking and extended thinking (Webb, 2005). This is reminiscent of Bloom's Taxonomy of the Cognitive Domain, which assigned analysis, synthesis, and evaluation as the higher, more complex, levels of thinking (Bloom, 1956).

To introduce parents and students to the middle school curriculum, the district of study publishes a *Middle School Course Description Guide*, which provides information regarding elements and expectations of the courses offered at the middle schools in the district. Distributed yearly, this guide includes course descriptions that explain the differences between regular courses and Challenge courses. As an example, the description of the sixth-grade science course includes words like *participate in hands-on investigations*, *explore*, and *examining*, whereas, the description for the sixth-grade Challenge science course includes words like, *inquiry-based*, *analyze*, *research*, *evaluate*, and *apply critical thinking* (Rockwood School District, 2008a, p. 41–42). Again, the educational outcomes, or intended behaviors, as Bloom (1956) would have called them, represent more complex thinking in the Challenge courses than in the regular courses.

The *Middle School Course Description Guide* also includes a Challenge Course Eligibility Matrix (Challenge Matrix), which addresses the qualifications now required for enrollment in a Challenge course. Prior to 1998 Challenge courses were only available for students who qualified for the gifted program. Qualification for the gifted program required a minimum intelligence quotient (IQ) score of 130, along with a specific grade point average (GPA). District officials developed the new Challenge Matrix to expand the student participation in higher-level classes. The board of education recognized that the higher level of rigor would also be appropriate for and would benefit high-achieving, hard-working students, even if they were not identified as gifted by this district's standards.

Since the state does not mandate gifted education, identification of gifted students and delivery of services to them vary greatly among districts, even in the immediate area of the district of study. In some districts the middle school gifted program involves pulling identified students out of a regular class for part-time enrichment. Other districts serve these students solely by offering honors courses or Challenge courses. Still others use clustering, so that in a regular class, teachers group the gifted students together for certain activities. In some cases the middle schools do not offer a formal, differentiated educational program for the gifted population, or even for the high-achieving students. As part of a continuing effort to appropriately serve the educational needs of all students, the district of study has made adjustments to course offerings, course prerequisites, and professional development so that more and more students achieve at high levels. As the Challenge courses became available for high-achieving students, the delivery model for the gifted students in middle school evolved as well.

According to the Challenge Matrix introduced in 1998 (Rockwood School District, 2008a), eligibility was determined separately for each of the four core subject area courses: language arts, social studies, science, and math. At the time of this study, counselors still used this matrix to determine Challenge course enrollments. The equation for eligibility included the student's most recent semester GPA (based on a 4.0 scale) times 25, representing grades in all four of the core subject areas, not just the subject area of the Challenge course in question. The equation also included the national percentile on the subject area achievement test (based on a scale from 0 to 99). All students in the district in this study take the Stanford Achievement Test, Tenth Edition (Stanford), a nationally normed achievement test that includes the core subjects: reading, language arts, mathematics, social studies, and science (Schwoebel-Mills, 2008). The national percentile from any other nationally normed achievement test is inserted into the Challenge Matrix for students who did not take the Stanford.

The Stanford percentile score for the science subtest is inserted into the Challenge Matrix to determine eligibility for the Challenge science course, and the Stanford percentile score for the social studies subtest is inserted into the Challenge Matrix to determine eligibility for the Challenge social studies course. These two numbers—the

GPA times 25 and the Stanford subtest percentile—add up to a total number. A total of 174 or more qualifies the student for enrollment in the more rigorous Challenge course in a certain subject area. One possible combination that qualifies a student for the Challenge course is a GPA of 4.0 and a score on the Stanford subject subtest in the 74th percentile ((4.0 x 25) + 74 = 174). Another possibility is a GPA of 3.0 and a score on the Stanford subtest in the 99th percentile ((3.0 x 25) + 99 = 174). Table 1 shows some of the possible combinations for minimum eligibility.

Table 1

Challenge Eligibility Examples

Subtest Percentile	GPA[a]	GPA x 25	Total
99	B (3.0)	75	174
86.5	B+ (3.5)	87.5	174
74	A (4.0)	100	174

Note. Maximum possible total = 199. Any combination that totals 174 or higher indicates eligibility.

[a]GPA is Cumulative grade point average based on a 4 point scale, where 4 = A, 3 = B, 2 = C, 1 = D, and 0 = F.

Before the adoption of the Challenge Matrix, the Challenge program served as the only delivery model for gifted services in the middle schools of the district in this study, since qualification for the gifted program meant qualification for the Challenge courses.

At the middle school, the Challenge program *was* the gifted program, which meant that only the gifted population enrolled in Challenge courses. With the addition in 1998 of the Challenge Matrix, which expanded the enrollment in Challenge courses beyond the gifted students, the gifted students had the option to enroll in a Compacted Challenge language arts course in conjunction with a course called Academic Stretch. Academic Stretch is an interdisciplinary, thematic course, designed to serve the social, emotional, and academic needs of gifted students. Teachers of this course must have current gifted education certification from the state. From 1998 until the time of this study, this district's middle school gifted program delivery model consisted of enrollment in Compacted Challenge language arts and Academic Stretch on alternating days.

While all other middle school students in the district enrolled in a language arts class every day, these identified gifted students enrolled in language arts only every other day, for half the time. This required that the Challenge language arts course taken by the gifted students be compacted. Curriculum compacting is a method of delivering curriculum to gifted or advanced learners; not simply covering *more* material *faster*. According to Reis, Burns, and Renzulli (1992), curriculum compacting was "the process of identifying learning objectives, pretesting students for prior mastery of these objectives, and eliminating needless teaching or practice if mastery can be documented" (p. 10). This process, when done correctly, saves time that teachers can allocate for enrichment for the gifted students.

The Challenge courses in math, science, and social studies were then open to any student who qualified according to the Challenge Matrix, thus increasing the number of students who enrolled in these higher-level courses. Those students not identified as gifted, but who qualified according to the Challenge Matrix for language arts, enrolled in a Challenge language arts course that met every day. In these Challenge courses, the high-level discussions, rigor, and projects were purported to prepare students for advanced course work in high school and college. Preparation for college was and continues to be a priority in the district of study, as reflected in high-level course offerings as early as sixth grade.

As mentioned earlier, at the high school of study, all students had the unrestricted option to enroll in high-level courses in many areas, including language arts, math, social studies, science, world languages, computer science, music, and art. In other words, there were no criteria for enrollment in advanced-level courses, including AP courses, beyond the prerequisites. AP courses are college-level courses taken in high school. At orientation meetings, all high school students are encouraged to enroll in at least one AP course in the 4 years of high school, whether or not they have previously participated in Challenge courses or in the gifted program.

Relevance

The middle school in this study was a suburban, middle-class, middle school in St. Louis County, Missouri, which served 11- through 14-year-olds in grades six to eight. Most students in this district are college-bound. For the approximately 350 students in each middle school grade, two levels of core courses were available, regular courses and Challenge courses. There were additional levels of language arts courses offered, including Reading Initiative, for those who read below grade level, and Compacted Challenge language arts, for the gifted students, as explained earlier. Enrollment in Challenge courses was by choice of the students who qualified with this minimum score.

Students whose grades and achievement test scores did not earn the minimum numerical score on the Challenge Matrix did not have the option of taking the Challenge-level course, and therefore were automatically enrolled in the regular-level course.

In this same suburban school district, the high school in this study served 14- through 18-year-olds in grades 9 through 12, with a student population of 1,400 in the year of the study. Although there were three other high schools and five other middle schools in this district, the middle school in this study was the only feeder school in the district for the high school in this study. In the case of each of the other high schools, more than one middle school fed into it. Therefore, the study high school is the only high school in the district that has only one feeder middle school, the study middle school. The researcher chose this middle school and this high school in order to reduce the effect of the limitations presented by multiple feeder schools.

For students enrolled at the high school in this study, there were recommended prerequisites for AP college-level courses, but an individual's enrollment in an AP class was not contingent upon any eligibility requirements. If a student chose to enroll in an AP course, he or she was able to do so. Initial recommendations for class placement included 3.5 GPA, teacher approval, and counselor approval. Students who did not meet the recommended criteria were still able to enroll in the AP course, but only after signing a waiver to show that "they and their parents understand that the students may not be prepared for the level of difficulty of the course" (Rockwood School District, 2008b, p. 28).

At the conclusion of an AP course, a student has the opportunity to take the AP exam, which earns college credit at some colleges depending on the category score. Most colleges confer college credit if the student's category exam score was a 4 or 5 (on a scale of 1 to 5, 1 being the lowest). Some colleges confer credit for a category exam score of 3, 4, or 5. High school personnel advise students to find out the status of AP exams at each of their intended colleges. Studies by the College Board have compared the mastery demonstrated on the AP exam with the expectations of a college course and have determined that

> Students who earn AP exam grades of 3 or above are generally considered to be qualified to receive college credit and/or placement into advanced courses due to the fact that their AP exam grades are equivalent to a college course grade of 'middle C' or above. (College Board, 2009c, para. 11)

Criteria for eligibility for advanced-level courses vary from district to district and even from grade level to grade level. The district of study not only has eligibility requirements for enrollment in a middle school Challenge course, but it has a policy whereby a student is moved to a regular course if the semester grade falls to a C-. However, the advanced courses at the high school follow a policy of open enrollment, and there is no exit policy or requirement to maintain a certain grade to stay enrolled. In fact, high school personnel strongly discourage students from dropping AP courses. Although there are no prerequisites for an AP course in the high school in this study, there are prerequisites for students who wish to take these same courses at a college (Mathews, 2008).

Importance

"Should my child take the Challenge courses if he or she qualifies?" The parents of incoming sixth graders have asked this question every year at middle school orientation meetings since the inception of the Challenge program. Every year school personnel at the middle school have answered this question with a recommendation that each student takes all of the Challenge courses for which he or she qualifies. In conversations about transitions to middle school and high school, counselors and teachers have expressed the belief that the higher-level thinking required and the more rigorous instruction in the Challenge courses more effectively prepare the students for the more difficult courses at the high school, which in turn prepares students for college and then the workplace.

The *Middle School Course Description Guide*, published by the district of study and distributed to parents, reflected this philosophy. The response to a Frequently Asked Question was, "You should definitely encourage your children to take any upper level course for which they qualify at the middle school level" (Rockwood School District, 2008a, p. 4). Later, this same guide made a connection between the Challenge courses and the AP courses when it stated that in social studies Challenge courses, "students are challenged to work on skills that will enable them to be successful in Advanced Placement Social Studies classes" (p. 9). The researcher designed this study to determine the validity of these recommendations and claims.

Purpose

In an effort to meet the individual needs of all of the students in educational systems, policy makers offer a variety of programs and curricula. For high-achieving, college-bound students, advanced courses available as early as middle school include Challenge courses, or honors courses. Often, the justification for these courses is the belief that these courses more adequately prepare students for college-level courses than regular-level courses do.

In the district of study, the middle school offered Challenge courses in mathematics, language arts, science, and social studies for each of the 3 years: sixth, seventh, and eighth grade. The researcher included only social studies and science because the district offered only two levels of courses in each of these content areas. Students may have been accelerated in mathematics according to placement tests. As a result, some mathematics courses contained students from multiple grade levels. In the area of language arts, there were four different courses available at the middle school, depending on the reading level of the students or the identification of giftedness of the students. In order to support or refute the claim that these Challenge courses prepare students for advanced rigor, the researcher sought to determine if there was a correlation between the level of enrollment (number of years) in middle school Challenge courses and category scores on the AP exam in the same subject area: either social studies or science.

Specifically, in December 2009, the researcher obtained and recorded the category scores for all students who had taken any of the May 2009 AP social studies exams in U.S. Government, Comparative Government, European History, World History, Microeconomics, Macroeconomics, U.S. History, or Psychology. Any student could have enrolled in more than one AP course, but for the purposes of this study, the researcher considered each AP exam separately. For each of these students, the number of years of enrollment in Challenge social studies in middle school was recorded. In the 3 years of middle school, grades six through eight, a student may have taken from zero to 3 years of any given Challenge course. There are two semesters in each year. Thus, if the student enrolled in Challenge social studies for the sixth-grade year and one semester of the seventh-grade year, the value of this variable would have been 1.5.

Concurrently, this study looked at the students who had taken any of the May 2009 AP science exams in Chemistry, Biology, Environmental Science, Physics B, Physics C-Mechanics, or Physics C-Electricity and Magnetism. The researcher accessed transcripts to determine for each of these students the number of years in Challenge science in middle school. These numbers were recorded along with the AP exam category scores.

Hypothesis

The alternate hypothesis was that there was a positive correlation between the level of involvement, as measured by the number of years of enrollment, in a middle school Challenge course and the subsequent category score earned on the AP exam in the corresponding high school course.

For example, students who took 3 years of Challenge science in middle school would be more likely to achieve a category score of 3, 4, or 5 on an AP science exam taken during high school. In addition, students who took 3 years of Challenge social studies in middle school would more likely achieve a category score of 3, 4, or 5 on an AP social studies exam taken during high school. In other words, more years of enrollment would correlate to a higher AP exam category score. Conversely, the fewer years a student enrolled in a Challenge-level course in middle school, the less likely it would be that the student would achieve a category score of 3, 4, or 5 on the corresponding AP exam taken during high school.

Null Hypothesis

The null hypothesis was that there was no correlation between the level of involvement, as measured by the number of years of enrollment, in a middle school Challenge course and the subsequent score earned on the AP exam in the corresponding high school course.

Research Question

What was the correlation between the number of years of enrollment in a Challenge social studies or science course in the middle school and the category score earned on the corresponding social studies or science AP exam?

Variables

The independent variable was the number of years of enrollment in the Challenge course. Since eligibility and enrollment could have changed at each semester, the values for the independent variable ranged from zero to 3 in increments of 0.5 (i.e., 0, 0.5, 1.0, 1.5, 2.0, 2.5, or 3.0). The dependent variable was the category score on the corresponding AP exam (1, 2, 3, 4, or 5). The researcher set out to determine if there was correlation between the number of years of enrollment in the Challenge course in middle school and the AP exam category score in the same subject area.

Justification

Studies claimed that category scores of 3, 4, or 5 on AP exams predicted achievement in college. “Success on an AP exam is defined as an exam grade of 3 or higher, which represents the score point that research finds predictive of college success and college graduation” (College Board, 2008c, p. 1). Many colleges accepted an AP exam score of 3 to be equivalent to earning a C in the college course, a 4 to be equivalent to earning a B, and a 5 to be equivalent to earning an A.

Determining whether enrollment in the middle school Challenge courses correlated to achievement on AP exams would support or refute the present practice of encouraging enrollment in all the Challenge courses for which a student qualified. In addition, since enrollment in the middle school Challenge courses was limited to those who qualified according to grades and nationally normed achievement test scores, while enrollment in AP courses was determined only by student choice, results of this study may lead to a reexamination of the eligibility requirements for Challenge courses. With a positive correlation, limiting access to Challenge courses may result in limiting opportunities for success in high school or college.

School personnel needed to examine how to direct students to enroll in middle school and high school courses and how to help and encourage students to challenge themselves, adequately and appropriately. These issues were a part of an ongoing discussion in the district. As a result, in the fall of 2009, a district-wide Middle School Review Committee began to explore scheduling issues, course offerings, and delivery options in the middle school, including Challenge courses and eligibility requirements. According to the Middle School Focus Group Summary, which was an overview of concerns by parents, teachers, students, and administrators in the district, “One of the most complicated issues facing middle school administrators now is the fallout from Challenge classes: who gets in, how many get in, who is left out, socio-economic factors, effects on high school AP participation . . .” (Rockwood School District, 2009, p. 8). In recent years, the enrollment in Challenge courses had accounted for 60% of the middle school population. The results of this study would be one piece of the ongoing discussion.

Limitations

The scope of this study was limited to students enrolled at one high school who took certain AP exams, dictated by offerings in the course catalog. The researcher considered the number of years of enrollment in the corresponding middle school Challenge course and subsequent AP exam category scores achieved during high school enrollment in the corresponding content area. Some factors not included in this study were GPAs, IQ scores, grades in the Challenge courses, and grades in the AP courses. In fact, students may have taken an AP exam without having first taken the AP course.

Other factors not included in this study were the different teaching styles, years of experience, levels of education, and genders of the teachers of these courses. The students in this study may have had different teachers for the Challenge courses and different teachers for the AP courses, since there were multiple sections of many of these courses. Each of these teachers may have had a different level of expertise, a different amount of teaching experience, a different area of specialty, and a different degree of training for teaching advanced students.

The amount and type of professional development varied among teachers of the courses included in this study. The middle school teachers were not required to undergo any special training or preparation before teaching a Challenge course. State certification in social studies or science was the only requirement. The teachers of AP courses did receive some district and national training in preparation for teaching AP courses, but this training was not consistent for all of the teachers. In order to assure some consistency in

AP courses, College Board requires that the teacher of an AP courses have the syllabus approved by the College Board reviewers before teaching an AP course. To address inconsistencies, according to administrators and AP teachers at the high school, teachers of AP courses who did not regularly elicit AP exam category scores of mostly 3, 4, or 5 from their students were reassigned to teach non-AP courses. This occasional change in teaching staff can result in variations in the quality of instruction across the AP courses.

This study also did not address developmental issues. Middle school students are at different stages of maturity and readiness than their high school counterparts. Depending on the AP exam, there may have been 2 to 4 years between the eighth-grade Challenge course and the AP exam. The purpose of school and the importance of the learning may have changed for many students between the ages of 12 and 18. The fragility of self-esteem and the stress of doing well on exams may have changed dramatically in these “tween” years, as Clifford-Poston called them (2005).

In addition, the number of students who enrolled in AP courses, and the number of these who chose to take the AP exams, fluctuated from year to year. Thus, this study may not have represented the number of students capable of achieving high scores on AP exams. Although enrollment in AP courses is encouraged in this district, scheduling conflicts, both inside and outside school, may have prevented able students from taking certain AP courses or may have prevented optimum performance in school. For instance, a 16-year-old who had a job may not have chosen to take an AP course because he or she was too busy. At the same time, a student with a job who did take the AP course may not have performed as well on the exam as he or she would have if he or she did not have the job. Another limitation of this study was the fact that several factors contributed to a student's performance on an AP exam, or even participation in an AP course, such as employment, scheduling, or stress. Thus, this study is only examining a correlational, not causal, relationship between the independent and dependent variables.

A change in life circumstances may also have affected attitudes toward school and performance on an exam. Financial situations or health issues may have changed drastically between the time that the student was in middle school and the time he or she was in high school. Some of the AP courses, such as European History and World History, were available primarily to sophomores. Some of the AP courses included in this study, such as Economics, U.S. History, Government, Psychology, Physics, Biology, and Chemistry, were only available to juniors and seniors,. This means that 2 to 4 years passed between the most recent middle school Challenge course and the AP exam.

This study included AP exams in social studies and science. This study did not include AP exams in mathematics or language arts. Mathematics was not included because, in this district, students took the mathematics course, for which they qualified, regardless of grade level. As a result, a sixth grader may have been in a mathematics course with seventh and eighth graders, thus the distinction between regular courses and Challenge courses was less clear in the mathematics curricula because the students moved sequentially through the courses regardless of grade level or age. Decades ago, Bruner predicted this development as a first step in allowing students to advance through subjects as "rapidly as they can" (1977, p. 11). Specifically, Bruner said that "the answer will probably lie in some modification or abolition of the system of grade levels in some subjects, notably mathematics, along with a program of course enrichment in other subjects" (p. 11). Language arts courses were also not included in this study because there were four levels of courses instead of two. In addition to regular courses and Challenge courses, students may have enrolled in Reading Initiative courses (for those who read below grade level) and Compacted Challenge Language Arts (for those participating in the gifted program). Because of the complexity of the mathematics and language arts curricula, this study was limited to social studies and science.

Scheduling differences between middle school and high school were potentially noteworthy. In middle school each social studies and science course met for 90 minutes every other day. In high school, some social studies and science courses met for 90 minutes every other day, and some met every day for approximately 50 minutes. Some students may have performed better with one or the other of these scheduling arrangements.

Even if a positive correlation were found, this study alone would not have strongly supported the claim that taking a Challenge course in middle school prepares a student to achieve a level of success in the corresponding AP exam. A number of capable, qualified students may have chosen not to take a Challenge course in middle school. A student, who qualified for a Challenge course by achieving a certain GPA and earning a particular score on a standardized test, may have scored well on an AP exam without having taken any of the corresponding Challenge courses. There may also have been students who enrolled in Challenge courses but chose not to take the corresponding AP courses in high school. These latter students were not included in this study.

Although the middle school in the study was the only public school that fed into the high school in this study, there were private grade schools in the area that served students up to the age of 14. Thus, some of the students who took the AP exams in this high school did not attend the public middle school for 3 years. The researcher did not have access to their transcripts from sixth, seventh, and eighth grade; therefore, the data sets for these students were incomplete. The researcher did not include these students in the study. At the same time, some students who attended the middle school for 3 years moved or attended one of the private high schools in the area. These students were also not included.

Definition of terms

Academic Stretch. An interdisciplinary course designed to serve the gifted students by facilitation of the development of process skills, such as leadership, critical thinking, and information processing

Achievement test. A nationally normed test that includes subject area subtests. The Stanford is administered by the district in this study.

Advanced Placement (AP) course. A college-level course in high school, sponsored by the College Board, which prepares him or her for taking an examination (Rockwood School District, 2008b, p. 24).

Advanced Placement (AP) exam. An examination at course end, the score of which may qualify a student for college credit (Rockwood School District, 2008b, p. 24)

American College Testing (ACT). A national college admissions examination that consists of subject area tests in English, mathematics, reading, and science. “ACT results are accepted by all 4-year colleges and universities in the U.S.” (ACT, 2010d, para. 3)

Challenge course. A higher-level, more rigorous course that focuses more on critical thinking and depth of knowledge than a regular course in the middle school. Also referred to as an honors course. Eligibility is determined by the Challenge Matrix.

Challenge course enrollment. The number of years that the student was enrolled in a challenge science or social studies course, based on a student's middle school transcript. The possible values are 0, 0.5, 1.0, 1.5, 2.0, 2.5, or 3.0.

Challenge Course Eligibility Matrix (Challenge Matrix). The criteria, established by the district of study, for qualifying for enrollment in a Challenge course. This matrix includes GPA and achievement test scores from nationally normed tests (such as Stanford).

Challenge program. Higher-level course offerings available to middle school students who qualify by meeting the criteria of an assessment matrix based on academic performance.

Curriculum compacting. A method of delivering curriculum to gifted or advanced learners, which involves identifying learning objectives, pretesting students for prior mastery of these objectives, and eliminating needless teaching or practice if mastery can be documented (Reis, Burns, & Renzulli, 1992).

Differentiation. The practice of modifying instruction in order to effectively teach students with a variety of abilities, learning styles and interests.

Gifted program. A district-wide program that identifies and serves identified gifted students with curricular offerings and services.

Gifted resource teacher. A teacher who has successfully completed certain coursework and obtained state certification in the area of gifted education.

Gifted student. Student who gives "evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities" (National Association for Gifted Children, 2008a, para. 1)

Grade point average (GPA). Cumulative grade point average on a 4-point scale.

High ability learner. Student who demonstrates "advanced academic abilities and . . . have the potential to work at advanced levels" (National Association for Gifted Children, 2008b, para. 3).

Preliminary Scholastic Achievement Test/National Merit Scholarship Qualifying Test. (PSAT/NMSQT). "A preparatory tool for the SAT that is administered by high schools to sophomores and juniors each year in October. The PSAT/MNSQT serves as the qualifying test for scholarships awarded by the National Merit Scholarship Corporation" (College Board, 2009a, p. 45).

Scholastic Achievement Test (SAT). "The College Board's test of critical reading, writing, and mathematics skills . . . used by most colleges and sponsors of financial aid programs" (College Board, 2009a, p. 46).

Stanford Achievement Test, Tenth Edition (Stanford). A nationally normed achievement test that includes the core subjects: reading, language arts, mathematics, social studies, and science (Schwoebel-Mills, 2008).

Summary

Does enrollment in Challenge, or advanced courses in middle school correlate to higher levels of achievement in college-level courses, such as AP courses? The development of sound educational policies depends on knowing how to provide students with developmentally appropriate preparation for further studies and for life.

As stated earlier, most students in this district plan to attend college. College-bound students have the opportunity to earn college credit in high school in several ways, one of which is by scoring well on AP exams that are offered in a variety of subject areas. Research has repeatedly shown that category scores of 3, 4, or 5 on these AP exams indicate readiness for college-level work.

In the district of study, one of the middle schools feeds exclusively into one of the high schools. The three other high schools in the district have multiple feeder middle schools. In order to minimize the effects of multiple teachers in multiple settings, this researcher limited the study to one middle school and one high school. As a result, the sample sizes are smaller than they would have been district-wide.

Research was sparse, however, in the connections between middle school courses and the high school AP exam category scores. The researcher examined the effect of enrollment in middle school Challenge courses and the AP exam category scores in social studies and science in a St. Louis County, Missouri, school district. Since students in the district of study must have met eligibility requirements in order to enroll in Challenge courses, the strength of the relationship between the middle school experience and the high school experience would help to inform those who determine district policy concerning accessibility to eventual college or workplace success. The next chapter reviews programs, curriculum, and diagnostic tools that connect high school and college, as well as middle school and high school. The next chapter also summarizes theories and studies relating to intelligence and readiness of students for advanced learning.

Chapter 2: Literature Review

The journey from birth to adulthood contains many challenges and gateways. With each grade level or course exam, a student's path can change. At each turn, new decisions affect the future path of someone's preparation for college and for employment. Educational institutions, corporations, and other organizations have worked to develop programs and diagnostic tools that would help to inform these important decisions.

The following literature review is a summary of many curricular options, developed to help students prepare for upcoming challenges in their educational career. Since some of these options are available only to those who achieve certain standards, the literature review is also an overview of some of the tests that serve as prerequisites for programs or courses. The first section concerns curricular options and tests used in high school either to prepare students for college or to determine eligibility for college. The second section covers curricular options and tests used in middle school that are designed to prepare students for high school courses or to inform course selection in high school. The third section is an overview of attitudes concerning readiness of young students for advanced challenges, such as Challenge courses in middle school or college-level courses in high school.

High School to College

College Board Advanced Placement Program. "The College Board is a not-for-profit membership association whose mission is to prepare, inspire, and connect students to college success and opportunity" (College Board, 2010a, p. 2). The AP program is one of the programs sponsored by the College Board, wherein high school students take college-level courses. At the end of each AP course, the students may complete an AP exam, which is nationally normed by trained scorers on a scale of 1 to 5, 1 being the lowest and 5 being the highest.

Since its beginning in 1955 as “the best large-scale option currently available for challenging academically prepared youth while they are still in high school” (as cited in Bleske-Rechek, Lubinski, & Benbow, 2004, p. 217), the AP program has grown in the number and availability of AP courses and the number of students taking AP exams. Nationwide, the number of AP exams completed increased from 65,878 exams in 2004 to 108,284 exams in 2008 (College Board, 2010e, 2008b). The district of study has promoted the AP program and encouraged all students to consider attempting at least one AP course while they are in high school. As a result, the number of students taking AP exams at the district of study (61%) is commensurate with the increase nationally (64%) in the same time period, as indicated in Table 2 (D. Menke, personal communication, July 13, 2010).

Some educators are concerned with the tremendous growth of the AP program. The concern is that its predictability for college performance and the rigor of the AP experience might be diluted if more students, some of whom may be unprepared, participate. Amid this growth, however, researchers determined that earning a 3 or higher on an AP exam was still “a strong predictor of a student’s ability to persist and earn a bachelor’s degree,” (College Board, 2008c, p. 1) measured by higher grades in college and higher college graduation rates. The AP exam category score continues to be an accurate assessment of proficiency in a college course. The correlations to college grades and graduation “have held consistent across the decades” (College Board, 2009b, p. 3).

Table 2

History of Advanced Placement Exams

Year	No. of exams completed	
	RSHS	US
2004	319	65,878
2005	373	76,786
2006	431	88,237
2007	468	98,033
2008	512	108,284
Increase	61%	64%

Each year the AP exams are nationally normed, and each year the College Board statistically analyzes the results and conducts comparability studies of subsequent college grades, maintaining the College Board's claim of validity and college-level rigor. The College Board requires submission and approval of a high school course syllabus before a course can be officially called an AP course and sanctioned by The College Board. This practice serves to uphold the integrity of the AP courses so that colleges and university can accurately interpret a student's transcript for college readiness.

The number of AP exams available has also increased. In the spring of 2009, the high school of study offered 25 AP courses. Sophomores, juniors, and seniors completed

617 exams, as shown in Table 3. Because there are opportunities to explore many different subject areas, students are able to pursue college level rigor in their particular areas of interest.

Table 3

RSHS 2009 AP Courses and No. of Exams Completed

AP course	No. of exams completed
Art-drawing	1
Art-2D design	2
Biology	15
Chemistry	24
Computer Science A	6
Economics-Micro	13
Economics-Macro	17
English Language/Composition	24
English Literature/Composition	88
Environmental Science	13
European History	66
French Language	1
Government and Politics-U.S.	85
Government and Politics-Comparative	67
Calculus AB	42

Music Theory	5
Physics B	5
Physics C-Mechanics	4
Physics C-Electricity and Magnetism	4
Psychology	51
Statistics	47
Subscription-Aural	5
Subscription-Nonaural	5
U.S. History	6
World History	21
Total	617

"Each AP course is modeled upon a comparable college course, and college and university faculty play a vital role in ensuring that AP courses align with college-level standards" (College Board, 2010c, para. 2). For example, two of the AP courses considered in this study were AP Comparative Government and AP U.S. Government. According to the *AP Comparative Government and Politics: Workshop Handbook* (College Board, 2008a, p. 3), each of these courses is equivalent to a one-semester college introductory social studies course. Such vertical articulation between high school and college may be an important factor in the predictive nature of AP exam scores. This study extends the importance of and justification for vertical articulation to the middle school. In the Fifth Annual AP Report to the Nation, the College Board (2009b), acknowledged this importance with the following assertion:

> Major initiatives are needed to ensure adequate preparation of students in middle school, 9th grade and 10th grades so that all students will have an equitable chance at success when they go on to take AP courses and exams later in high school. (p. 7)

In the district of study, since the only option for such adequate preparation in middle school was the Challenge program, an evaluation of these Challenge courses was justified. The first step, and the focus of this study, was to determine correlation between enrollment in Challenge courses and subsequent AP exam category scores, specifically in the areas of social studies, with eight AP courses, and science, with six AP courses.

In its Fourth Annual AP Report to the Nation, the College Board (2008) focused on educators' quantifiable successes in helping a wider segment of the nation's students gain access and achieve success in college-level work. A national goal of the College Board was to reach a point where the demographics of AP participation reflected the demographics of the nation. The 2009 Report maintained that despite the continued efforts of educators across the United States, "Significant inequities remain, however, which can result in traditionally underserved students not receiving the sort of AP opportunities that can best prepare them for college success" (College Board, 2009b, p. 4).

Each year, the College Board reports the demographic data for the AP exams, comparing ethnicity percentages of the total student population with the percentages of the students achieving 3 or higher on AP exams. Missouri is one of the many states in which the Equity and Excellence Gap has been eliminated for two of the groups, Hispanic/Latino and American Indian/Alaska Native, though this latter group represents less than 1% of the population. Only the Black/African American group still shows a gap between the population, 15.5%, and the AP success rate, 2.4% (College Board, 2009b, p. 11). This gap, however, may be at least as much a reflection of lower enrollment in the AP classes as the measure of success on the exams. Further research, which analyzes AP course enrollment and AP exam category scores by these demographic groups, would shed more light on this issue.

Part of the progress toward equity may have been, in part, due to the Access to High Standards Act, a subsection of the No Child Left Behind Act of 2001 (No Child Left Behind, 2003), which included incentives and allocations of federal grants designed to support AP programs (USDE, 2002, p. 182). One grant funded an intervention program that offered the opportunity for eighth-grade Hispanic students in a Texas school to enroll in AP Spanish (Kettler, Shui, & Johnsen, 2006). Positive results, besides the high exam scores, included greater self-efficacy, more school involvement, and higher college aspirations. This and other programs often incorporated extra help or enrichment experiences that served affective as well as academic needs for students who may have otherwise been unprepared or unmotivated.

For students who are academically and emotionally ready for college level rigor, AP classes offer opportunities to explore areas of interest in great depth. This challenge and exploration can help inform the students' decisions about appropriate colleges, majors, and careers. Under the heading of Achievement, Career Preparation is one of the performance standards that was established "for the classification and accreditation of Missouri school districts" as a part of the Missouri School Improvement Program

(MODESE, 2004, p. 2). The state board of education defined the level of career preparation as “percent of students demonstrating adequate preparation for postsecondary education and/or employment” (p. 27). This performance standard includes “percent of credits taken by juniors and seniors in Department-designated advanced classes” and “percent of students who attend postsecondary education within six months of graduating” (p. 27). AP courses count as advanced courses in this calculation (MODESE, 2010).

“Public schools are ranked according to a ratio devised by Jay Mathews: the number of Advanced Placement, Intl. [*sic*] Baccalaureate and/or Cambridge tests taken by all students at a school . . . divided by the number of graduating seniors” (Newsweek, 2009). According to Mathews, “it’s one of the best measures available to compare a wide range of students’ readiness for higher-level work” (Rockwood District News, 2008). If AP participation, or participation in advanced-level courses, serves as an indication of future college performance, a reasonable inference would be that advanced-level courses in middle school would serve as an indication of high school performance, specifically performance on AP exams. This study was testing that inference by determining if participation in Challenge courses in middle school correlated to performance on AP exams.

Some Strategic Improvement Plans (in buildings and districts) often include increasing the number of students who challenge themselves to take AP courses in high school, even if they have never previously taken honors level or Challenge-level courses. The high school of study is one of these buildings. Each year the principal distributes to the staff a chart that shows the history of participation in AP courses and exams at the high school. This chart includes the number of tests, the number of students who completed AP exams, the number of AP exams completed, and the percent of exams scoring a 3 or higher, the percent of exams scoring a 4 or a 5, and the percent scoring a 5. Staff development meetings have been dedicated to strategies that would increase participation and exam category scores. According to the principal of the high school of study, the goal for this school has been to have 400 students complete 800 AP exams with a qualifying rate (3 or higher) of 80% (D. Menke, personal communication, July 14, 2009).

The spirit of this objective extends far beyond the boundaries of the district in this study or even the state. Even in the *Sixth Annual AP Report to the Nation*, one of the highlights of the year was that "across the nation, educators and policymakers are helping a wider segment of the U.S. student population experience success in AP" (College Board, 2010a, para. 1). While success is defined throughout the document as scoring a 3 or higher on the AP exam, which indicates adequate preparation for college-level course work, some research has suggested that simply exposing future college students to the rigorous AP curriculum can benefit college students (Hargrove, Godin, & Dodd, 2008, p. 34). Research has found the benefits to include improved study skills, improved writing skills, better ACT scores, higher college grades, more willingness to take academic risks, and higher graduation rates.

Opportunity to participate in such advanced courses should be available to all students, according to the Equity Policy Statement of The College Board. The practice at the high school in this study agreed that, "all students who are willing to accept the challenge of a rigorous academic curriculum should be considered for admission to AP courses" (College Board, 2008a, p. 2). Extending the simple criteria of being "willing to accept the challenge" to the middle school Challenge Matrix may serve to set the tone early for high expectations. The National Association for Gifted Children agreed, "every learner . . . should have supported access to the highest possible quality education" (National Association for Gifted Children, 2008b, para. 1).

After the 2007 *AP Report to the Nation*, which again demonstrated that students who do well on an AP exam are prepared for college rigor, the College Board president, Caperton, reiterated, "We must do more to ensure that *every* student receives adequate preparation for rigorous courses like AP. . . . Schools need to start preparing students as early as middle school so they are equipped to take on the challenges of AP courses once they get to high school" (College Board, 2007a, para. 3). According to studies following students through college, even students who were enrolled in an AP course but did not take the exam outperformed their non-AP college peers in terms of first-year GPA, subject area GPA, and additional college course work (College Board, 2007b, pp. 12–13). There is, therefore, "strong support for AP program benefits over non-AP experiences" (Hargrove, Godin, & Dodd, 2008, p. 54).

Other College Board programs. Other programs sponsored by the College Board include the Scholastic Achievement Test (SAT) and the Preliminary SAT/National Merit Scholarship Qualifying Test (PSAT/NMSQT). The traditional, more familiar SAT test is actually SAT I, which is a "standardized multiple-choice test of Critical Reading, Math, and Writing that is commonly required by colleges and universities for consideration of admission" (SAT Victory, 2005, p. 8). SAT II is a subject-specific test. The PSAT/NMSQT is a qualifying test for a National Merit Scholarship (p. 8).

There was conflicting research about the predictability of the SAT I for college success. The College Board and Educational Testing Service have conducted periodic studies to determine the correlation between SAT I test scores and first-year college grades. The National Center for Fair and Open Testing disputed the predictability claimed by these tests, because The College Board's correlation was based on r, the correlation coefficient, instead of r^2, the coefficient of determination. The correlation coefficient is a measure of the linear relationship between two variables. In such a statistical analysis, when the null hypothesis is rejected, there are five possible conclusions. Either there is a cause-effect relationship, a reverse cause-effect relationship, a third variable that causes the effect, a complexity of relationships among many variables, or a coincidental relationship between the variables (Bluman, 2008, p. 527).

In fact, "the role of the ACT and SAT in determining who gains entry into the nation's colleges and universities continues to be a hotly debated topic" (NACAC, 2008, p. 7). Although these tests are generally based on subject areas, tests like the College Board's AP exams and International Baccalaureate exams "are more predictive of first-year and overall grades in college" (p. 7). Even the Educational Testing Service, who developed the SAT, maintained that "class rank and/or high school grades are still both better predictors of college performance than the SAT I" (FairTest, 2007, para. 2). Despite these statistical differences, researchers and educators agreed that any one score or number should be only one of several factors considered in determining an appropriate course of action for a student. Thus, this study examined AP scores as an objective link between middle school and college.

Educators continue to consider alternative ways to determine predictive eligibility requirements for higher-level classes. Sternberg, a Yale University psychology professor, was working on an alternative test that will more accurately predict college performance. Sternberg's Rainbow Project was not meant to replace the SAT but to augment it. In fact, the College Board (sponsor of the SAT) was collaborating on this project (Pink, 2005, p. 59). Discovering a reliable predictive measure, with further longitudinal study, would help to guide curriculum development that supports more widespread academic achievement.

American College Testing (ACT). The pursuit of predictive measures was not limited to The College Board. The ACT, Inc. and The Education Trust co-authored a study that looked at which high school courses would best prepare students for college. ACT is an independent, not-for-profit organization that developed the ACT assessment, which is a "well established predictor of success in first-year college courses" (ACT and The Education Trust, n.d., p. iv) and is the most widely required and preferred entrance exam by 4-year colleges (ACT, 2010b, para. 15). The ACT assessment is a curriculum-based national test that assesses a student's "ability to complete college-level work" (ACT, 2010a, para. 1). Rather than being an intelligence test or a measure of aptitude, the ACT, Inc. claims that the ACT questions are more directly related to the content that students have learned in high school, at least more than the SAT I but still not as directly related as the AP or international baccalaureate exams, as stated earlier. Specifically, one of the sections of the SAT I is critical reading. Critical reading is not directly linked to any particular high school courses.

Admission into a college is only part of what is necessary for ensuring successful navigation through life. Postsecondary education requires well-developed cognitive skills. Students who do not have the “strong high school curriculum” (Barth, 2003, p. 22), and thus do not pass placement tests often must take remedial courses in college before they can even enroll in college-level courses. In spite of all the attention on ACT, SAT, GPA, or class rank, “research conducted by the U.S. Department of Education shows unequivocally that the single biggest predictor of college success is the quality and intensity of a student’s high school courses” (Barth, 2003, p. 21; ACT, 2007, p. 2).

In terms of curriculum, ACT has developed a program called QualityCore, designed to “help ensure that the outcomes of high school preparatory courses are aligned with essential skills” (ACT, 2010c, para. 1). QualityCore was ACT’s response to the need for rigorous content in high school and included educator’s resources, end-of-course assessments, formative items, and an optional professional development component (ACT, 2010e). The 12 courses included English, Precalculus, Chemistry, Physics, and U.S. History. The QualityCore program was not only appropriate for college-bound students, however, but also for workplace preparation, since ACT researchers found that preparation for postsecondary education was similar to preparation for the workplace (ACT, 2006). Other researchers agreed. “This is a world in which a very high level of preparation in reading, writing, speaking, mathematics, science, literature, history, and the arts will be an indispensable foundation for everything that comes after for most members of the workforce” (NCEE, 2007, p. 6).

Early college enrollment. Another option for college-bound students is early enrollment in college. Early enrollment has disadvantages, however, in that “talented students who entered postsecondary education early were prohibited from receiving any type of high school diploma and therefore could not receive financial aid" (Plucker, Burroughs, & Song, 2010, p. 32). An empirical analysis of achievement, or excellence, gaps and the effects of educational policies led the researchers at the Center for Evaluation and Education Policy to conclude that allowing "for early college entrants would be a low-cost, low-risk, high-reward policy change" (p. 33). In other words, reducing or eliminating eligibility requirements or restrictions seems to have more advantages than disadvantages.

Toward this end, Board Examination Systems piloted a program in eight states to allow students to "enroll in college as early as the end of their sophomore year in high school" (Lense, 2010, para. 1). First proposed in a 2007 report by the National Center on Education and the Economy (NCEE), this program offered State Board Qualifying Examinations in 2010 that reflected learning from core subject courses in high school. Depending on a student's score, he or she would have had the option of moving ahead to college (NCEE, 2007, p. 11–12).

College credit courses and early enrollment continue to be viable options for many students. Restrictions imposed by the age of the student seem to be peeling away as educational systems evolve and more research is conducted. As early as middle school, and perhaps earlier, students are at different stages of readiness within their traditional age groups. This suggests that reaching the goal of meeting the individual needs of all students to prepare them for their future requires multiple delivery systems. Lifting restrictions on access to Challenge courses in the middle school, therefore, may be a reasonable, low risk extension of practices, such as early college enrollment, that serve diverse educational needs.

Middle School to High School

Diagnostic tools. Interest in extending college readiness to the middle school has taken several forms, including a diagnostic tool and some curriculum models. Educators have searched for middle school tests and curricula to serve as preparation for the challenges of high school and college. The College Board has developed programs like ReadiStep and SpringBoard, while think tanks like the Partnership for 21st Century Skills and other educators and authors identified skills and habits that students need for lifelong learning.

As a part of the continuing effort to help identify ways to prepare students for college, the College Board developed ReadiStep, a test for eighth graders that would predict future college success. In October of 2008, "Officials at the New York City-based College Board… rolled out their newest product: ReadiStep." Jones, the College Board's senior vice president of college readiness products, told reporters, "They wanted a measure of students' progress toward college earlier than the 10th grade" (Cech, 2008, para. 5). "ReadiStep is a low-stakes middle school assessment that helps teachers provide the guidance middle school students need to start preparing for high school and college," one component of "the College Readiness Pathway, an integrated assessment system that includes the PSAT/NMSQT and SAT" (College Board, 2010b). Through multiple-choice assessments aligned with reading, writing, and mathematics curricula, this tool serves to provide early feedback "while there is still time to make necessary adjustments and target academic areas that may need attention" (2010b). This and other assessment-based tools focus primarily on academic benchmarks, and do not necessarily take into account the developmental differences between middle school, high school, and college students.

ACT established College Readiness Benchmarks, like the EXPLORE test and the PLAN test, which serve to indicate levels of achievement at earlier points in the educational journey. The scores on these tests correspond to subsequent ACT scores. In the district in the study, all eighth graders take the EXPLORE test, although some districts administer the test in ninth grade. The same four sections on the ACT test are also on the EXPLORE test: English, mathematics, reading, and science. This EXPLORE test thus serves as a predictive, pre-ACT test, since it mirrors the expectations of the ACT. Results of the eighth-grade test indicate whether a student is "on target to be ready for first-year college-level work when they graduate from high school" (ACT, 2007, p. 5). For example, scoring a 13 on the English section of the eighth-grade EXPLORE test predicts a score of 18 on the English section of the ACT taken in high school.

The SAT is another test that colleges consider in enrollment decisions. Even though "scores on the SAT aren't recorded or reported to colleges before a student's ninth grade year," (McIntosh, 2006, para. 2) some middle school students are taking this test each year for practice. In addition to serving as a way for students to acclimate themselves to this college entrance test, a middle school SAT score is one criterion used to determine eligibility for some summer enrichment and talent search programs at Johns Hopkins University, Northwestern University, and Duke University. In fact, the Duke University Talent Identification Program even includes students in fourth and fifth grade.

Studies have found positive benefits to participation by elementary and middle school students in rigorous enrichment summer programs, which were separate from the regular school year. The benefits spanned social, psychological, and academic realms (Li, Alfeld, Kennedy, & Putallaz, 2009). Academic benefits, in particular, extended to curriculum issues such as achievement and course selection. This early exposure to rigor plays a role in a student's tendency to seek out and perform well in advanced courses.

However, many of the diagnostic tools available for middle school students measure content-area knowledge. Such tools do not measure emotional maturity, resiliency, or habits. These characteristics, along with the educational experiences in the middle school, may be more predictive of future success.

Curriculum. Some curriculum options for the regular school year, mostly but not exclusively for advanced learners, include early entrance to the next grade level, curriculum compacting, concurrent enrollment, single subject acceleration, whole grade acceleration, grouping, pull-out classes, mentorships, internships, and independent study (Strip & Hirsch, 2000, pp. 82–90). As explained earlier, the district of study offers curriculum compacting in language arts to the middle school gifted students. Single subject acceleration is also offered in mathematics beginning in the elementary schools to all students who demonstrate mastery of the next year's content in a test administered at the end of each school year. The district's acceleration policy allows students to skip the next grade level in mathematics. The district offers professional development in cluster grouping, differentiation and enrichment. High school students can explore individual interests and passions by taking advantage of opportunities for mentorships, internships, independent study, concurrent enrollment in high school and college, and early entrance to college.

Gardner was one of many researchers to acknowledge "individuals have quite different minds from one another" and "Education ought to be so sculpted that it remains responsive to these differences" (1993, p. 71). In an effort to be responsive to the various styles and needs in a school or classroom, ability grouping is one way that "school personnel use test scores and school records to assign same-grade children to classes or instructional groups that differ markedly in characteristics affecting school learning" (Kulik & Kulik, 1997, p. 230). This broad definition includes elementary school reading groups, special classes for the gifted students, and enrollment in regular or Challenge courses. Such grouping is generally not a matter of choice on the part of the student or parent; rather, it is based on objective data, such as grades, test scores, or even attendance. Many researchers, including Renzulli (1994), Reis, Burns, and Renzulli (1992), Colangelo, Assouline, and Gross (2004), Delisle (1992), Davidson, Davidson, and Vanderkam (2004), and Rogers (2002), have weighed in on the negative or negligible effects on high-achieving students who are not given the opportunity to learn with their intellectual peers.

Kulik, in a summary of major research on ability grouping, concluded, "it is beneficial for all levels of students" (Kulik, 1993, para. 1). Specifically, educational researchers noted, "the most dramatic impact is for academically talented students who are offered accelerated classes" (para. 1). Oakes disagreed, however, and suggested that "grouping programs are unnecessary, ineffective, and unfair" (as cited in Kulik, 1993, para. 11), but extensive research that included high ability learners has since made a compelling case for enrichment and acceleration (Colangelo, Assouline, & Gross, 2004).

Tracking was distinguished by most educational researchers from ability grouping and was usually reserved “for high school programs in which students choose either college-preparatory, general, or vocational classes” (Kulik & Kulik, 1997, p. 230). Oakes argued, “tracking is unfair to students because it denies them their right to a common curriculum” (Kulik, 1993, para. 10). If teachers and curriculum coordinators effectively adopted Bruner’s notion of a spiral curriculum, however, each level of instruction would be meaningful and appropriate (Bruner, 1977). Ideally, tracking should “reflect differences in students’ prior learning” (Loveless, 1998a, para. 3). Still, “the research on tracking and ability grouping is frequently summarized in one word: inconclusive” (Loveless, 1998b, para. 1). Effects of grouping practices can be non-academic and difficult to measure or test. More research, both qualitative and quantitative, is needed that focuses on the long-term advantages and disadvantages of ability grouping for all students.

In the context of the high school of study, course selection is the option of the student and the parent. Enrollment in AP courses, for example, is open to any interested student who accepts the responsibility. At the middle school of study, interest and motivation were not factors in the assignment of ability groups or Challenge courses. The question, therefore, does not seem to be whether to offer appropriate educational opportunities at all levels but how to determine who should participate. Eligibility for enrolling and for remaining in an advanced course is different at the middle school of study than it is at the high school of study. This researcher proposes that interest and motivation should weigh more heavily in the grouping decisions, even at the middle school level.

In terms of specific curriculum, the College Board developed programs for the middle school that were intended to equip students with what they will need in the high school AP courses. One such program, SpringBoard, is the College Board's official pre-AP program. "The foundation of SpringBoard is the College Board Standards for College Success, which set out the knowledge and critical-thinking skills" needed "to succeed in high school and in future college-level work" (College Board, 2010d, p. viii). The design of this program includes "backward mapping," which includes scaffolding and differentiated instruction. Such strategies were designed so that all students can be successful in college work, as well as other real life challenges (College Board, 2010d). The district of study adopted the Springboard program in the fall of 2009 as a component of the middle school language arts curriculum for all levels. According to the SpringBoard philosophy, early exposure to the critical thinking strategies will help students become more confident and skillful not only in college, but also "in the work place, and . . . in civic life" (College Board, 2006, vi). Thus, district officials deemed this early exposure to pre-AP skills appropriate for all students, whether they were college bound or not.

An important goal of any educational program is preparation of students for their adult lives. According to *The Partnership for 21st Century Skills*, infusing work ethic, collaborative skills, and critical thinking into the middle school curriculum was not only crucial for critical citizenry and media literacy, but also developmentally appropriate for the adolescent student. Young adolescents who are motivated and engaged are more likely to succeed in higher-level courses in high school (Kay, 2009).

The seeds of a positive attitude toward learning need to be sown before high school, when students are still eager to be challenged. In an effort to redefine educational processes that would be necessary for 21st century learners, Costa and Kallick identified what they call “Habits of Mind,” which are “dispositions or attitudes that reflect the necessary skillful behaviors that students will need to practice as they become more thoughtful in their learning and in their lives” (2010, p. 212). Some of these 16 Habits of Mind are “persisting,” “applying past knowledge to novel situations,” and “taking responsible risks.” Such Habits of Mind, if introduced early in a students’ education and practiced, contribute to learning in high school, in college, and in life. Research supported that “college readiness also means workplace readiness” (ACT, 2007, p. 5). Meanwhile, identification of these qualities in middle school students may serve to predict success in college and the workplace.

All of the gateway tests, such as PSAT, SAT, and ACT, require logic and analysis, which are necessary, but, according to Pink (2005), author of *A Whole New Mind*, not sufficient for success in the world in which our students will be competing for jobs. In light of this, too much emphasis on test scores was perceived as a potential weakness in the U.S. educational system. Pink asserted that the whole-minded aptitudes necessary for success in the 21st Century, such as design, story, empathy, and play, were not accurately measured with ACT or SAT scores. Even IQ was a small part of what accounts for “career success” (Pink, 2005; Goleman, 2004). Also not measured in these standardized tests are “global knowledge, skills, and perspectives that will be important in the 21st century,” according to Stewart (2010, p. 102). Again, success in the globalized future will depend on more than content area skills. In light of each of these considerations, a reasonable conclusion is that one number or score cannot predict a student's future educational or career success.

Indeed, academic achievement was just one component of what Renzulli would like to have seen as a systemic change in education. His vision of schools for talent development was also most appropriate for the adolescent student, who is struggling to find his or her place in the world. Renzulli's Schoolwide Enrichment Model embraced individual passions and interests so that each student would reach his or her full potential (1994). Such an educational background would serve well to prepare students for the AP courses of their choosing, as well as any other learning they pursue. As long ago as 1959, Bruner's report of the Woods Hole Conference had expressed the same sentiment: "Ideally, interest in the material to be learned is the best stimulus to learning, rather than such external goals as grades or later competitive advantage" (Bruner, 1977, p. 14). In light of these endorsements, perhaps eligibility requirements should weigh more heavily toward a student's personal interests than toward past performance in school or on achievement tests.

Readiness

With all of these options, the proverbial elephant in the room is the question of the readiness of preteen middle school students for Challenge or honors-level courses. "Every parent wants their child to be motivated and challenged" (Poremba, n.d., para. 3). However, children who are not academically prepared for the honors classes should not be pushed into the advanced classes. According to DeBroff (2005), nationally acclaimed parenting expert and founder of MomCentralConsulting.com, "children who are pushed too hard and too soon often fall short, and they inevitably feel crushed when they do

(p. 103). There was a tension in the research between allowing preteens to enjoy the benefits of a healthy childhood and preparing them for their adulthood. Self-concept and school achievement are undeniably linked, and “attitude affects performance” (Delisle, 1992, p. 49). A delicate balance is necessary in order to avoid problems associated with stress and low self-esteem. Despite the tension, Bruner may have been correct when he wrote, “there need be no conflict between fostering intellectual power and cultivating emotional maturity” (1977, p. x).

Developing this intellectual power is indeed dependent upon one’s view of intelligence. More and more research has come to support the incremental view of intelligence or talent, as identified by psychologist Dweck in the 1990’s. Dweck’s two theories of intelligence are entity theory and incremental theory. The entity theory suggests that intelligence is unchangeable; the incremental theorists believe that intelligence is malleable (Dweck, 2007). Incremental theorists are considered to be in a “growth mindset” and “people in a growth mindset don’t just *seek* challenge, they thrive on it” (Dweck, 2006, p. 21). On the other hand, Dweck demonstrated “irrefutably that people who believe in inborn intelligence and talents are less intellectually adventurous and less successful in school” (Shenk, 2010, p. 80). If some middle school students are restricted from enrolling in Challenge courses, they may come to believe in the entity theory of intelligence and dismiss future opportunities to take difficult courses.

Amid the debate between genetics and environment, in an effort to shed light on how talent develops, Bloom led a study of 120 outstanding individuals, which

> provided strong evidence that no matter what the initial characteristics (or gifts) of the individuals, unless there is a long and intensive process of encouragement, nurturance, education, and training, the individuals will not attain extreme levels of capability in these particular fields. (Bloom, 1985, p. 3)

Bloom's study was a retrospective study because it was, and still is, not possible to predict which 10-year-olds would become eminent in their fields. The fact that this difficulty persists today supports the philosophy that the opportunity to be exposed to this "encouragement, nurturance, education, and training" should be accessible to all students. Shenk (2010) agreed that one's dynamic interaction with the environment determined relative greatness. Studies (e.g., Bloom, 1985; Jensen, 1998; Shenk, 2010; Simonton, 1997; Wolfe, 2001) supported that the effect of enriched environments on learning can eclipse the effect of genetics.

This is not a new idea. Even in the early 20th century, when Terman conducted a longitudinal study following children identified with above average IQs through adulthood, he eventually found that family background mattered more than intelligence as measured in childhood (as cited in Gladwell, 2008, p. 111). Included in the final publication of Terman's research was one of his doctoral students' retrospective study of eminent adults. It was hoped that this retrospective study would complement Terman's longitudinal study to show that early measurements could predict later achievement. In fact, neither study supported this proposition. "Many of the 301 geniuses in her sample would not have qualified for inclusion in Terman's longitudinal study" (Simonton, 1997, pp. 335–336). The conclusion here is that early measures of intelligence do not yet seem to accurately predict eminence or greatness in adulthood.

With the preponderance of experts and researchers suggesting that multiple environmental factors play roles in a person's brain development and eventual achievements, educators should be hesitant to limit opportunities according to test scores or grades in the early years. What happens early in the human brain "is essential to laying the foundations for later learning" (Jensen, p. 32), so it is reasonable to wonder, "Can we really afford to rob all of the 'nongifted' students of their biological destiny to grow an enriched brain?" (p. 32).

In the community where this study took place, participation in AP courses is encouraged and admired in itself. In fact, the name of each student who achieved a 3, 4, or 5 on any AP exam is posted on a "wall of fame" in the high school. In addition to the positive perception attached to participation in AP classes, teachers, principals, and district administrators who admire and encourage risk-taking and the attempt to stretch oneself beyond the comfort zone recognize other benefits. According to the founders of the Davidson Institute for Talent Development, "a nation that truly values achievement would do everything in its power to identify bright students . . . and provide them with academic work that stretches their minds" (Davidson et al., 2004, p. 49). Renzulli, education professor and director of the Neag Center for Gifted Education and Talent Development at the University of Connecticut, also recognized the connection between student engagement and student achievement. "True engagement comes from learning activities that challenge young people to stretch above their current comfort level" (Renzulli, 2008, p. 31). In light of this, encouraging more students to enroll in AP courses would be appropriate, and restricting access would be a disservice. Research supported that the challenge and the exposure to rigor were more important than the final grade or exam score. Wise educational leaders realize and pass on to their students that “the point of life is not to reach perfection but to befriend the fact that human beings are works in progress” (Lesser, 2004, p. 295).

At the same time, educators need to provide the most appropriately challenging learning experiences to each child. According to VanTassel-Baska, a specialist in curriculum for high ability learners, “we are in a position to enrich curriculum experiences for all learners and focus ever more clearly on the needs of top students who can reach those standards earlier and through differential pathways” (1994, p. 35). Siegle, who served as the president of the National Association for Gifted Children from 2007–2009, wrote the Gifted Children’s Bill of Rights, which included the right to “learn something new every day” (2007, p. 3). This, however, was a natural extension of the Children’s Bill of Rights, which was drafted and ratified in 1996 by 650 children from seven countries. In this document, the right to education included an education that develops each student’s “personality, talents, and mental and physical abilities to the fullest extent” (Children’s Bill of Rights, 1996). Even the Universal Declaration of Human Rights, adopted by the United Nations (1948) after World War II, addressed education as a universal and fundamental right of all. Education that meets the individual needs of each student serves everyone in the pursuit of peace, justice, and security.

Therefore, it is vital, though sometimes difficult, to determine and provide the most appropriate level of education for each student. Even high-achieving students may struggle in advanced courses, and how they handle this may affect the rest of their academic career. “Children should be challenged intellectually, but the challenge should be constructive, not debilitating” (Elkind, 1988, p. 36). The preadolescent years are vital in setting the stage for emotional stability and life-long habits. The earlier a person develops positive habits, the more automatic those habits will become. According to Covey (1998), habits can either “make us or break us,” and the paradigms that determine how we react to setbacks are established early in life. Through her work with underachieving students, Rimm has developed Laws of Achievement, number 6 of which is, “Children develop self-confidence through struggle” (1995, p. 390). Developing persistence in the face of adversity is an important life skill. In middle school, the time for many developmental and emotional changes, these factors may overshadow academic concerns. “Whether or not honors classes in middle school prepare students for high school honors classes is questionable” (Poremba, n.d., para. 13). This study will add to the body of knowledge in this area.

The key to the effectiveness of the earlier years in school is the “teaching and learning of structure,” (1977, p. 12) as Bruner called it, in a way that is appropriate to the child’s present and next stage of development and readiness. “Experience has shown that it is worth the effort to provide the growing child with problems that tempt him into the next stages of development” (p. 39). If students are exposed to the foundational ideas in a subject area early, this “has the effect of making later learning easier” (p. 47). This led to the development of Bruner’s spiral curriculum, which required strategic scaffolding that facilitated transfer and optimally resulted in students learning how to learn (1977). ”Young children need to learn how to learn and to think” (Hirsch-Pasek & Golinkoff, 2003, p. 148). In order for such a spiral curriculum to be effective, vertical articulation through the grade levels must happen so that complex learning builds on earlier learning. The implications are clear for curriculum coordinators, charged with writing curriculum for different levels of middle school courses that may lead to AP courses in high school.

Some may dispute justification for Challenge courses, or honors courses, in middle school, but high-achieving and gifted students who are not sufficiently challenged early in their academic career may join the ranks of the underachievers. “As the National Association for Gifted Children points out, ‘…Many researchers consider the gifted as the largest group of underachievers in education’” (Davidson et al., 2004, p. 49). Studies found that “between 10 and 20 percent of high school dropouts are in the superior range of abilities” (Rimm, 1995, p. 3). These students, who spend years effortlessly earning good grades in school, may “hit the academic wall” as this researcher called it (Glaude-Bolte, 2008). In an article about why bright kids get bad grades, Steinberg wrote that, “When the work becomes more difficult, children who have come to expect a string of successes may fall apart” (1992, para. 26).

In presentations to parents and teachers of gifted students at district, state, and national conferences this researcher, an experienced educator of gifted students, recommended that children be taught how to overcome low-risk challenges (walls) in elementary school and middle school so that they will have learned how to respond to difficulties by the time they reach high school (Glaude-Bolte, 2008). Ideally, a student would be presented with such a challenge early enough in his or her academic career so that he could develop strategies that apply to more difficult challenges that come with more risk. An example of this would be taking the Challenge-level courses in the middle school instead of the regular courses. The risk involved with trying a higher-level course is lower in middle school than in high school. Middle school grades do not figure into the high school GPA which is factored into college admissions, and the middle school courses do not serve as strict prerequisites for high school courses, at least not in the district of study.

Betsy McCoach, assistant professor at the University of Connecticut's Neag School of Education, asserted that if schools do not challenge high achievers early, they "turn off when they hit challenges in middle or high school" (as cited in Cleaver, 2008, para. 11). Preferable, too, was the earlier development of effective study habits, especially for high-achieving students for whom school may not have been difficult, so far. The Jack Kent Cooke Foundation study concluded that challenging high achievers "from the start and teaching them good habits gets them through eighth grade and beyond" (as cited in Cleaver, 2008, para. 14). After the success of his father's book, *The Seven Habits of Highly Effective People*, Covey explained to teenagers that these same seven habits were important to develop and practice at an early age. "The paths you choose today can shape you forever," (Covey, 1998, p. 76) he wrote, to try to persuade middle school students and teenagers that their habits and choices have a powerful influence on the future. The *Middle School Course Description Guide* echoed this attention to habits by including that success in the Challenge science course "requires attention to work and study habits" (Rockwood School District, 2008a, p. 8).

Again, preparing students for future educational coursework or predicting future accomplishments may depend on factors that curriculum-based tests do not measure. According to Tannenbaum, outstanding production or performance requires five factors: intelligence, aptitude, supportive traits, a nurturing environment, and some element of chance (as cited in Cohen & Frydenberg, 1996, pp. 46–48). Some of these indicators of future performance are generally difficult to test or identify, particularly the supportive traits, which include energy, motivation, and task-commitment. However, Mischel's Marshmallow Test has proven to be a "powerful predictor" of SAT scores by establishing a child's ability to delay gratification, control impulses, and persevere (Goleman, 1995, pp. 80–82). This one-on-one session asks children to choose between one marshmallow now and two marshmallows later. Children who are willing to wait for twice the reward demonstrate the propensity for perseverance that will serve them in challenging educational settings. Thus, affective and environmental factors may contribute to achievement at least as much as intellectual factors to a student's achievement in AP courses, college, and life.

Summary

A common goal of educators and researchers is to provide students access to advanced-level courses to prepare for college. Research has demonstrated that exposing high school students to the content and work that colleges expect does contribute to better grades in college and persistence to graduation. The skills attained also benefit those entering the 21st century workforce (ACT, 2006). Encouraging students to attempt the more difficult courses in high school, therefore, continues to be a practice that is in everyone's best interest, including the student, the college, and the future employer.

One condition of this that may be appropriate, however, is that educational decisions should, at least in part, be based on the particular interests and talents of the student. In the early years of education, it is important to discover and nurture the interests and talents of students so that they do not drop out, physically or psychologically. In terms of AP courses, then, the quality should be more of a consideration than quantity. In other words, a student should especially be encouraged to take AP courses in areas of interest, rather than simply for the sake of taking an AP course.

Open eligibility for AP courses historically stemmed from the belief that all students should have access to the same opportunities for success in college and the workplace. Despite concerns that that exam scores would decrease as more students enrolled in AP courses, the official policy of the College Board and of many schools was to allow any interested student to enroll. In the high school of study, as well as in the nation, the concerns were unwarranted. In fact, as the number of students taking the AP exams increased, so did the exam category scores (D. Menke, personal communication, July 13, 2010). During the formative middle school years, adopting such a policy for the Challenge program, which allows interested students to enroll in rigorous courses despite previous grades or test scores, may lead to positive attitudes and motivation that profoundly affect future success. More longitudinal studies involving districts that have open eligibility for middle school Challenge courses would shed some light on this issue.

Global competition and other economic forces have been putting more and more pressure on students to excel in postsecondary education and training. Job security and income depend on mastering 21st century skills. Parents and students who want a competitive edge have started earlier and earlier to build a solid enough educational foundation. There is a definite trend toward multiple opportunities to master these skills. Programs like ACT, SAT, and even the Board Examination System permit students to attempt the tests multiple times. For SAT and ACT, some colleges and universities use super scoring, which is a method of combining the best of the subsection scores to create a larger composite score. Only the National Merit Scholarship Corporation considers a single test score, the PSAT taken in October of the third year in high school, for their scholarship program, although many students take advantage of the opportunity to take this test in previous years, for practice.

More research is needed, however, that examines the role of middle school courses in the preparation for college and workplace challenges. Middle school students are literally in the middle, between childhood and adulthood, developmentally and emotionally. Thus, any effective educational policy should balance a number of developmental, emotional, academic and social issues when considering how best to prepare students for their future.

All students develop skills and interests at different ages, and researchers have yet to develop a reliable instrument for predicting adult achievement. Until they do, with so many factors at play, restricting initial access to advanced courses as early as middle school may not be advisable. The open access policy that is in place at the high school of study does not seem to hinder progress toward the educational goals of the district and the nation. Eligibility based on interest is consistent with the latest research about the development and malleability of the brain, as well as research about the effects of motivation and mindset on performance.

Chapter 3: Methodology

Eligible middle school students in the district of study were encouraged to enroll in Challenge courses, which were purported to prepare them for rigorous AP courses in high school. In order to determine the strength of the relationship between Challenge course enrollment and AP exam category scores, the researcher conducted a correlational study with secondary data: AP exam category scores and middle school Challenge course enrollment. The researcher collected and analyzed category score data for 14 different AP courses in two different subject areas, science and social studies, then recorded the number of years each represented student took Challenge courses in the corresponding subject area. The strength of the relationship between these two variables was statistically analyzed and evaluated. This chapter includes the overview of the study, the procedures followed, the methodology framework, and a description of the sample population. The final section of this chapter is an analysis of the procedure.

Overview

In this quantitative study, the researcher utilized secondary data. For each of the 14 AP courses included in this study, the researcher calculated the Pearson product moment correlation coefficient (PPMC) to determine the relationship between the two variables: The number of years of middle school enrollment in Challenge courses (independent variable) and the corresponding AP exam category score (dependent variable). Correlational research was chosen for this study “to determine relationships among two or more variables” (Fraenkel & Wallen, 2009, p. 11). The researcher sought to determine if there was a relationship between enrollment in Challenge classes and subsequent AP exam category scores achieved in the same academic content area. To establish the extent to which Challenge course enrollment was a factor in explaining each subsequent AP exam category score, the researcher calculated the coefficient of determination.

The purpose of the study was to analyze the effectiveness of the middle school Challenge courses as part of the preparation for the rigor of college-level courses, specifically AP courses. There are multiple factors that contribute to a student's enrollment and success in an AP course and subsequent success on the exam. One of these factors, previous educational experiences, specifically the enrollment in Challenge courses at the middle school level, was the focus of the study.

An important issue underlying this study was the fact that enrollment in Challenge courses at the middle school in this study was limited to students who had certain GPAs and who achieved certain scores on subject area achievement tests. On the other hand, enrollment in AP courses at the high school in this study was open to all, as long as the students acknowledged and accepted in writing that college-level work would be required. Since research has consistently shown a correlation between enrollment in AP courses and college performance, equity practices demand that adequate preparation for these AP courses should be accessible to all students. The results of this study will add to the body of knowledge about how best to adequately prepare students for high school, college and the workplace.

The overarching research question was "Is there a relationship between the number of years of enrollment in subject area Challenge courses in middle school and the subsequent AP exam category score in the same subject area?" The subject areas examined in this study were social studies and science. Within social studies, the AP courses considered were U.S. Government, Comparative Government, European History, World History, U.S. History, Psychology, Microeconomics, and Macroeconomics. The science AP courses considered were Biology, Chemistry, Environmental Science, Physics-B, Physics-C-Mechanics, and Physics C-Electricity and Magnetism. See Table 4 for the AP courses offered at the high school of study.

Table 4

Social Studies and Science AP Courses Offered at RSHS 2009

Social studies	Science
Comparative Government	Biology
U.S. Government	Chemistry
World History	Environmental Science
European History	Physics B
U.S. History	Physics C-Mechanics
Psychology	Physics C- Electricity & Magnetism
Microeconomics	
Macroeconomics	

Procedure

Data Collection. The study began in December 2009. By accessing district records, the researcher collected the May 2009 social studies and science AP exam category scores for students at the study high school. The AP exam category scores were the dependent variables, represented as *y*, and ranged from 1 to 5. These values were recorded on an Excel document. For each examinee, the researcher obtained the middle school transcripts and recorded the number of years he or she was enrolled in Challenge social studies or science. These data were recorded on the same Excel document. The number of years enrolled in Challenge courses was the independent variable, represented as x. The range for this value was zero through 3. Each student was assigned a unique code consisting of a number and two letters.

For each of the complete data sets for the eight social studies AP exams and the six science AP exams, a table was created showing (a) the student code, (b) years of enrollment in the Challenge course or x, (c) AP exam category score or y, (d) xy, (e) x^2, and (f) y^2. Then the researcher calculated the sum of each of the columns ($\sum x$, $\sum y$, $\sum xy$, $\sum x^2$, and $\sum y^2$). See Table 5 for the layout of the data collection sheets, using U.S. Government as an example.

Table 5

Data Collection Sheet Layout

AP U.S. Government

Student code	Years in challenge social studies (x)	AP exam score (y)	xy	x^2	y^2
	$\sum x$	$\sum y$	$\sum xy$	$\sum x^2$	$\sum y^2$

Note. x = years in challenge courses and y = AP exam category score.

See Appendix C, Tables 6 - 13 for the complete raw data tables for each of the eight AP social studies exams and Appendix C, Tables 14–19 for each of the six science exams considered in this study.

Data Analysis. In order to calculate the PPMC, the researcher inserted the values of n, x^2, y^2, xy, $\sum x$, $\sum y$, $\sum x^2$, $\sum y^2$, and $\sum xy$ for each of the AP exam courses into the formula for the correlation coefficient r and determined the value of r (PPMC) for each course. See Appendix A for the formula for the correlation coefficient r. For the purpose of this study, each AP exam score was treated separately. In other words, even if the same student took two or more AP exams, the data for each was treated as a different student (data pair).

The researcher calculated a value for the coefficient r for each of the courses. This correlation coefficient "measures the strength and direction of a linear relationship between two variables" (Bluman, 2008, p. 525). The possible values of r range from -1 to +1, where -1 indicates a "strong negative linear relationship," where +1 indicates a "strong positive linear relationship," and where zero indicates "no linear relationship" (Bluman, p. 525).

In order to test whether or not the r values indicate significant linear relationships, the researcher used the t test as the hypothesis-testing procedure, calculating the value of t using the formula for the t test for the significance of the correlation coefficient, as found in Appendix A.

Then, for each AP course, the researcher determined the critical values based on a confidence interval of 95%, with a standard deviation of 0.05. The critical values were found on the standard *t*-distribution table (Bluman, 2008, p. 635). This was a two-tailed test, since the null hypothesis was that there would be no significant linear relationship between the number of years of enrollment in Challenge and the subsequent AP exam category score in the same content area ($r = 0$). Only a strong positive or negative linear relationship would justify rejecting the null hypothesis.

The researcher compared the critical values to the value of *t* for each AP course that had a large enough sample size for a definable *r* value. If the *t* value fell in the critical region, then the null hypothesis was rejected because there was evidence of a significant relationship between the variables. In the cases when the *t* value did not fall in the critical region, the researcher concluded that there was not enough evidence to reject the null hypothesis because there was not enough evidence to say that there was a significant linear relationship between the variables. Then the researcher calculated the PPMC for the sample of social studies AP exam average category scores compared to the average number of years of enrollment in middle school Challenge courses. Using the correlation coefficients, the researcher calculated the coefficient of determination (r^2) for each of the AP exams that yielded a definable *r* value, as well as for the samples of social studies and science AP exam average category scores. The resulting percentages represented how much of the variability in AP exam category scores in high school can be attributed to the number of years of enrollment in Challenge courses in middle school.

The researcher then took a randomized sample consisting of 45 of the data sets for the social studies AP exams and determined the value of *r* (PPMC) using the formula for the correlation coefficient *r* in Appendix A. For the science AP exams, a randomized sample of 30 of the data sets was analyzed with the same formula. The purpose of these calculations was to establish whether there was a relationship between the level of enrollment in Challenge courses in the middle school and the subsequent AP exam category scores in the areas of social studies or science as a whole. Randomizing these samples provided a more reliable representation of the data and its implications beyond the study year.

Statistical Methodology Framework

This study involved two variables, the number of years of enrollment in a Challenge course and the AP exam category score. The purpose of the study was to determine correlation, which is “a statistical method used to determine whether a relationship between variables exist” (Bluman, 2008, pp. 522–523). Since there were only two variables in this study, the type of relationship was a simple relationship. Although the study was not meant to establish predictability, determination, r^2, served to illustrate the strength of the linear relationship between the two variables by determining how much of the variability in the subsequent AP exam category scores could be attributed to the number of years of enrollment in middle school Challenge courses in the district of study.

Sample Population

The researcher used historical data from student permanent records in the form of AP exam category scores and the number of years of enrollment in middle school Challenge courses for each of those students who took an AP exam in social studies or science in May 2009 in the district of study. Of the students who took these AP exams, only those students who attended the middle school of study for sixth, seventh, and eighth grade were included. Since students who attended any other middle school for any part of their middle school experience represented incomplete data sets, they were not included in this correlational study.

This study included AP exam category scores from one high school and enrollment data from the middle school that fed into this high school. The results specifically apply to these schools but may be representative of other similar programs. Much research has been completed as to how schools might best prepare students for rigorous courses in high school, college, and the workplace. Some of this research has led to curriculum programs that offer opportunities to effectively prepare students for the next level of education.

However, specific research that considered the relationship between the length of middle school Challenge course enrollment and subsequent AP exam category scores was sparse, at best. This study will add to the body of knowledge because it will be one of the first to determine and analyze if a relationship exists between enrollment in a middle school course and subsequent achievement on an AP course in high school.

Enrollment numbers vary greatly among the AP courses. In the high school of 1,400 students, there are seven periods per day in a modified-block schedule, which means that some courses are scheduled for 45 minutes daily and other courses are scheduled for 90 minutes every other day. Several factors contribute to enrollment numbers, including scheduling conflicts, college requirements, personal interests, and teacher recommendations. Since students are responsible for the cost of the AP exams, financial considerations may also have led to a reduction in the number of exams taken, and thus the number of data sets. The number of complete data sets for each AP social studies exam considered in this study is shown in Table 20 (social studies) and Table 21 (science).

Table 20

Social Studies Sample Sizes

AP exam	*N*
U.S. Government	66
European History	59
Comparative Government	51
Psychology	42
World History	16
Macroeconomics	12
Microeconomics	8
U.S. History	4

Table 21

Science Sample Sizes

AP exam	*N*
Chemistry	22
Biology	13
Environmental Science	12
Physics C- Mechanics	4
Physics C- Electricity and Magnetism	4
Physics B	3

These samples of data consisted of AP exam category scores, which is the dependent variable in this study. Students in an AP course may choose to take or not to take the exam upon completion of the course. The researcher, therefore, began with the enrollment numbers in each of the social studies and science AP courses. The number of students who chose not to take the exam and the number of students who did not attend the study middle school were subtracted from the enrollment numbers, resulting in the number of complete data sets included in this study. The social studies enrollment and test information is shown in Table 22.

Table 22

Class Enrollment Compared to AP Social Studies Exams

Subject	Enrollment*	No test	Tested	Incomplete data sets	This study sample
Comp Gov	89	22	67	16	51
U.S. Gov	89	4	85	19	66
World	23	2	21	5	16
European	66	0	66	7	59
U.S. History	7	1	6	2	4
Psychology	60	9	51	9	42
Microecon	15	2	13	5	8
Macroecon	18	1	17	5	12
Totals	367	41	326	68	258

*At time of AP exam

The number of complete data sets reflected the number of students who took a social studies or science AP exam and *also* attended the middle school of study for 3 years. At the high school of study, 617 AP exams were completed in May of 2009, including 326 in social studies. At the time of the exam, 367 students were enrolled in an AP social studies course, but 41 students chose not to take the exam. Of these 326 exams taken, 68 (21%) of the exams were completed by students who did not attend middle school in the same district, and therefore represented incomplete data sets. Thus, as Table 22 shows, the remaining 258 AP social studies exams (79%) were included in this study.

Table 23

Class Enrollment Compared to AP Science Exams

Subject	Enrollment*	No test	Tested	Incomplete data sets	This study sample
Biology	15	0	15	2	13
Chemistry	27	3	24	2	22
Environmental	13	0	13	1	12
Physics B	6	1	5	2	3
Physics C-M	4	0	4	0	4
Physics C-EM	4	0	4	0	4
Totals	69	4	65	7	58

*At time of AP exam

Meanwhile, at the time of the exams, 69 students were enrolled in AP science courses. Since four decided not to take the exam, 65 AP science exams were completed. Of these 65, seven (11%) of the exams were completed by students who did not attend middle school in this district, representing incomplete data sets. The remaining 58 (89%) AP science exams were included in this study. Tables 23 shows, for each of the AP science exams, the enrollment at the time of the AP exam, the number of students who did not take the AP exam, the number of incomplete data sets, and the resulting sample size.

The researcher wondered whether the AP exam category scores of those who attended the middle school of study differed significantly from the scores of those who attended other middle schools. Since the number of incomplete data sets was greater in social studies (68) than in science (7), the researcher conducted a secondary statistical analysis of the difference between the two groups of social studies AP exam category scores.

If the students who attended the district middle school earned significantly higher scores than the students who did not attend the district middle school, regardless of Challenge course enrollment, then the middle school itself may have correlated to the AP exam category scores more than the specific level of courses correlated to the exam scores. However, if the reverse were true, then the district middle school's social studies curriculum may need to be scrutinized

The mean AP category score was calculated for each of the exams in each of these two sets. See Table 24. The variance of the means for those who attended the study middle school was compared with the variance of the means for those who did not attend the study middle school. The researcher performed the *F* test to determine whether the variances were equal, and then performed the *t* Test for the difference in means on the two samples. See Appendix A for these two formulas. In each of these tests, the researcher used the confidence level of 95%.

Table 24

Comparison of Means of Exam Scores-Social Studies

Exam	Middle school in study site	Middle school elsewhere	Difference
Comp Gov	3.1	2.8	0.3
U.S. Government	3.4	3.5	-0.1
World History	3.7	4.4	-0.7
European History	3.6	3.2	0.4
U.S. History	4.3	2.5	1.8
Psychology	4.3	4.1	0.2
Microeconomics	3.9	3.8	0.1
Macroeconomics	3.0	3.8	-0.8

Further Data Analysis

The researcher computed the gender distribution for participants in each of the AP exams to determine if the study sample reflected national trends and patterns illustrated in the research. For the social studies exams, Tables 25 shows the gender distributions at the high school of study compared with the gender distributions nationally. The distribution in the World History study sample was the same as that of the nation. The distributions in the U.S. Government and U.S. History courses differed by less than 10%. Some notable differences between the study sample and the U.S. were in the areas of Microeconomics and Macroeconomics. In these two courses, the male to female proportion nationwide was approximately half and half, but the males outnumbered the females by more than seven to one in this high school.

Table 25

Comparative Social Studies Gender Distributions

	Study High School		U.S.	
Subject	% Male	% Female	% Male	% Female
Comp Gov	41	59	52	48
U.S. Government	42	58	46	54
World History	44	56	44	56
European History	37	63	46	54
U.S. History	50	50	45	55
Psychology	24	76	35	65
Microeconomics	87.5	12.5	55	45
Macroeconomics	92	8	53	47

The science gender distributions at the study high school were more similar to the national distributions. In fact, Environmental Science and the Physics courses in the study sample showed percentages that were within 1 or 2 percentage points of the national percentages. However, Chemistry and Biology courses contained a higher ratio of female students in the high school of study than in the nation by 10%. For example, 59% of the

Biology examinees were female in the U.S., while 69% of the examinees at the high school of study were female. See Table 26 for the science distributions.

Table 26

Comparative Science Gender Distributions

	Study High School		U.S.	
Subject	% Male	% Female	% Male	% Female
Biology	31	69	41	59
Chemistry	41	59	52	48
Environmental	42	58	43	57
Physics B	67	33	65	35
Physics C-Mech	75	25	73	27
Physics C-E&M	75	25	76	24

The sample sizes and corresponding *r* values were also graphed to determine if there was an observable relationship between sample size and the strength of the correlation. Such a positive relationship would be such that "as the values for the *x* variable increase, the values for the *y* variable are increasing" (Bluman, 208. p. 87). If higher correlation coefficients corresponded to larger sample sizes, then the very small sample sizes may have compromised the validity of this study.

In addition, the researcher charted the AP exam qualifying rates according to the number of years enrolled in Challenge courses. The qualifying rate was the percentage of qualifying exam category scores in a certain group, such as the percentage of qualifying scores achieved by those students who attended 3 years of Challenge courses or the percentage of qualifying scores earned by those students who attended zero years of Challenge courses at the study middle school. For the purposes of this study and consistent with the College Board policy, qualifying scores on AP exams are 3, 4, or 5. These scores represent a student's readiness to continue college-level study in the subject area beyond the introductory level, thus qualifying the student for further study. Thus, the College Board "uses an AP Exam score of 3 or higher as the definition of success" (College Board, 2009a, p. 3). The College Board recommends that students who achieve a category score of 1 or 2 on an AP exam should consider repeating the introductory level college course before advancing to sophomore or junior level college courses. This analysis of qualifying rates was meant to determine whether the sample population of students enrolled in 3 years of middle school Challenge courses was the same as the population of students who were achieving the most successful category scores on AP course exams.

If students achieved qualifying scores on AP exams without having enrolled in Challenge courses, then the legitimacy of limiting eligibility to enroll in a middle school Challenge course might come into question. Likewise, if students who were enrolled in 3 years of Challenge courses did not receive qualifying scores on AP exams, then the validity of the district's claims that Challenge courses contribute to preparation of students for the rigor of AP courses deserves scrutiny.

Analysis of Procedure

The relatively few studies found in the literature that sought to determine correlational links between middle school and high school considered factors such as GPA, statewide assessments, achievement test scores, and scores on gateway tests, such as EXPLORE, PSAT, or ACT. Thus, these studies focused on snapshots of a student's educational experience. Preparatory sessions could affect a student's performance on some of these gateway tests. Many considered GPA to be a subjective measure, in some cases artificially inflated. Even statewide assessments were perceived by some to be inconsistent, and not representative of a student's ability to be successful in college.

This study examined the middle school experience in a more comprehensive way, by considering the effect of enrollment in a certain Challenge course throughout the years. The possible benefits of a Challenge curriculum would result from the cumulative exposure to high-level discussions and rigorous, meaningful project work. By looking at AP exam category scores, which are nationally normed each year, this study measured the effect of the middle school experience in terms that colleges and employers understand on a national level.

The conclusions set forth in this quantitative study, however, should not lead anyone to make sweeping changes without further study. Differences in student readiness, teacher training, or instructional delivery may explain any lack of evidence of relationship between the enrollment in Challenge courses and the AP exam category score.

On the other hand, if the researcher found that there was enough evidence to support a statistically significant positive linear relationship between these variables; this would not imply that there was a causal relationship. In this study, where enrollment in the Challenge courses was limited, the population of students taking Challenge courses may have already represented those who would have been successful in AP courses. In fact, a lack of correlation may even suggest that the enrollment in Challenge courses should be open to any student.

Chapter 4: Results

Overview

The researcher sought to determine if there was a relationship between the number of years of enrollment in middle school Challenge social studies and science courses and the subsequent AP exam category scores achieved in the corresponding subject areas. The hypothesis was that there would be a positive linear relationship between these two variables, which, if supported, would indicate that more years of enrollment in Challenge courses contributed to higher AP exam category scores. Though this was not a causal study, a positive linear relationship would suggest that Challenge courses in the middle school may have played a part in preparing students for the rigor of AP exams. The null hypothesis was that there would be no relationship between the number of years of enrollment in Challenge courses and subsequent AP exam category scores.

This particular study focused on one middle school and one high school in a suburban, St. Louis county school district. The middle school fed almost exclusively into the high school, with the exception of those students who attended area private schools or those students who moved to or from another district. These students, whose middle school transcripts were not available to the researcher, were not included in the correlational study and represented incomplete data sets.

The independent variable was the number of years of enrollment in the middle school Challenge course in either social studies or science. The dependent variable was the category score on an AP exam in a corresponding subject area following enrollment in the AP course in high school. In the 2008–2009 school year, the high school in this study offered 8 AP courses in social studies and 6 AP courses in science. Thus, this correlational study encompassed 14 AP exams, in total.

For each individual AP exam, the researcher tested the following null hypothesis:

There was no relationship between the number of years of enrollment in middle school Challenge courses at the study district and the subsequent AP exam category score in the corresponding subject area.

Samples

As explained in chapter 3, because not all students in the AP courses chose to take the exams and some had not attended the study middle school, the sample sizes were smaller than the enrollment numbers. Consequently, 70% of the total enrolled in social studies AP courses and 84% of the total enrolled in science AP courses were included in this study.

Table 27

Enrollment to Sample Totals

Subject area	Enrollment*	No test	Tested	Incomplete data sets	This study
Social studies	367	41	326	68	258
Science	69	4	65	7	58
Totals	436	45	391	75	316

Note: * indicates enrollment at the time of the AP exam.

Although the science courses experienced lower enrollment numbers, the percentage of enrolled students who ultimately took the AP exam (94%) was greater in science AP courses than in social studies AP courses (89%). Thus, the students who enrolled in science AP courses may have had more focused motivations to pursue the full benefits of the AP courses. See Table 27 for the comparison of enrollment totals with study samples.

Students chose not to take the AP exams for a variety of reasons. The choice of college and the choice of college major are two of the reasons. Not every college and university confers credit, even for AP category exam scores of 3, 4, or 5. Some degree programs will not accept college credit for courses in a student's major area of study. Cost is another issue. While the cost of one test is relatively nominal, this cost adds up for a student taking multiple AP courses. Stress is also a factor. The AP exams and final exams are administered in the same month, and many students have the option of opting out of certain final exams if they earned an A in the course. Students make choices about which courses require more attention.

High school credit requirements and college major requirements may play a role in the difference between enrollment numbers and AP exams completed. A general social studies course, like government, is a basic requirement for many major areas of study in college. In addition, AP Government courses are available to sophomores, who may or may not have chosen a particular field of study. College-bound students, therefore, may recognize and appreciate the benefits of exposure to this subject, even if they do not take the exam. In the high school of study, the only other course option is a regular social studies course, which may be much less rigorous and challenging.

On the other hand, the AP science courses are more specialized and specific. The content of these science courses, such as chemistry or physics, would not be as widely required in many major programs. Therefore, the students who enroll in these AP courses are more likely to be invested in these areas of study. These courses are offered to juniors and seniors, too. All of these factors may serve to explain why 84% of those enrolled in the science AP courses took the exam while only 70% of those enrolled in the social studies AP courses took the exam.

These and other factors affected sample sizes. Of the eight social studies AP courses, the number of students who took the AP exam in AP U.S. History was four, which was too small of a sample to determine correlation. Three of the science AP courses, Physics B, Physics C-Mechanics, and Physics C-Electricity and Magnetism, also had sample sizes too small to be statistically relevant. See Appendix C for the charts with the raw data for each of the 14 AP exams. In light of these small sample sizes, the researcher probed further into the nature of the data. Specifically, the researcher compared the AP scores of those who did not attend the district middle school with those who did. The researcher also calculated the gender distributions in each of the 14 subject areas considered in this study and compared these distributions with the national data.

The researcher statistically analyzed and compared the 68 scores of those students who did not attend the middle school of study with the scores from the social studies study samples to determine if the exclusion of the incomplete data sets might have skewed the results. Since only a very small sample of seven science AP students represented incomplete data sets, this secondary analysis was not performed for the science AP exams. The means of the scores for each social studies subject area was calculated, along with the difference between the two means for each subject, as shown in Table 24.

Table 24

Comparison of Means of Exam Scores-Social Studies

Exam	Middle school in study site	Middle school elsewhere	Difference
Comp Gov	3.1	2.8	0.3
U.S. Government	3.4	3.5	-0.1
World History	3.7	4.4	-0.7
European History	3.6	3.2	0.4
U.S. History	4.3	2.5	1.8
Psychology	4.3	4.1	0.2
Microeconomics	3.9	3.8	0.1
Macroeconomics	3.0	3.8	-0.8

Generally, the scores of those who did not attend the middle school of study demonstrated ranges and means similar to those of the included scores, indicating that excluding the incomplete data sets did not significantly alter the results of this study. For example, the average AP exam score for U.S. Government and Microeconomics in the study is only 0.1 different between the study group and the incomplete data set group. The largest difference between a study group and an incomplete data set group is in the category of U.S. History at 1.8. In the case of social studies, the average for the study group was higher in five subject areas and lower in three subject areas. Even though the number of incomplete data sets in science was very low, totaling seven, the observable distribution was comparable to those included in the study.

The researcher also examined the gender distribution of the AP test-takers in this study and compared this to the nationwide gender distribution of AP test-takers (College Board, 2009a). See Tables 25 and 26 for the comparative gender distributions in social studies and science.

Table 25

Comparative Social Studies Gender Distributions

	Study High School		U.S.	
Subject	% Male	% Female	% Male	% Female
Comp Gov	41	59	52	48
U.S. Government	42	58	46	54
World History	44	56	44	56
European History	37	63	46	54
U.S. History	50	50	45	55
Psychology	24	76	35	65
Microeconomics	87.5	12.5	55	45
Macroeconomics	92	8	53	47

Most of the distributions in this study are consistent with the nationwide percentages. However, Microeconomics and Macroeconomics each had far greater male participation in the study high school. Ten percent more females than males took the Biology and Chemistry exams at the study high school, compared with the national figures. One possible explanation is that the high school of study has been successful at encouraging young women to pursue science studies, but not as successful at encouraging young women to pursue economic studies.

Table 26

Comparative Science Gender Distributions

	Study High School		U.S.	
Subject	% Male	% Female	% Male	% Female
Biology	31	69	41	59
Chemistry	41	59	52	48
Environmental	42	58	43	57
Physics B	67	33	65	35
Physics C-Mech	75	25	73	27
Physics C-E&M	75	25	76	24

Correlation

The researcher conducted further statistical analysis for the 10 AP courses for which the sample sizes were statistically meaningful: Comparative Government, U.S. Government, World History, European History, Psychology, Microeconomics, Macroeconomics, Biology, Chemistry, and Environmental Science. To determine the strength of the correlation between enrollment in middle school Challenge courses and the AP exam category score, a PPMC coefficient (*r*) was calculated for these 10 courses and applied to the following null hypothesis.

Null Hypothesis: There will be no relationship between the number of years of enrollment in middle school Challenge courses and the subsequent category score earned on the AP exam in the same field of study.

Table 28

Pearson Product Moment Correlation Coefficient (r) Values

Subject	*n*	*r*
U.S. Gov	66	0.399
Euro	59	0.209
Comp Gov	51	0.321
Psychology	42	0.104
Chemistry	22	0.276
World	16	0.343
Biology	13	0.283
Environ Science	12	-0.0558
Macroecon	12	0.172
Microecon	8	0.345

The strongest positive correlation would be represented by a correlation coefficient (*r*) of +1, while a strong negative, or inverse, correlation would be represented by a correlation coefficient (*r*) of -1. A lack of correlation would be represented by a correlation coefficient (*r*) of zero (Bluman, 2008, p. 528). See Table 28 for the *r* values.

The largest *r* value, for AP U.S. Government, was 0.399. The correlation was weak. The correlation coefficients ranged from -0.0558 to 0.399. Only four of these values exceeded 0.3. Since the largest *r* value, which was 0.399, was closer to zero than to +1, strong correlations between the variables were not likely.

For each of the PPMC coefficients calculated for comparison of the number of years of Challenge enrollment to the AP exam category scores, the *t* test of significance value was calculated. See Appendix A for the formula. The confidence level for the test of statistical significance was 95%. This was a two-tailed test because the linear relationship could have been positive or negative. The critical values were obtained from the *t* distribution table after the value of *t* was determined for each AP exam (Bluman, 2008, p. 635).

Null hypothesis: There is no difference between rho (*r*) and zero.

A value of *t* that fell in the critical area indicated by the *t* distribution table would lead to the rejection of the null hypothesis. Rejection of the null hypothesis provides evidence to support a significant linear relationship between the two variables. Table 29 shows the test (*t*) values and the critical values (CV) for data generated by each of the social studies AP exams.

The null hypothesis for Comparative Government was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP Comparative Government exam. The test value was 2.37, which is greater than the critical value 1.96. The test value fell in the critical area, so the researcher rejected the null hypothesis and there was enough evidence to support a significant positive linear relationship between the two variables.

Table 29

Critical Values (CV) and Test Values (t) for Social Studies

Subject	*n*	*r*	*T*	CV (+/-)
Comp Government	51	0.321	2.373*	1.96
U.S. Government	66	0.399	3.481*	1.96
European History	59	0.209	1.614	1.96
World History	16	0.343	1.366	2.145
Psychology	42	0.104	0.6613	1.96
Microeconomics	8	0.345	0.9	2.447
Macroeconomics	12	0.172	0.552	2.228
U.S. History	4	--	--	--

Note: *Indicates rejection of null hypothesis.

The null hypothesis for U.S. Government was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP U.S. Government exam. The test value was 3.48, which is greater than the critical value 1.96. Again, the test value fell in the critical area, so the researcher rejected the null hypothesis and there was enough evidence to support a significant positive linear relationship between the two variables.

The null hypothesis for European History was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP European History exam. The test value was 1.61, which is less than the critical value 1.96. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The null hypothesis for World History was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP World History exam. The test value was 1.37, which is less than the critical value 2.15. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The null hypothesis for Psychology was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP Psychology exam. The test value was 0.66, which is less than the critical value 1.96. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The null hypothesis for Microeconomics was that there is no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP Microeconomics exam. The test value was 0.90, which is less than the critical value 2.45. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The null hypothesis for Macroeconomics was that there was no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on the AP Macroeconomics exam. The test value was 0.55, which is less than the critical value 1.96. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The sample size for U.S. History was too small to yield an *r* value and measure the strength of the relationship. Therefore, no *t*-test for significance of the relationship was performed on this sample.

When each *r* value was tested for statistical significance, the test value fell in the critical area in only two of the 10 cases, AP Comparative Government and AP U.S. Government. In these two cases, the researcher rejected the null hypothesis. There was a significant relationship between the variables. This means that there is possible support for the statement that the more years a student was enrolled in Challenge social studies in middle school, the higher the AP exam category score was likely to be. The sample sizes for AP Comparative Government and AP U.S. Government were 51 and 66, respectively, two of the three highest sample sizes in the study. As discussed earlier, however, there was not a linear relationship between sample size and correlation coefficients.

In the remaining eight courses, European History, World History, Psychology, Microeconomics, Macroeconomics, Biology, Chemistry, and Environmental Science, the researcher did not reject the null hypothesis because there was not enough evidence to say that there was a significant relationship between the variables. The *t* value did not fall in the critical area in any of these cases.

The researcher then randomized a sample of 45 of the social studies AP exams and calculated the correlation coefficient *r*. For these social studies AP exams, the *r* value was 0.156; the *t*-test value was 1.03. Since the critical value was 1.96, this *t*-test value did not fall in the critical region. The null hypothesis was that there was a no relationship between the number of years of enrollment in Challenge social studies and the AP exam category score on an AP social studies exam. The researcher did not reject the null hypothesis. There was not enough evidence to support a relationship between the two variables. The result of the analysis of this randomized sample further supports the possibility that enrollment in Challenge social studies in middle school may not play a significant role in the preparation of students for AP coursework.

The test values and critical values for the science AP exams are listed in Table 30. The *r* values ranged from -0.0558 to 0.283, indicating weak correlation.

The null hypothesis for Biology was that there was no relationship between the number of years of enrollment in Challenge science and the AP exam category score on the AP Biology exam. The *t*-test value was 0.98, which is less than the critical value 2.20. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis, since there was not enough evidence to say that there was a significant linear relationship between the two variables.

Table 30

Critical Values (CV) and Test Values (t) for Science

Subject	*n*	*R*	*t*	CV (+/-)
Biology	13	0.283	0.979	2.201
Chemistry	22	0.276	1.284	2.086
Environmental	12	-0.0558	-0.177	2.228
Physics B	3	--	--	--
Physics C- Mech	4	--	--	--
Physics C- E&M	4	--	--	--

Note: *Indicated rejection of null hypothesis

The null hypothesis for Chemistry was that there was no relationship between the number of years of enrollment in Challenge science and the AP exam category score on the AP Chemistry exam. The *t*-test value was 1.28, which is less than the critical value 2.09. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

The null hypothesis for Environmental Science was that there was no relationship between the number of years of enrollment in Challenge science and the AP exam category score on the AP Environmental Science exam. The *t*-test value was -0.18, which is greater than the critical value -2.23. Therefore, the test value did not fall in the critical area. The researcher did not reject the null hypothesis; there was not enough evidence to say that there was a significant linear relationship between the two variables.

For Physics B, Physics C-Mechanics, and Physics C-Electricity and Magnetism, the sample size was too small to yield an *r* value and measure the strength of the relationship. Thus, the researcher did not calculate a test value for these three courses.

The researcher then randomized a sample of 30 of the science AP courses and calculated the correlation coefficient *r*. The *r* value was 0.274, and the *t*-test value was 1.507. In this case, the null hypothesis was that there was a no relationship between the number of years of enrollment in Challenge science and the AP exam category score on an AP science exam. Again, the test value was less than the critical value of 1.96 and did not fall in the critical region. The researcher did not reject the null hypothesis. There was not enough evidence to say that there is a significant linear relationship between the two variables. This result corresponds to the findings in each of the AP science courses, indicating a lack of correlation with middle school Challenge science enrollment.

Determination

In order to calculate the coefficient of determination, each of the *r* values were squared, because

> The coefficient of determination is a better indicator of the strength of a relationship than the correlation coefficient. It is better because it identifies the percentage of variation of the dependent variable that is directly attributable to the variation of the independent variable. (Bluman, p. 556)

Table 31 shows the resulting values for r^2 for the 10 AP exams that had a large enough sample size for statistical analysis. Again, the researcher is not measuring predictability of the AP exam category scores based on enrollment in Challenge courses in the middle school. A coefficient of determination suggests how much of the outcome might be explained by a variable. In this case, the outcome is the AP exam category score and the variable is the number of years of enrollment in Challenge courses. The difference between one and the r^2 value indicates how much of the outcome, or AP exam category score, can be attributed to unknown or confounding variables. The detailed results follow.

Table 31

Coefficients of Determination

AP exam	r	r^2
U.S. Government	0.399*	0.16
European History	0.209	0.04
Comparative Government	0.321*	0.10
Psychology	0.104	0.01
World History	0.343	0.12
Macroeconomics	0.172	0.03
Microeconomics	0.345	0.12
Biology	0.283	0.08
Chemistry	0.276	0.08
Environmental Science	-0.056	0.003

Note: *Indicates a significant relationship between the two variables.

U.S. Government yielded a significant mild positive relationship with a coefficient of determination of 0.16. Based upon this determination, the researcher can state with 95% confidence that 16% of the AP U.S. Government exam category score can possibly be attributed to enrollment in the middle school Challenge social studies course.

Comparative Government yielded a significant mild positive relationship with a coefficient of determination of 0.10. Based upon this determination, the researcher can state with 95% confidence that 10% of the AP Comparative Government exam category score can possibly be attributed to enrollment in the middle school Challenge social studies course.

Coefficients of determination indicate the degree to which the independent variable is a determining factor in the dependent variable. In this study, the coefficients of determination indicated the extent of the role of enrollment in middle school Challenge courses in a student's eventual AP exam score. The highest coefficient of determination (r^2) was 0.16 for U.S. Government, which means that enrollment in Challenge courses accounted for only 16% of the resulting AP U.S. Government exam scores. The next highest r^2 value was 0.12, for World History and Microeconomics. While neither of these two subjects showed a positive linear correlation, the coefficient of determination suggested that 12% of the factors that led to the AP exam scores might have been related to enrollment in Challenge courses. While minimal, this level of determination is more than Comparative Government (10%), for which a positive linear relationship was indicated by the correlation coefficient. All other values for coefficients of determination suggest that less than 10% of the reason for an AP exam score could be attributed to enrollment in Challenge courses.

Even the Pearson correlation coefficients calculated seemed to indicate weak to mild positive relationships for many of the exams, suggesting that enrollment in Challenge courses in middle school had little effect on the subsequent AP exam category scores. Only two of the exams yielded results that are statistically significant: U.S. Government and Comparative Government.

In descending order of sample sizes, the AP exams are U.S. Government, European History, Comparative Government, Psychology, Chemistry, World History, Biology, Environmental Science, Macroeconomics, and Microeconomics. As stated earlier, the largest *r* value was calculated from the U.S. Government exam, which coincidentally was the exam with the largest sample size. To find out if there was a pattern, the researcher made a graph with the sample sizes on the x-axis and the *r* values on the y-axis. Observable analysis indicated that the descending order of *r* values did not correspond with the descending order of sample sizes. Thus, there was no observable relationship between the sample size and the *r* value. See Figure 1 for the graph of sample sizes and *r* values.

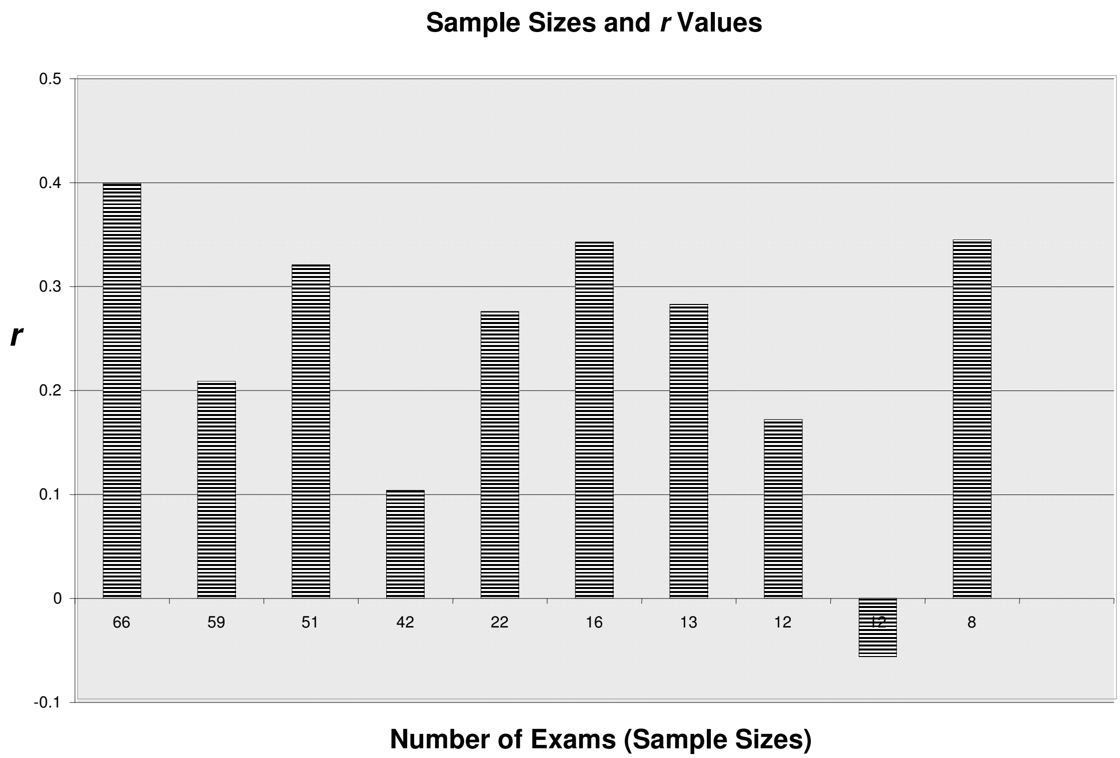

Figure 1. Sample sizes and *r* values.

A relationship would have been suggested if the values of the coefficient decreased as the sample sizes decreased. They did not. In other words, a greater sample size did not correspond to a higher correlation coefficient in this study.

Further Analysis

Because most of the individual correlation coefficients were low with only two significant categories and all of the coefficients of determination were less than 0.20, the researcher analyzed the AP exam category scores further. The total sample size for all of the social studies AP courses in this correlational study was 258. However, students who did not attend the study middle school took 68 social studies AP exams. The researcher compared the statistics for these two groups, including the average, or mean, for each AP exam. Only the students who attended the middle school of study would have had the opportunity to qualify for or participate in the particular Challenge program, which is the focus of this study. Middle school transcripts for students who attended middle school outside the district of study were not available to this researcher. The researcher conducted this secondary analysis to discover whether the average results of the AP exam category scores generated by these two groups differed.

Table 24

Comparison of Means of Exam Scores-Social Studies

Exam	Middle school in study site	Middle school elsewhere	Difference
Comp Gov	3.1	2.8	0.3
U.S. Government	3.4	3.5	-0.1
World History	3.7	4.4	-0.7
European History	3.6	3.2	0.4
U.S. History	4.3	2.5	1.8
Psychology	4.3	4.1	0.2
Microeconomics	3.9	3.8	0.1
Macroeconomics	3.0	3.8	-0.8

The sample sizes for the science AP exams were much smaller. Students who attended the study middle school took 58 AP science exams, while only seven students from other middle schools took AP science exams. Thus, the researcher did not perform the secondary analysis on the science data.

As discussed in chapter 3, the differences in the means were very small, ranging from -0.8 to 1.8. The most meaningful categories to observe are Comparative Government and U.S. Government, since these categories yielded significant relationships between variables. See Table 24.

The researcher performed the *F* test to compare the two variances. The null hypothesis was that the variances are equal. The variance (s^2) for the students who attended the study middle school was 0.2427; the variance (s^2) for the students who attended middle school elsewhere was 0.4184. The *F* test yielded a value of 1.7239. The critical value for this two-tailed test at a 95% confidence interval was 4.99. Since the test value did not fall in the critical range, the researcher did not reject the null hypothesis. There was not enough evidence to reject the claim that the variances are equal.

With these statistically equal variances, the researcher calculated the *t*-test value using the appropriate formula. See Appendix A for the formula for testing the difference between the means of two independent samples when the variances are assumed to be equal. The resulting *t* value was 0.28745. The null hypothesis for this test was that the means of the two groups of AP exam scores were not statistically different. With a 95% confidence interval, the critical value for this two-tailed test was 2.365. Since the test value (0.28745) did not fall in the critical region, the researcher did not reject the null hypothesis. There was not enough evidence to support the claim that the means of the two groups were different. Therefore, with 95% confidence, the researcher accepted that the mean of the AP exam scores in the study group was considered to be the same as the mean of the AP exam scores of those who did not attend middle school in the study district. This secondary analysis does not support the study hypothesis that enrollment in Challenge courses in the study district middle school results in higher scores on the subsequent AP exam in the same content field.

Qualifying Rates

In spite of the low incidence of positive linear correlation and very low coefficients of determination, another question about the relationship between enrollment in middle school Challenge courses and AP exam scores remained. How do individual qualifying rates in the AP exams relate to the number of years of enrollment in Challenge Courses? As stated in chapter 3, comparison of AP exam qualifying rates with the number of years of enrollment in Challenge courses would support or refute any claim that students in Challenge courses tend to perform better on AP exams. The corollary to this claim is that students not enrolled in Challenge courses tend not to perform as well. Again, the College Board and many colleges consider an AP exam score of 3, 4, or 5 to be a qualifying score. Scores of 1 or 2 on an AP exam are not considered qualifying and do not indicate readiness of the student to continue with advanced courses in the area of study (College Board, 2009a, p. 3). In descending order, Table 32 shows the overall qualifying rate for each of the AP exams considered in this study.

Table 32

Qualifying Rates by Exam

Exam	No. of exams	Qualifying rate
U.S. History	4	100
Microeconomics	8	100
European History	59	97
Psychology	42	95
World History	16	88
U.S. Government	66	82
Environmental Science	12	75
Chemistry	22	73
Physics B	3	67
Comparative Government	51	65
Physics C – Mechanics	4	50
Physics C – E/M	4	50
Biology	13	46
Macroeconomics	12	42

The qualifying rate is the number of scores of 3, 4, or 5 divided by total number of exams taken. In 10 out of the 14 courses, the qualifying rate exceeded 50%. As Table 32 shows, the range of qualifying rates is 42% to 100%. In two of the courses, U.S.

History and Microeconomics, every student who took the AP exam earned a 3, 4, or 5. The lowest percentage of qualifying scores was in the Macroeconomics course.

A further breakdown of qualifying rates by number of years of Challenge course enrollment revealed the percentage of students who passed even though they did not attend Challenge courses in middle school. Table 33 lists the percentages of qualifying scores earned by those who did not take 3 years of Challenge courses and those who did take 3 years of Challenge courses.

As stated earlier, 100% of those who took the U.S. History exam earned a category score of 3, 4, or 5. However, only 75% of these students had enrolled for 3 years in the middle school Challenge social studies program. Therefore, 25% of those who were successful on the AP exam did not enroll in Challenge social studies at the middle school for 3 years. In the case of Microeconomics, where 100% of the students qualified, only 37.5% of these students had enrolled in 3 years of Challenge social studies in the middle school of study. This means that 62.5% of the students were successful on the AP exam without taking 3 years of challenge social studies. The number of exams considered in each of these two areas was small, however.

More than 50 students earned qualifying scores in each of two subject areas: European History and U.S. Government. It is noteworthy that 25% and 30% respectively of these qualifying scores were earned by students who did not participate in Challenge courses for 3 years.

Table 33

Qualifying Rates Without and With 3 Years of Challenge

Subject	No. qualifying	% of examinees with qualifying scores	
		Without 3 years	With 3 years
U.S. History	4	25	75
Microeconomics	8	62.5	37.5
European History	57	25	75
Psychology	40	40	60
World History	14	29	71
U.S. Government	54	30	70
Environmental Sci	9	22	78
Chemistry	16	12.5	87.5
Physics B	2	0	100
Comp Government	33	18	82
Physics C - Mech	2	0	100
Physics C - E & M	2	0	100
Biology	6	17	83
Macroeconomics	5	40	60

Table 34 shows, in decreasing order, the qualifying rates in the social studies courses for those who had taken 3 years of middle school Challenge social studies. Though the sample sizes for four of these exams are smaller than 20, the sample sizes for each of the other four exams are greater than 30. Still, the smallest percentage of examinees who earned qualifying scores without participating in 3 years of Challenge social studies is 18%, in the case of Comparative Government. The largest percentage, as stated earlier, was 62.5% in Microeconomics. Students who did not take Challenge social studies for 3 years earned 63 of the qualifying social studies exam category scores.

Table 34

Qualifying Rates after 3 Years in Challenge Social Studies

Exam	Total no. qualifying	% qualifying after 3 years
Comparative Government	33	82
European History	57	75
U.S. History	4	75
World History	14	71
U.S. Government	54	70
Psychology	40	60
Macroeconomics	5	60
Microeconomics	8	37.5

The percentage of qualifying AP exam category scores after 3 years of Challenge science indicates higher rates of success than in social studies. In the three physics courses, 100% of the students who had enrolled in 3 years of Challenge science earned qualifying score on the science AP exam. The lowest percentage is 78%. Analysis of this breakdown of the science qualifying rates supports the possibility that introduction to content is perhaps one of the most valuable contributions that Challenge courses could claim. Each of the science topics is specifically included in the middle school curriculum. The sixth-grade curriculum covers life science, the seventh-grade curriculum covers earth science, and the eighth-grade curriculum covers physical science. Environmental science encompasses only a small section of the seventh-grade curriculum, and as Table 35 shows, environmental science is the AP exam where a smaller percentage of the qualifying scores belonged to students who enrolled in 3 years of Challenge science in middle school. In fact, less than 10 of the qualifying AP exam category scores were earned by students who did not take Challenge science for 3 years.

Table 35

Qualifying Rates after 3 Years in Challenge Science

Exam	Total no. qualifying	% qualifying after 3 years
Physics B	2	100
Physics C – Mechanics	2	100
Physics C – E & M	2	100
Chemistry	16	87.5
Biology	6	83
Environmental Science	9	78

Table 36 illustrates the examination of the qualifying rates according to how many years a student had enrolled in the middle school Challenge social studies course. For each exam, the researcher charted the percentage of the qualifying scores according to Challenge social studies enrollment.

Table 36

Qualifying Rates by Number of Years Enrolled in Challenge Social Studies

	Number of years enrolled in Challenge						
Exam	0	0.5	1.0	1.5	2	2.5	3
Comp	12		3		3		82
U.S. Gov	13		11		6		70
World	7		0		14	7	71
European	2		9		14		75
U.S. Hist	0		0		25		75
Psych	15	2.5	12.5		10		60
Micro	25		25		12.5		37.5
Macro	20		0		20		60

Of the students who earned a qualifying score on the Psychology exam, 15% had not taken any Challenge social studies course in middle school. Likewise, 13% of the qualifying scores on the U.S. Government exams and 12 % of the qualifying scores in Comparative Government belonged to students who had not enrolled in Challenge social studies in middle school. The relative familiarity with content, then, does not sufficiently explain the success of these students on AP exams.

Summary

This study determined the correlation between the number of years of enrollment in the middle school social studies and science Challenge courses and the AP exam score in the corresponding subject area AP exam in the high school. Data sets from 14 AP exams, 8 social studies exams and 6 science exams, were obtained from district records at a high school in a large suburban, St. Louis county school district. The eight AP social studies courses were U.S. Government, Comparative Government, World History, European History, Psychology, Microeconomics, Macroeconomics, and U.S. History. The six AP science courses were Biology, Chemistry, Physics B, Physics C-Mechanics, Physics C-Electricity and Magnetism, and Environmental Science.

Only data sets that included students who took the AP exam at the high school of study and also attended the feeder middle school were included in this study. Complete middle school data from those students who transferred in or out of the district between grade six and the time they took an AP exam were not available. Since the independent variable, years of enrollment in Challenge courses, could be zero, even students who did not participate in the Challenge program at the middle school were included in this study if they took one of these AP exams. In addition, not every student enrolled in an AP course took the AP exam, again reducing the sample sizes. Statistical analyses and gender distributions indicated that those scores included in the study were, nonetheless, representative of all of the students who took AP exams.

The sample sizes were too small for meaningful analysis in the case of U.S. History, Physics B, Physics C-Mechanics, Physics C-Electricity and Magnetism. As a result, the correlation coefficient could not be determined, and the *t* test could not be performed for these AP course exams.

Of the remaining 10 AP exams, only two were shown to suggest a positive linear relationship with the number of years of enrollment in Challenge courses. For Comparative Government and U.S. Government, the null hypothesis was rejected because there was enough evidence to support a statistically significant relationship between the variables. For all other AP exams, there was not enough evidence to say that there was a significant relationship between the variables, so the null hypothesis was rejected.

Analysis of a randomized sample of all of the AP social studies exams, however, yielded no evidence of a significant positive linear correlation between the number of years in Challenge social studies and the AP social studies exam category score. Analysis of a randomized sample of all of the AP science exams also did not indicate enough evidence to say that there was a significant relationship between Challenge course enrollment and AP science exam category scores.

The coefficients of determination calculated from the two subjects that indicated a relationship were relatively small, as seen in Table 37. For U.S. Government, the coefficient of determination was 0.16, and for Comparative Government, the coefficient was only 0.10. Thus, the influence of Challenge course enrollment on these AP exam category scores seems to be negligible. The coefficients of correlation and the coefficients of determination are not high enough to support that enrollment in middle school Challenge courses had a notable effect on AP exam category scores. Even the largest coefficient of determination, 16%, suggests that 84% of the AP exam category score can be attributed to other factors besides enrollment in Challenge courses.

Table 37

Coefficients of Determination in Descending Order

AP exam	r^2	Significant correlation
U.S. Government	0.16	Yes
World History	0.12	No
Microeconomics	0.12	No
Comparative Government	0.10	Yes
Biology	0.08	No
Chemistry	0.08	No
European History	0.04	No
Macroeconomics	0.03	No
Psychology	0.01	No
Environmental Science	0.003	No

A low coefficient of determination may have more to do with what happens in the high school classroom than in the middle school classroom. Very high qualifying rates may be attributed to the ability of the AP teacher to facilitate high rates of success with students, regardless of their background. In addition, the content of some of the high school courses differs greatly from the content of the middle school courses. As a result, preparation through these middle school courses may not have as much effect as the experience in the high school course. Psychology is an example of a high qualifying rate (95%) and a low coefficient of determination (1%). Though Psychology is a social studies course, the middle school social studies curriculum does not include any introduction to this content.

Further analysis of qualifying rates suggests that while Challenge social studies courses in middle school may serve to familiarize students with content that is taught later in AP courses, they do not seem to prepare students with transferable study skills and habits. In other words, students who did not participate in the Challenge program seemed to have no disadvantage in AP courses with new content, such as Psychology or Microeconomics. Science Challenge courses may also serve to familiarize students with content area knowledge, though the sample sizes are too small to permit meaningful conclusions. This assumption will be examined in more detail in the next chapter.

Chapter 5: Implications and Recommendations

Overview

In an effort to ensure a citizenry that is educated and competent, schools at every level from elementary to college seek to provide the necessary skills and foundation for the next stage of education and life. Middle schools must balance the charge of providing the appropriate level of rigor with the responsibility of supporting students emotionally and psychologically through important transition periods. Since research supports the value of high school AP courses as a preparation for the college curriculum, the researcher strove to extend this issue of preparation to the middle school years to evaluate the effectiveness of the Challenge curriculum in laying the groundwork for high school and college coursework.

Research Question

The purpose of this study was to determine if there was a correlation between the number of years of enrollment in middle school social studies and science Challenge courses and the subsequent AP exam category score in the corresponding course. A positive correlation would have suggested that enrollment in the middle school Challenge courses helped to prepare the students for success in the subsequent AP courses in high school. Success is defined as an exam category score of 3, 4, or 5 on the AP exam. A negative correlation would have suggested that Challenge course enrollment may lead to low category scores on the AP exam. The absence of a significant relationship would have suggested that enrollment in Challenge courses in the middle school of study may have played little part in a student’s performance in AP courses at the high school of study.

Implications

Gifted students and high-achieving students are often misunderstood. Misconceptions have led to an assumption by some that students who were in Challenge courses in middle school would naturally do well in AP courses in high school. If this were true, then it would also be likely that those students who were not in Challenge courses would perform poorly on subsequent AP exams. As a gifted education specialist with more than 20 years of experience teaching middle school students, the researcher was hesitant to jump to any such conclusions. Adolescence is a complicated period, in terms of brain development and readiness. Middle school may not be an appropriate time to make reliable determinations about a student's potential, particularly if such determinations limit curricular options.

The objective data and correlation studies suggest that Challenge courses, at least as they were implemented in the middle school of study, did not necessarily provide the groundwork needed to prepare students for specific AP exams, except in the case of two AP courses, Comparative Government and U.S. Government. In fact, students who did not participate in Challenge courses sometimes performed very well on subsequent AP exams. Since 12 of the 14 courses did not indicate a relationship with the number of years in Challenge courses, the previous assumption was not supported. In other words, those who enroll in Challenge courses in the middle school of study did not necessarily achieve qualifying scores on subsequent AP exams in the corresponding subject. Concurrently, those who did not enroll in middle school Challenge courses did not necessarily earn lower category scores on the subsequent AP exams. In fact, students who did not participate in the corresponding Challenge program in middle school earned more than

10% of the qualifying scores in some subject areas. The results of this study do not even indicate a relationship between enrollment in middle school Challenge social studies or science courses and subsequent corresponding AP exam category scores using randomized samples.

The researcher observed that the higher qualifying rates corresponded to the courses where more of the content is introduced in the middle school curriculum, such as government and history. The exams with the lowest percentages are topics that are new to the high school student, psychology and economics. These are not directly covered in the middle school of study. Therefore, taking Challenge courses in middle school may only be helpful if the content areas are similar. This seems to refute the claim in the district's *Middle School Course Description Guide*, as discussed in chapter 2, that enrollment in Challenge courses facilitates the development of study skills and habits that will lead to success in rigorous courses (Rockwood School District, 2008a).

Juniors and seniors populated 12 of the 14 AP courses considered in this study. See Table 38 for the grade levels for each of the 14 AP courses considered in this study. The exceptions were World History and European History, which were offered primarily to sophomores. No AP science courses were offered to sophomores. Therefore, the first possible exposure to AP coursework for most students was in a high school social studies course. By the time students took AP Comparative Government and AP U.S. Government as juniors, many of them had become familiar with features of an AP social studies course, such as Document Based Questions. Thus, a reasonable possibility is that the high school World History and European History teachers had at least as much to do with preparing students for college-level rigor in subsequent courses as the middle school teachers.

Table 38

Grade Levels in AP Courses

AP course	Majority grade level
Comparative Government	11
U.S. Government	11
World History	10
European History	10
U.S. History	12
Psychology	12
Microeconomics	12
Macroeconomics	12
Biology	11 & 12
Chemistry	11
Environmental Science	12
Physics B	12
Physics C- Mechanics	12
Physics C- Electricity & Magnetism	12

In addition, each of the two government courses is a semester-long course at the high school, as opposed to a yearlong course. Chemistry and Biology, on the other hand, are each yearlong courses that culminate with one AP exam. The fact that the some AP exams covered less material than others may have been a factor in how successfully the students completed the exams.

Historically, the open enrollment policy for the AP courses has proven to foster increased enrollment *and success* in AP courses at the high school of study. Contrary to some predictions, the increased participation has not led to a decrease in average scores. Requiring the students to acknowledge and accept the expectation of rigor may be an important factor in their success in AP courses. Extending this practice to the middle school Challenge courses may set the tone early for serious academic preparation and personal responsibility.

Recommendations

The results of this study suggest that, at least as the courses were taught at the time of the study, the social studies and science Challenge courses generally did not provide students with the skills or background that they need to be successful in AP courses. The lack of any special training for the teachers of these Challenge courses may partly explain this. If courses continue to be designated Challenge or regular, there should be identifiable and specific differences between the two levels of course, at least in terms of expectations. Parents and students deserve to receive accurate information as they register for middle school courses, both at orientation meetings and in the course description guide.

There may be a need for more vertical curriculum alignment between middle school and high school, not only in content but also in instructional strategies. The district has recently focused on project-based learning in professional development meetings. While project-based learning offers appropriate meaning to the middle school experience, it may not prepare students for the AP exam questions without further scaffolding. A balance between content and skills is necessary. High school and middle school teachers should plan curriculum together.

In terms of eligibility, one recommendation is to consider interest and perseverance as possible eligibility requirements for Challenge course enrollment. However, the open enrollment policy similar to the policy for AP courses may be sufficient. Perhaps part of the agreement could be that the student maintains a certain grade in the course to remain enrolled. At the time of the study, the grade required to remain enrolled in a Challenge course was a C-. The researcher would also recommend that this grade requirement be changed to a B.

Further examination of Challenge courses, i.e., teacher training, level of rigor, and thinking skills is warranted. In addition, the advice given to incoming middle school students that they should enroll in Challenge courses to better prepare them for high school AP courses needs to be reevaluated, at least in the areas of social studies and science.

Meanwhile, this researcher recommends that the district consider training or professional development for middle school teachers assigned to teach Challenge courses. Exposure to content seemed to have contributed to some AP success, as indicated by the higher qualifying rates in AP courses that were related in content to middle school courses. In terms of readiness for rigorous work or development of transferable study skills, however, the middle school Challenge courses did not seem to serve as preparation for the subsequent college-level courses. Such training should include the characteristics and needs of each kind of student in the class. For example, many gifted students populate the Challenge courses, but most of the middle school teachers have no training in gifted education.

Further Studies

Both of the courses that indicated a relationship between the number of years of enrollment in middle school Challenge courses and the AP exam category score are semester courses: AP Comparative Government and AP U.S. Government. Further analysis comparing semester long exams with yearlong exams would shed more light on whether or not students perform better on AP exams that cover less material. In addition, further study analyzing the qualifying rates according to the grade level of the AP course would help determine the extent to which the age of the student plays a role in how successfully the student completes AP exams. The amount of time between the middle school courses and the AP course may also be a factor.

Another suggestion is to explore the effects of other independent variables, such as GPA, IQ, or grades earned in the Challenge courses. However, while GPA and course grades are available in the district database, not every student has an IQ test score on file. In addition, the issues surrounding grades, such as subjectivity or inflation, might serve to provide less meaningful diagnostic or predictive information. Thus, this type of study might best include qualitative data or case studies.

The researcher also recommends a study that compares two equal groups: one of students who took Challenge courses and one of students who did not, in order to determine whether there is a difference in the subsequent AP exam category scores. Such a study may provide information about the causal relationship between Challenge course enrollment and AP exam category scores.

A longitudinal study that encompasses multiple years would illuminate trends in participation and success in AP courses through the years. Such a study could include gender distributions. A notable discrepancy between the nationwide gender distribution and this study is that females outnumber males in the AP Chemistry and Biology courses in this study, but not nationally, as shown on Table 26 on page 70. Perhaps, at the high school of study, more and more females are pursuing scientific fields. Further studies comparing the scores of females with the scores of males would be a worthy topic of research. Such research would do well to consider the cultural and educational factors that affect participation and success in programs such as a middle school challenge program, a gifted program, or an AP program. For the purposes of this present study, the researcher is satisfied that the samples, though small in some cases, were sufficiently representative in terms of gender distribution.

Expanding the methodology of this study to other subject areas may provide some ideas about how to proceed with curriculum revisions. Although language arts and mathematics are delivered with more complicated model options than either Challenge or regular, an analysis of the data even with these limitations would be worthwhile.

Recommendations for qualitative studies include researching attitudes toward school in general and Challenge courses or AP courses specifically. The culture of the school and community may have an effect on the motivations for taking advanced courses as well as the commitment to excel in such courses. Motivation is also dependent upon a child's interests, thus, interest and choice should perhaps play a larger role in determining a middle school student's course enrollment. Ideally, any Challenge course should provide students with transferable tools and thinking skills that would help them prepare for any advanced-level course in high school. If Challenge courses can indeed make a difference in a student's success by providing strategies and meaningful learning, then, based on the results of this study, all interested and motivated students should be offered access to these courses. At the same time, further research, including a qualitative study probing the motives for high school course enrollment choices would be a valuable continuation of this study.

What is the difference between a Challenge course and a regular course in the middle school of study? The answer to this lies at the heart of the issue. The district may want to examine, with direct observations and detailed research, whether or not the difference between Challenge and regular courses really reflects the description in the course description guide.

Meanwhile, it is incumbent upon any educational system to provide students with the best possible foundation for future success. All children have the right to an appropriate and challenging school experience as they grow and transition from elementary school to college to life. A balance of meaningful content and transferable skills, introduced as students are ready and eager to learn, requires thoughtful planning and collaboration with all stakeholders. The future quite literally depends on these students.

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Appendix A – Formulas

Formula for Correlation Coefficient r

$$r = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\left(\sum x^2\right) - \left(\sum x\right)^2}\sqrt{n\left(\sum y^2\right) - \left(\sum y\right)^2}}$$

Where x=number of years enrolled in Challenge course, y=score on AP exam, and n=the number of data pairs.

Formula for the t Test for the Correlation Coefficient

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

With degrees of freedom equal to n – 2.

Variance formula for a sample

$$S^2 = \frac{\sum\left(X - \overline{X}\right)^2}{n-1}$$

Formula for the F Test

$$F = \frac{s_a^2}{s_b^2}$$

t Test formula

(for testing the difference between two means, small independent samples

where variances are assumed to be equal)

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S_{X_1X_2} \cdot \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where

$$S_{X_1X_2} = \sqrt{\frac{(n_1 - 1)S_{X_1}^2 + (n_2 - 1)S_{X_2}^2}{n_1 + n_2 - 2}}.$$

where degrees of freedom are equal to $n_1 + n_2 - 2$

Appendix B – Data Set Analysis

Table 22

Class Enrollment Compared to AP Social Studies Exams

AP exam	Enrollment*	Incomplete sets	Chose not to test	In this study
Comp Gov	89	16	22	51
U.S. Gov	89	19	4	66
World History	23	5	2	16
European History	66	7	0	59
U.S. History	7	2	1	4
Psychology	60	9	9	42
Micro	15	5	2	8
Macro	18	5	1	12
Totals	367	68	41	258

*At time of exam

Table 23

Class Enrollment Compared to AP Science Exams

	Enrollment*	Incomplete sets	Chose not to test	In this study
Biology	15	2	0	13
Chemistry	27	2	3	22
Environmental	13	1	0	12
Physics B	6	2	1	3
Physics C-Mech	4	0	0	4
Physics C-E&M	4	0	0	4
Totals	69	7	4	58

*At time of exam

Table 39

Incomplete Data Set Gender Distribution-Social Studies

Comp (16)	U.S. Gov (19)	World (5)	Euro (7)	U.S. Hist (2)	Psych (9)	Micro (5)	Macro (5)
5M 11F	8M 11F	3M 2F	4M 3F	1M 1F	2M 7F	3M 2F	3M 2F

Table 40

Incomplete Data Set Gender Distribution-Science

Biology (2)	Chem (2)	Environ (1)	Physics B (2)	C-Mech (0)	C-E&M (0)
0M 2F	1M 1F	1F	2M 0F	--	--

Table 24

Comparison of Means of Exam Scores - Social Studies

Exam	Middle school in study site	Middle school elsewhere	Difference
Comp Gov	3.1	2.8	0.3
U.S. Government	3.4	3.5	-0.1
World History	3.7	4.4	-0.7
European History	3.6	3.2	0.4
U.S. History	4.3	2.5	1.8
Psychology	4.3	4.1	0.2
Microeconomics	3.9	3.8	0.1
Macroeconomics	3.0	3.8	-0.8

Table 41

Mean Calculations

Subject	District middle school X_1	Other middle school X_2	X_1X_2	X_1^2	X_2^2
Comp Gov	3.1	2.8	8.68	9.61	7.84
U.S. Gov	3.4	3.5	11.9	11.56	12.25
World	3.7	4.4	16.28	13.69	19.36
European	3.6	3.2	11.52	12.96	10.24
U.S. History	4.3	2.5	10.75	18.49	6.25
Psychology	4.3	4.1	17.63	18.49	16.81
Microecon	3.9	3.8	14.82	15.21	14.44
Macroecon	3.0	3.8	11.4	9	14.44
Σ	29.3	28.1	102.98	109.01	101.63

Table 42

Sample Variance Data X_1 – District Middle School

Subject	X	$X - \bar{X}$	$(X - \bar{X})^2$
Comp Government	3.1	-0.5625	0.3164
U.S. Government	3.4	-0.2625	0.0689
World History	3.7	0.0375	0.0014
European History	3.6	-0.0625	0.0039
U.S. History	4.3	0.6375	0.4064
Psychology	4.3	0.6375	0.4064
Microeconomics	3.9	0.2375	0.0564
Macroeconomics	3.0	0.6625	0.4389

Note: $\bar{X}$ = 3.6625

Table 43

Sample Variance Data X_2 – Other Middle School

Subject	X_2	$X_2 - \bar{X}$	$(X_2 - \bar{X})^2$
Comp Government	2.8	-0.7125	0.5077
U.S. Government	3.5	-0.0125	0.000156
World History	4.4	0.8875	0.7877
European History	3.2	-0.3125	0.0977
U.S. History	2.5	-1.0125	1.025
Psychology	4.1	0.5875	0.345
Microeconomics	3.8	0.2875	0.0827
Macroeconomics	3.8	0.2875	0.0827

Note: $\bar{X} = 3.5125$

Table 20

Social Studies Sample Sizes

AP subject	*n*
U.S. Government	66
European History	59
Comparative Government	51
Psychology	42
World History	16
Macroeconomics	12
Microeconomics	8
U.S. History	4

Table 21

Science Sample Sizes

AP subject	*n*
Chemistry	22
Biology	13
Environmental Science	12
Physics C- Mechanics	4
Physics C- Electricity and Magnetism	4
Physics B	3

Table 45

Nationwide Gender Distribution

AP exam	% males	% females
Comparative Government	52	48
U.S. Government	46	54
World History	44	56
European History	46	54
U.S. History	45	55
Psychology	35	65
Microeconomics	55	45
Macroeconomics	53	47
Biology	41	59
Chemistry	52	48
Environmental Science	43	57
Physics B	65	35
Physics C-Mechanics	73	27
Physics C-E & M	76	24

Appendix C – Raw Data Tables

Table 6

AP Comparative Government Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1435SA	3	3	9	9	9
1383AA	3	4	12	9	16
8824AB	3	3	9	9	9
6560SB	3	2	6	9	4
1284CB	3	3	9	9	9
7070AC	0	3	0	0	9
2726DC	1	2	2	1	4
7367SC	2	1	2	4	1
8499BE	3	4	12	9	16
1323CE	3	5	15	9	25
8595BF	0	2	0	0	4
6592JF	3	4	12	9	16
7001ZF	3	4	12	9	16
1318JF	3	2	6	9	4
8811AH	0	4	0	0	16
6565EH	3	5	15	9	25
2664VH	3	5	15	9	25
7006EH	3	4	12	9	16
7007CH	3	5	15	9	25
7008PH	3	3	9	9	9
6581DH	3	3	9	9	9
7011MK	3	3	9	9	9
2667AK	3	3	9	9	9
7013CK	3	3	9	9	9
9952RM	3	4	12	9	16

1335LM	3	1	3	9	1
1404SM	3	4	12	9	16
2671MM	0	2	0	0	4
2673AM	3	5	15	9	25
7020HM	3	4	12	9	16
2674AM	0	3	0	0	9
2676MM	3	4	12	9	16
8201JN	0	2	0	0	4
1339SP	3	2	6	9	4
1341AP	0	4	0	0	16
1342HP	3	4	12	9	16
7110AP	0	2	0	0	4
1308SR	1	2	2	1	4
1310AR	3	3	9	9	9
7414NS	3	2	6	9	4
6613DS	3	5	15	9	25
6607AS	3	1	3	9	1
6606CS	3	1	3	9	1
1347MS	3	2	6	9	4
7029BS	2	3	6	4	9
1393TS	1	3	3	1	9
1313AS	3	4	12	9	16
7032NS	0	2	0	0	4
7034LV	3	4	12	9	16
1927KW	0	2	0	0	4
6576AW	1	2	2	1	4
$\sum$	113	157	371	327	551
	($\sum x$)	($\sum y$)	($\sum xy$)	($\sum x^2$)	($\sum y^2$)

Table 7

AP U.S. Government Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1435SA	3	3	9	9	9
1383AA	3	4	12	9	16
8824AB	3	3	9	9	9
8490BB	3	3	9	9	9
6560SB	3	3	9	9	9
8981AB	3	3	9	9	9
1284CB	3	3	9	9	9
7070AC	0	3	0	0	9
2726DC	1	2	2	1	4
7367SC	2	2	4	4	4
6746LE	0	1	0	0	1
8499BE	3	4	12	9	16
1323CE	3	5	15	9	25
8595BF	0	2	0	0	4
6592JF	3	4	12	9	16
7001ZF	3	5	15	9	25
1318JF	3	3	9	9	9
6594TG	3	4	12	9	16
8811AH	0	4	0	0	16
6565EH	3	5	15	9	25
1374CH	3	3	9	9	9
2664VH	3	5	15	9	25
7006EH	3	5	15	9	25
1327HH	3	3	9	9	9
7007CH	3	5	15	9	25

7008PH	3	5	15	9	25
6581DH	3	2	6	9	4
7011MK	3	5	15	9	25
2667AK	3	3	9	9	9
7013CK	3	4	12	9	16
9952RM	3	5	15	9	25
1335LM	3	2	6	9	4
1404SM	3	4	12	9	16
2672SM	2	3	6	4	9
2671MM	0	2	0	0	4
2673AM	3	5	15	9	25
1301BM	3	2	6	9	4
7020HM	3	5	15	9	25
2674AM	0	4	0	0	16
2676MM	3	5	15	9	25
4562RM	0	2	0	0	4
8201JN	0	3	0	0	9
1339SP	3	3	9	9	9
1341AP	0	4	0	0	16
1342HP	3	4	12	9	16
7110AP	0	3	0	0	9
1308SR	1	3	3	1	9
1310AR	3	3	9	9	9
7414NS	3	4	12	9	16
6613DS	3	5	15	9	25
1347MS	3	2	6	9	4
7029BS	2	3	6	4	9
1393TS	1	4	4	1	16
1313AS	3	3	9	9	9

1352ES	1	3	3	1	9
2680HS	2	4	8	4	16
7032NS	0	3	0	0	9
0568SS	1	3	3	1	9
1437ST	3	4	12	9	16
1359DT	3	2	6	9	4
2681ET	3	4	12	9	16
7034LV	3	4	12	9	16
1315EV	3	3	9	9	9
1927KW	0	2	0	0	4
6576AW	1	3	3	1	9
7245JY	1	3	3	1	9
$\sum$	144	227	528	410	851
	$(\sum x)$	$(\sum y)$	$(\sum xy)$	$(\sum x^2)$	$(\sum y^2)$

Table 8

AP World History Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
6711MB	3	5	15	9	25
8853JB	2.5	4	10	6.25	16
3188SD	3	3	9	9	9
1405MG	3	4	12	9	16
2740DH	3	3	9	9	9
2770TH	3	4	12	9	16
6691AK	0	2	0	0	4
1480RL	2	5	10	4	25
6721JP	3	5	15	9	25
8687WP	3	2	6	9	4
6991LP	3	3	9	9	9
6700EP	0	3	0	0	9
8503JS	3	3	9	9	9
6723ES	3	5	15	9	25
8510HS	3	4	12	9	16
7229MW	2	4	8	4	16
Σ	39.5	59	151	113.25	233

Table 9

AP European History Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1451MA	3	3	9	9	9
7186GA	3	5	15	9	25
3690SB	3	5	15	9	25
6712HB	3	3	9	9	9
1453AB	3	4	12	9	16
9649AB	2	5	10	4	25
1455MB	3	3	9	9	9
1456JC	3	3	9	9	9
8742KC	2	3	6	4	9
2732BC	1	3	3	1	9
1459SD	1	3	3	1	9
3010DC	3	5	15	9	25
2734AD	3	4	12	9	16
1463KD	3	3	9	9	9
7143ED	3	4	12	9	16
7144AD	3	4	12	9	16
1465CE	3	4	12	9	16
1467KF	3	4	12	9	16
6767DF	3	4	12	9	16
1405CG	3	4	12	9	16
8533JG	3	4	12	9	16
7146TG	3	3	9	9	9
1527AG	2	4	8	4	16
2767JH	3	4	12	9	16
1470ZH	2	2	4	4	4
7148SH	0	3	0	0	9
7150JJ	3	4	12	9	16

1367HK	3	4	12	9	16
1475CK	3	4	12	9	16
1476AK	3	3	9	9	9
1410AL	3	4	12	9	16
2905EL	2	3	6	4	9
1673MM	3	5	15	9	25
6837KM	3	3	9	9	9
6720JM	3	5	15	9	25
7162KM	2	4	8	4	16
1488AN	1	3	3	1	9
8580BO	3	3	9	9	9
2751AR	3	1	3	9	1
7167KR	3	3	9	9	9
7342MR	3	3	9	9	9
6701JR	3	3	9	9	9
2779CR	3	4	12	9	16
4067MS	2	5	10	4	25
6835JS	3	4	12	9	16
6827KS	3	5	15	9	25
8501CS	3	4	12	9	16
8507AS	3	3	9	9	9
2755RS	3	3	9	9	9
2291MS	2	4	8	4	16
8513KS	3	4	12	9	16
7171ZT	3	3	9	9	9
7172JT	3	3	9	9	9
7187JT	3	3	9	9	9
8516AT	3	4	12	9	16
7173NT	3	5	15	9	25
8517PT	1	3	3	1	9
0238AT	2	4	8	4	16

2758AV	1	3	3	1	9
Σ	155	215	572	437	823

Table 10

AP U.S. History Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1383AA	3	4	12	9	16
6593MG	2	5	10	4	25
7365SR	3	4	12	9	16
8411JV	3	4	12	9	16
Σ	11	17	46	31	73

Table 11

AP Psychology Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
2692AA	3	4	12	9	16
6440RB	1	5	5	1	25
2702MB	2	5	10	4	25
1870BB	3	5	15	9	25
1868RB	3	3	9	9	9
2712MD	3	5	15	9	25
8366AD	3	5	15	9	25
6437KE	3	5	15	9	25
7809BE	0	4	0	0	16
8431QF	3	4	12	9	16
6461AF	3	5	15	9	25
8374PF	2	3	6	4	9
0090NF	1	5	5	1	25
8375CF	3	4	12	9	16
1176LH	3	4	12	9	16
1233MH	3	5	15	9	25
6513NK	2	5	10	4	25
8381EK	0	5	0	0	25
8429KK	3	4	12	9	16
9952RM	3	5	15	9	25
2595PM	3	5	15	9	25
8391NM	3	5	15	9	25

2676MM	3	5	15	9	25
1194RM	1	5	5	1	25
2970CN	1	5	5	1	25
7331AN	3	5	15	9	25
6445SO	3	3	9	9	9
7534AO	0.5	4	2	0.25	16
7365SR	3	4	12	9	16
7343MR	0	5	0	0	25
8398AS	3	5	15	9	25
1206SS	3	2	6	9	4
8401AS	3	5	15	9	25
1207RS	3	4	12	9	16
1208SS	0	3	0	0	9
1743LS	3	4	12	9	16
2600KS	0	2	0	0	4
8407KT	3	5	15	9	25
6463KU	2	3	6	4	9
1212CW	0	5	0	0	25
6433KW	1	4	4	1	16
1213HW	0	4	0	0	16
Σ	88.5	182	388	246.25	820

Table 12

AP Microeconomics Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
8358GB	2	5	10	4	25
6443AB	1	3	3	1	9
8359KB	3	3	9	9	9
1299BM	1	4	4	1	16
2704KM	3	5	15	9	25
1195BN	0	3	0	0	9
1204KR	3	4	12	9	16
8479AW	0	4	0	0	16
Σ	13	31	53	33	125

Table 13

AP Macroeconomics Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
8358GB	2	4	8	4	16
6443AB	1	2	2	1	4
8359KB	3	4	12	9	16
1565NC	3	2	6	9	4
1299BM	1	2	2	1	4
2704KM	3	5	15	9	25
1192KM	3	2	6	9	4
1195BN	0	2	0	0	4
1204KR	3	5	15	9	25
2960JS	3	2	6	9	4
8479AW	0	4	0	0	16
8414JW	3	2	6	9	4
Σ	25	36	78	69	126

Table 14

AP Biology Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
8361JC	3	2	6	9	4
1553MC	2	1	2	4	1
1323CE	2	5	10	4	25
7809BE	0	1	0	0	1
1327HH	3	2	6	9	4
7007CH	3	3	9	9	9
1528KJ	3	3	9	9	9
8391NM	3	5	15	9	25
2597BO	3	1	3	9	1
6460EQ	3	3	9	9	9
6613DS	3	5	15	9	25
1313AS	3	1	3	9	1
2600KS	0	2	0	0	4
$\sum$	31	34	87	89	118
	($\sum x$)	($\sum y$)	($\sum xy$)	($\sum x^2$)	($\sum y^2$)

Table 15

AP Chemistry Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1383AA	3	2	6	9	4
6560SB	3	3	9	9	9
8365BD	0	3	0	0	9
8499BE	3	4	12	9	16
6592JF	3	5	15	9	25
1318JF	3	2	6	9	4
6593MG	2.5	4	10	6.25	16
6565EH	3	5	15	9	25
1374CH	3	1	3	9	1
2664VH	3	3	9	9	9
7008PH	3	3	9	9	9
7013CK	3	4	12	9	16
1407AL	3	2	6	9	4
2673AM	3	3	9	9	9
8391NM	3	5	15	9	25
7020HM	3	2	6	9	4
2674AM	3	3	9	9	9
2970CN	3	3	9	9	9
1308SR	3	3	9	9	9
2785JS	3	3	9	9	9

7034LV	3	3	9	9	9
2605AW	0	1	0	0	1
$\sum$	59.5	67	187	177.25	231
	($\sum x$)	($\sum y$)	($\sum xy$)	($\sum x^2$)	($\sum y^2$)

Table 16

AP Environmental Science Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
8204NA	3	2	6	9	4
2702MB	3	3	9	9	9
1453AB	3	3	9	9	9
1553MC	2	1	2	4	1
0090NF	3	2	6	9	4
7006EH	3	3	9	9	9
1410AL	3	3	9	9	9
8390AM	3	3	9	9	9
2676MM	2	4	8	4	16
7534AO	2	4	8	4	16
2616ES	3	3	9	9	9
2775GW	3	4	12	9	16
Σ	33	35	96	93	111

Table 17

AP Physics B Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1565NC	3	3	9	9	9
1164MD	3	3	9	9	9
8377JH	3	2	6	9	4
Σ	9	8	24	27	22

Table 18

AP Physics C-Mechanics Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
6451NB	3	2	6	9	4
1185RJ	3	4	12	9	16
2704KM	3	5	15	9	25
2956KR	3	2	6	9	4
Σ	12	13	39	36	49

Table 19

AP Physics C-Electricity and Magnetism Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
6451NB	3	2	6	9	4
1185RJ	3	4	12	9	16
2704KM	3	3	9	9	9
2956KR	3	2	6	9	4
Σ	12	11	33	36	33

Table 46

Randomized Social Studies Raw Data

Number	Years(x)	Score(y)	xy	x^2	y^2
1	0	3	0	0	9
2	3	4	12	9	16
3	3	4	12	9	16
4	3	3	9	9	9
5	3	4	12	9	16
6	3	4	12	9	16
7	3	1	3	9	1
8	0	2	0	0	4
9	3	3	9	9	9
10	1	2	2	1	4
11	3	4	12	9	16
12	3	3	9	9	9
13	3	2	6	9	4
14	3	4	12	9	16
15	0	4	0	0	16
16	3	4	12	9	16
17	3	2	6	9	4
18	0	3	0	0	9
19	3	3	9	9	9
20	3	5	15	9	25
21	3	4	12	9	16
22	3	4	12	9	16
23	1	3	3	1	9
24	3	4	12	9	16
25	2	4	8	4	16
26	3	4	12	9	16
27	3	5	15	9	25

28	3	3	9	9	9
29	3	4	12	9	16
30	3	3	9	9	9
31	1	3	3	1	9
32	1	5	5	1	25
33	3	5	15	9	25
34	3	4	12	9	16
35	3	5	15	9	25
36	3	5	15	9	25
37	3	2	6	9	4
38	3	5	15	9	25
39	1	3	3	1	9
40	0	4	0	0	16
41	3	5	15	9	25
42	3	2	6	9	4
43	2	5	10	4	25
44	3	3	9	9	9
45	3	3	9	9	9
Σ	108	161	394	310	623

Table 47

Randomized Science Raw Data

Number	Years (x)	Score (y)	xy	x^2	y^2
1	2	5	10	4	25
2	3	2	6	9	4
3	3	3	9	9	9
4	3	1	3	9	1
5	3	5	15	9	25
6	0	2	0	0	4
7	3	3	9	9	9
8	3	4	12	9	16
9	3	2	6	9	4
10	3	5	15	9	25
11	3	3	9	9	9
12	3	4	12	9	16
13	3	3	9	9	9
14	3	2	6	9	4
15	3	3	9	9	9
16	3	3	9	9	9
17	0	1	0	0	1

18	3	3	9	9	9
19	2	1	2	4	1
20	3	3	9	9	9
21	3	3	9	9	9
22	2	4	8	4	16
23	3	4	12	9	16
24	3	3	9	9	9
25	3	2	6	9	4
26	3	5	15	9	25
27	3	2	6	9	4
28	3	3	9	9	9
29	3	2	6	9	4
30	3	2	6	9	4
Σ	81	88	245	237	298

Appendix D – Calculated Values

Table 44

PPMC (r) values

Subject	*n*	*r*
U.S. Government	66	0.399
European History	59	0.209
Comp Government	51	0.321
Psychology	42	0.104
Chemistry	22	0.276
World History	16	0.343
Biology	13	0.283
Environmental Science	12	-0.0558
Macroeconomics	12	0.172
Microeconomics	8	0.345

Table 31

Coefficients of Determination

AP exam	*r*	r^2
U.S. Government	.399	.16
European History	.209	.04
Comparative Government	.321	.10
Psychology	.104	.01
World History	.343	.12
Macroeconomics	.172	.03
Microeconomics	.345	.12
Biology	.283	.08
Chemistry	.276	.08
Environmental Science	-.056	.003

Table 36

Qualifying Rates by Number of Years Enrolled in Challenge-Social Studies

	Number of years enrolled in Challenge						
Exam	0	0.5	1.0	1.5	2	2.5	3
Comp	12		3		3		82
U.S. Gov	13		11		6		70
World	7		0		14	7	71
European	2		9		14		75
U.S. Hist	0		0		25		75
Psych	15	2.5	12.5		10		60
Micro	25		25		12.5		37.5
Macro	20		0		20		60

Table 33

Qualifying Rates Without and With 3 Years of Challenge

Subject	No. qualifying	% of examinees with qualifying scores	
		Without 3 years	With 3 years
U.S. History	4	25	75
Microeconomics	8	62.5	37.5
European History	57	25	75
Psychology	40	40	60
World History	14	29	71
U.S. Government	54	30	70
Environmental Sci	9	22	78
Chemistry	16	12.5	87.5
Physics B	2	0	100
Comp Government	33	18	82
Physics C - Mech	2	0	100
Physics C - E & M	2	0	100
Biology	6	17	83
Macroeconomics	5	40	60

Vitae

Katherine Glaude-Bolte currently serves as a gifted resource teacher in the Rockwood School District. In the course of her career, she has taught Academic Stretch (for gifted students), science, language arts, French, social studies, and math, mostly at the middle school level. She also taught English as a Second Language at the college level and spent two years teaching English in Japan.

Educational degrees include a bachelor of arts in French from Kansas University and a master of education in interdisciplinary curriculum and instruction from National-Louis University. In 2002, Katherine achieved National Board Certification as an early adolescent generalist. Since then, as a candidate support provider, a design team leader, and a cohort leader, she has assisted others in achieving National Board Certification.

Interested in travel and world languages, Katherine has visited school systems in France, Japan, Russia, and China and shares her international perspective with her students and colleagues.