Predictors of Success in High School Advanced Math and Science Coursework

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Abstract

The purpose of this study was to determine the difference in advanced course performance between students who met the listed prerequisite to enrollment and those who did not meet the listed prerequisite to enrollment. Students were selected for the study based on completion of an advanced mathematics course or advanced science course that had a performance level for the listed prerequisite course. The sample was taken from high school students of the Shawnee Mission School District from the 2010-2011 school year through the 2014-2015 school year. This research study was designed using quantitative, quasi-experimental methods. Chi-square tests of independence were used to determine the difference between students who met the prerequisite course performance level for enrollment in an advanced math or science course and those who did not meet the prerequisite performance level. There was a statistically significant result indicating students who met the enrollment criteria performed better in Algebra 2 Honors, College Algebra/Trigonometry, and Environmental Education 1. There was a statistically significant result indicating students who met the enrollment criteria performed better in Precalculus Honors and Statistics Honors/Advanced Placement; however, it should be noted the test was conducted after collapsing the dependent variable from five to two categories to prevent violation of the expected frequencies assumption. There was a statistically significant result indicating students who met the enrollment criteria performed better in Differential Equations Honors, Biology 2 Honors/Advanced Placement, Chemistry 2 Honors/Advanced Placement, and Environmental Education 2; however, these results could be compromised due to violation of the expected frequency assumption during the chi-square analysis, even after collapsing the dependent variable from five to two categories. The test statistic could not

be calculated for students in Geometry Honors due to the extremely low observed frequencies. All of the courses reviewed, except Geometry Honors, revealed students who did not meet the enrollment criteria yet still earned a grade of A in the advanced course. The implications of this study show it is critical for parents, students, teachers, and school leaders to work together to provide students opportunities in advanced coursework, whether they have met the enrollment criteria or not. Recommendations for further research include qualitative studies related to the students not meeting criteria for enrollment yet still being successful in the advanced courses and study of grading practice differences between teachers and schools.

Dedication

This study is dedicated to my wonderful and amazing family, Annie, Liam, and Lily, and all those family members I have lost during my dissertation journey, including my father, Dolph Flurry, and my grandparents, Walter and Geneva Stuber and Ruth Flurry. Completion of this study would not have been possible without their continued support and inspiration.

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Chapter One

Introduction

Advanced coursework in high school is often used as admissions selection criteria for colleges, and many students seek to enroll in advanced courses to better prepare themselves for the rigors of college coursework. School districts across the country use Advanced Placement enrollment numbers, the number of courses offered, and test scores as indicators of the quality of the educational experiences offered in their schools. Media outlets, including *Newsweek*, *US News and World Report*, and *The Washington Post* utilize Advanced Placement participation to develop lists of the United States' best schools. Access to advanced courses, Advanced Placement or otherwise, is desirable, but schools often limit enrollment based on a variety of criteria students must meet to enroll in a course. Many times these limitations begin before high school, as students are placed into ability tracks while still in middle school (Goldschmidt & Wang, 2003).

Background

The Shawnee Mission School District is located in northeast Johnson County, Kansas, serving a 72 square mile community encompassing the communities of Fairway, Lake Quivira, Leawood, Lenexa, Merriam, Mission, Mission Hills, Mission Woods, Overland Park, Prairie Village, Roeland Park, Shawnee, Westwood, and Westwood Hills. Shawnee Mission is a well-established community and has become more ethnically diverse as expansion continues to the south and west of the Kansas City metropolitan area. The district consists of 33 elementary schools, five middle schools, five high schools, an alternative high school, and one technical education center. The district is governed by a seven-member school board, five of whom are selected from each of the

five high school attendance areas and two selected at-large. The various municipalities have no fiscal control over the district. The cities of Leawood, Shawnee, Overland Park, and Lenexa are served by three other school districts, with Shawnee Mission serving the central area of these cities and other districts serving the far southern and far western sections of the cities.

Shawnee Mission has a predominately white student body (63.7%), with 8.9% reporting as African American, 17.5% reporting as Hispanic, and 9.9% reporting as Asian, American Indian or Alaskan native, native Hawaiian or other Pacific Islander, or multiple ethnicities (KSDE, 2015).

Table 1

Shawnee Mission School District Demographic Makeup By Percent

Ethnicity/Race	2010-11	2011-12	2012-13	2013-14	2014-15
Hispanic/Latino	15.2	16.0	16.8	17.2	17.5
White	67.8	66.6	66.0	65.5	63.7
African-American	8.1	8.6	8.6	8.8	8.9
Other	9.0	8.8	8.5	8.5	9.9

Note. Compiled from KSDE district report cards, KSDE, 2015

Approximately 37.8% of the students receive federal lunch support, and over 80% of seniors report attending a two- or four-year post-secondary education institution. The average composite ACT score for the class of 2014 school year was 24.0. Nearly 95% of the approximately 27,500 students attend school daily. Students have a wide array of sports and extra-curricular activities from which to choose, with nearly 70% of students participating in at least one after-school activity. Shawnee Mission School District teachers are a well-educated group of professionals, with 75% having at least one post-graduate degree.

Enrollment in advanced coursework is often limited to students who have received superior grades in lower-level courses. The Shawnee Mission School District High School Program of Studies lists 98 courses receiving honors-level credit. Twenty-nine of these courses are in the content areas of math and science. Ten of the math and science courses have perquisites listed with a required grade in the prerequisite course (SMSD, 2014). The instructors of the advanced courses set the level of achievement necessary for enrollment. Some advanced courses include a prerequisite performance level which can be bypassed with a teacher recommendation or administrator approval. Instructors and guidance counselors vary in the application of these pre-requisites, leading to confusion at times.

The College Board, which administers the Advanced Placement program, has recommended open admission policies. The Advanced Placement Equity Policy Statement relates the importance of open enrollment policies for schools:

> The College Board and the Advanced Placement Program encourage teachers, Advanced Placement Coordinators, and school administrators to make equitable access a guiding principle for their Advanced Placement programs. The College Board is committed to the principle that all students deserve an opportunity to participate in rigorous and academically challenging courses and programs. All students who are willing to accept the challenge of a rigorous academic curriculum should be given consideration for admission to Advanced Placement courses. The Board encourages the elimination of barriers that restrict access to Advanced Placement courses for students from ethnic, racial, and socioeconomic groups that have been traditionally underrepresented in the Advanced Placement

> Program. Schools should make every effort to ensure that their Advanced Placement classes reflect the diversity of their student population. (College Board, 2002, p. i)

Attewell (2001) claimed schools limit advanced courses to students sure to succeed. The reason behind these policies was reported as "school staff are convinced their school's reputation affects the ability of their strongest students to gain admission to the most sought-after colleges" (p. 291). Students also "avoid courses that may lower their GPAs" (p. 291), with math and science courses typically being the avoided courses.

Statement of the Problem

Klopfenstein (2003) found schools must "inevitably decide which students are allowed into rigorous and fast-paced classes" (p. 42). Requiring all students to take advanced coursework caused frustration for students and watering down of the content. Klopfenstein reported recommendations of the College Board, which included considering "enrollment criteria for Advanced Placement students and ensure it includes multiple measures of achievement and motivation. Goal-oriented, motivated students with relatively low test scores are likely to gain more from the program than unmotivated students with high test scores" (p. 47). The use of Advanced Placement test scores as a method to evaluate schools and teachers has caused instructors to seek out participation from students they believe will perform well on the test. Organizations such as *U.S. News and World Report*, *The Washington Post*, and *Newsweek* use Advanced Placement participation and scores along with demographic information to rate high schools nationally (Matthews, 2015; Morse, 2015; *Newsweek*, 2015).

Schools emphasize advanced coursework as a route to a college preparatory

curriculum for students, college dual credit options for students, and accolades for the school itself. Access to advanced courses can be limited by structural barriers put in place by the school, which include prerequisite courses and performance levels. Access to advanced courses can also be limited by students' self-disqualification due to previous course performance. The 2015-16 Shawnee Mission School District High School Program Planning Guide (SMSD, 2014) lists courses offered by the district's high schools. Included in the course descriptions are any prerequisite courses. Many of these courses include ambiguity in the form of a teacher or counselor recommendation being required for enrollment or as an option in overriding the listed prerequisite course or performance level. Table 2 summarizes the district advanced math and science courses requiring a specific grade in the prerequisite class, which were the courses of interest in this study. Five of the courses contain the phrase "or teacher recommendation," implying a student or parent must seek out a waiver to the stated prerequisite. The problem this study sought to clarify was the accuracy of these prerequisites as predictors of success when persuasive students and their parents can circumvent them.

Table 2

Study Target Courses and Prerequisites

Subject Area	Course Name	Prerequisite
Math	Algebra 2 Honors	Geometry with teacher recommendation only, or Geometry Honors with a grade of "B" or better or teacher recommendation, or concurrent enrollment in Geometry Honors with administrator approval
Math	Differential Equations Honors	Calculus 3 Honors with a "B" or better
Math	Geometry Honors	Algebra 1 with a "B" or better and teacher recommendation
Math	Precalculus/College Algebra & Trigonometry	Algebra 2 (a grade of "B" or better is strongly recommended)
Math	Precalculus Honors	Algebra 2 Honors with a "B" or better
Math	Advanced Placement Statistics	Algebra 2 with a grade of "B" or better
Science	Biology 2 Honors/Advanced Placement	Biology 1 with a "B" or better and previous or concurrent enrollment in Chemistry 1
Science	Chemistry 2 Honors/Advanced Placement	Chemistry 1 with a "B" or better and completion of Algebra 2 or teacher approval
Science	Environmental Education 1	Biology 1 with a "C" or better or teacher recommendation
Science	Environmental Education 2	Environmental Education 1 with a "C" or better or teacher recommendation

Note. Compiled from the *High School Program Planning Guide*, SMSD, 2014

Purpose Statement

The purpose of this study was to determine the difference in advanced course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment.

Significance of the Study

The study sought to assist educational leaders in guiding both students and teachers toward a more equitable method of determining which students are prepared for advanced coursework. The job of an educational leader is to provide for a rigorous curriculum that is relevant to students' career and college goals. School leaders must be certain students are not being left behind when it comes to accessibility to advanced courses. There is a need to understand what role can be played in breaking down institutional barriers and encouraging students to further their education.

Delimitations

Delimitations define the scope and boundaries of a study and are determined by the researcher (Lunenburg & Irby, 2008). The following delimitations were defined in this study:

1. Grade data were collected and analyzed over the course of six school years from 2010-2011 to 2014-2015 at the six high schools of the Shawnee Mission School District.
2. Grade data were collected and analyzed only in advanced math and science courses with a required grade in the prerequisite course as listed in the Shawnee Mission School District 2015-16 High School Program Planning Guide. (SMSD, 2014)

Assumptions

Most Shawnee Mission School District students are strongly encouraged by parents to attempt advanced coursework in preparation for college. Nearly 80% of graduating seniors indicate the intent to enroll in a two- or four-year college. The results of this study would not necessarily translate well to the inner-city schools of the adjoining urban center. The researcher assumes other schools with similar demographics and course requirements would show similar results.

Research Questions

The questions the researcher sought to answer are:

RQ1. To what extent is there a difference in first semester course grades in advanced mathematics courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

RQ2. To what extent is there a difference in first semester course grades in advanced science courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

Definition of Terms

Advanced courses. For the purpose of this study, advanced courses will be defined as those courses offered at Shawnee Mission high schools requiring completion of a prerequisite for enrollment. A list of these courses and the descriptions can be found in Table 2. (SMSD, 2014).

Advanced Placement Program (Advanced Placement). The Advanced Placement Program (Advanced Placement) is administered by the College Board. Students who successfully complete the culminating Advanced Placement exam may

earn college credit, depending on their level of achievement (College Board, 2015).

Prerequisite Coursework. Prerequisite courses are courses required to be completed prior to enrolling in an advanced course. Many prerequisites to enrollment include a certain grade be earned in the prerequisite course. Advanced courses in Shawnee Mission have prerequisites for enrollment listed in the course descriptions. Course descriptions for both the advanced courses and their prerequisites are listed in Table 2 (SMSD, 2014).

Overview of the Methodology

This study was designed to compare student performance in advanced courses with their performance in the listed prerequisite course. The population for the study was students from the six high schools of the Shawnee Mission School District enrolled in advanced math and science courses with prerequisites to enrollment. Chi-square tests of independence were used to compare students meeting the prerequisite performance level with students who did not meet the prerequisite performance level for each course pair. Details of the study methodology are reviewed in chapter three.

Organization of the Study

The purpose of this study was to determine the difference in advanced course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment. This chapter has provided background information related to the Shawnee Mission School District located in Johnson County, Kansas. Demographic information was reviewed. This chapter has also provided a brief overview of the current research and recommendations surrounding accessibility to advanced coursework in high school. Chapters two, three, four and five

provide an overview of current research related to advanced coursework enrollment, study methodology, study results and interpretation, and recommendations for further research.

Chapter Two

Review of Literature

This chapter reviews current literature relating to access to advanced high school courses. The information is organized into sections reviewing the history of honors courses and the Advanced Placement program, the importance of advanced coursework, the use of Advanced Placement and other measures to rank and compare schools, qualitative and quantitative research regarding predicting success in advanced high school coursework, racial equity in advanced high school coursework, tracking of students into curriculum paths, and common practices related to advanced course enrollment.

History of Advanced Placement and Honors Courses

The College Board (2003) described the history of the Advanced Placement program beginning in the years after World War II. The Ford Foundation commissioned a set of studies which concluded, "secondary schools and colleges work together to avoid repetition in course work at the high school and college levels and to allow motivated student to work at the height of their capabilities" (p. 1). The initial set of course descriptions and assessments was piloted in 1952, with the College Board taking over the program in the 1955-56 school year. The number of Advanced Placement tests administered has grown from 162 exams in seven schools in 1954 to nearly two million exams in 2011 (College Board, 2011).

Honors courses, curriculum tracking, and ability tracking have been a part of the educational landscape for several decades. Honors courses, according the district being studied, "are both accelerated and enriched" (Shawnee Mission School District, 2014).

These courses are designated as receiving extra grade points when determining grade point average. Curriculum tracking was defined by Oakes (1987) as a "sequence of courses designed for college-preparatory students, vocational students, or general track students" (p. 131). Oakes went on to define ability grouping as more subject specific and based on students' aptitude or interest in a particular content area.

Importance of Advanced Coursework for Students

Adelman (1999) completed a longitudinal study of students from eighth grade to postsecondary education, concluding "the intensity and quality of one's secondary school curriculum was the strongest influence not merely on college entrance, but more importantly, on bachelor's degree completion" (p. 19). Upper-level mathematics courses showed the strongest effect on post-secondary success. Adelman found completing a mathematics course above the level of Algebra 2 "more than doubles the odds that a student who enters postsecondary education will complete a bachelor's degree" (p18). Adelman also found the rigor of a student's high school curriculum outweighs the effects of socioeconomic status on bachelor's degree completion.

Adelman replicated his 1999 study in 2006, and reported additional recommendations for high schools and colleges. One recommendation was to take a critical look inside the high school classroom. "Secondary schools must provide maximum opportunity-to-learn, by which we mean not merely course titles, but course substance" (p. 108). Adelman also pushed for increased cooperation between high schools and local postsecondary institutions, "indeed, the first year of postsecondary education has to begin in high school, if not by Advanced Placement then by the growing dual enrollment movement" (p. 108).

Keng and Dodd (2008) compiled data for the College Board, administer of the Advanced Placement program, reviewing college success of students who had earned college credit through the Advanced Placement program and their academically-similar peers who did not earn college credit through the Advanced Placement program. College success was measured by college credit hours completed and college grade point average. Academically similar peers were determined through high school class rank and college entrance exam scores. The authors found students who had earned Advanced Placement credit "consistently outperformed others types of students in college, especially in the related subject area" (p. 18).

School Rankings and Comparisons Based on Advanced Coursework

Many high schools are ranked within their own district and at the state and national level. These rankings, in many cases, include some aspect of advanced coursework consumption and performance. Many schools use these ranking as points of pride and hang banners announcing the rankings.

Newsweek publishes an annual list of 500 schools it labels as "America's Top High Schools." The *Newsweek* methodology includes an analysis of state assessments in math and reading, an internally-developed college readiness index based on six criteria, which are detailed in Table 3, and an equity analysis based on economically disadvantaged students.

Table 3

Newsweek College Readiness Index

Criteria	Percentage of College Readiness Index
College enrollment rate	25
Graduation rate	20
Weighted Advanced Placement/IB/Dual Enrollment composite	17.5
Weighted SAT/ACT composite	17.5
Student retention	10
Counselor-to-student ratio	10

Note. Adapted from *Newsweek's Methodology for High School Rankings*, *Newsweek*, 2015

The rank-ordered list published each year by *Newsweek* is based solely on a school's score on the college readiness index (Newsweek, 2015).

U.S News and World Report publishes an annual list of schools it labels as "Best High Schools." The rankings "include data on more than 21,000 public high schools in 50 states and the District of Columbia" and "schools were awarded gold, silver or bronze medals based on their performance on state assessments and how well they prepare students for college" (Morse, 2015). The *U.S. News and World Report* methodology included three steps. Step one was based on state assessments in reading and math. Schools need to score one-third of one standard deviation above the state average to move to step two of the process. Step two incorporated demographic information, using state assessment data to review the school-level performance of black, Hispanic, and economically disadvantaged students to the state average of the same student groups. Step three used Advanced Placement and International Baccalaureate test data to determine each school's college-readiness performance. College-readiness performance

was gauged by the ratio of students taking an Advanced Placement or IB examination to the number of graduating seniors. The final step included student performance on Advanced Placement and IB examinations, calculating a ratio of the number of students receiving a three or higher on an Advanced Placement examination or a four or higher on an IB examination to the number of graduating seniors (Morse, 2015).

The Washington Post publishes an annual list of "America's Most Challenging High Schools." This list is created from an internally-developed challenge index, which is the ratio of students taking an Advanced Placement, International Baccalaureate, or International Certificate of Education examination to the number of graduating seniors (Matthews, 2015). Schools achieving a challenge index of 1.0 or greater are placed on the "Most Challenging High Schools" list in rank order from largest ratio to smallest. *The Washington Post* does not include performance on the exams as part of the methodology. Matthews (2015) explains he found "many high schools kept (performance) artificially high by allowing only top students to take the courses."

The Shawnee Mission School District publishes an annual report of students pursuing college credit through advanced coursework taken in high school. This report includes participation and performance on Advanced Placement and International Baccalaureate examinations, along with concurrent enrollment programs offered through the local community college. Each of the five Shawnee Mission School District high schools is identified with the participation and performance, and the data is reported publicly (SMSD, 2015a).

Predictors of Academic Success

Numerous studies have been completed on the variables contributing to students' academic success in mathematics courses. Islam and Al-Ghassani (2015) reviewed the college math success of 615 students and compared it with their gender, overall high school performance, and high school math performance using multiple regression analyses. The authors found "the correlation coefficients between overall high school score and GPA in Calculus I, and the high school math score and GPA in calculus were very close ($r = 0.506$ and $r = 0.501$, respectively)" (p. 74). The highest correlation was found when combining overall high school score with math score ($r = 0.635$). Strayhorn (2010) studied the influence of social, family, and school-related variables on the math achievement of African-American high school students. The author found college-education parents, parents involved in the school, and teachers who praise students for effort had positive effects on math achievement scores. Strayhorn also suggested "cultural capital (e.g., parent's level of education, strong support at home) might yield the academic capital (e.g., parental involvement, time spent studying) necessary to succeed in school" (p. 191).

The positive effects of adult support of students have been documented at length. Chen (2005) studied adolescent students finding "the adolescents' self-perceived academic support from parents and especially teachers are powerful predictors or their own perceived levels of academic engagement and achievement" (p. 114). Tucker et al. (2002) studied predictors of academic engagement of low-income African American students, reviewing both teacher behaviors and student behaviors. Academic engagement was measured using a self-rating questionnaire of the students covering emotional

engagement, the centrality of school, effort, attention, and going above and beyond the call. The authors found teacher involvement, defined as a "demonstration of caring and interest in the child" (p. 479), had the strongest positive effect on student engagement of all factors reviewed. Tucker et al. also emphasized the importance of teacher classroom structure, indicating "teachers can promote positive student self-perceptions by providing a positive, caring and consistent classroom structure, by allowing students to make choices, and by helping them see connections between their classroom work and other aspects of their lives" (p.486). Ferguson (2003) echoed these findings and attributed student performance to teacher expectations of students. A more recent study by Archambault et al. (2012) examined teacher expectations of students and sense of self-efficacy on student mathematics achievement, reviewing 79 teachers and 1,364 students, specifically focusing on low-socioeconomic status students. Student mathematics achievement was measured by class grades (as a percent). Teacher expectations of students and self-efficacy were assessed using a survey instrument. Similar to the studies above, they reported "the more teachers maintain high expectations and the more efficacious they feel in helping their students succeed, the more students' achievement increase over the year" (p. 324).

Student participation in extracurricular activities and its relationship to student achievement has also been extensively studied. Fredricks and Eccles (2010) examined the relationship between organized activity participation and developmental outcomes in high school juniors. The study followed the students into their first year after high school. The authors found that "participation in a greater number of organized activities is generally predictive of positive development" (p. 327). They did report a caveat on

participation, noting, "at high levels of involvement, the well-being of youth either declined or leveled-off slightly, suggesting there may be a threshold beyond which further increases in participation have diminished academic benefits" (p. 328). Bryan et al. (2012) studied the relationship between school bonding and academic achievement in high school students. Academic achievement was measured by comparing 10th and 12th grade mathematics scores. The authors found "even after prior academic achievement was accounted for, school involvement was still positively associated with academic achievement" (p. 475).

Archibald and Farley-Ripple (2012) reported on placement criteria in high school mathematics, finding "there is no single theory specifying appropriate and inappropriate criteria" and "there is disagreement about the degree to which academic criteria are the main determinants in allocating students to upper and lower mathematics course levels in high school" (p. 36). The authors found several studies related to these criteria, however, few contained any reference to prior grades. High schools in the study were consistent in their application of placement criteria. Decisions made at the middle school- or elementary school-level determined students' ability to take upper-level math courses high school. Ultimately, the authors recommended policy makers should "focus on middle schools as a vehicle for improving long-term education outcomes" (p. 49).

ACT (2008) echoed Archibald and Farley-Ripple's recommendations related to a focus on middle school preparation of students. "A key focus for the upper elementary grades and middle school should be to prepare students for the high school curriculum by focusing on the attainment of foundational skills" and "mastery of these foundational skills must become a nonnegotiable prerequisite for entry into high school" (p. 37).

ACT's data suggested early intervention is key. Students entering high school without these foundational skills will not be college- or career-ready upon high school graduation.

Palin (2001) examined Advanced Placement U.S. History scores at a private high school in Florida in relationship to standardized test scores and other academic measures. Seventy-three students took part in the three-year study, which reviewed PSAT scores, student GPA, and anticipated college majors. The results were mixed, as some students who scored in the 50th percentile on the PSAT out-performed those who scored higher on the PSAT. GPA was a more determining factor in Advanced Placement test performance. Students scoring 3, 4 or 5 on the Advanced Placement test had a GPA 0.7 higher than those scoring 1 or 2. Anticipated college major, as listed on PSAT registration, played a large role in predicting success on the Advanced Placement test. Fifty percent of the students scoring a 5 on the test were planning on pursuing social science majors in college. Eighty-six percent of those who scored 1 or 2 expressed no interest in pursuing the social sciences.

Camara and Echternacht (2000) reviewed SAT college entrance examination scores and high school grades in comparison with college success, which was measured by freshman year grade point average. Freshman year grade point average was used assuming most college freshmen take similar basic courses and freshman grade point averages correlated well with final cumulative grade point averages. The study authors reported "high school grades typically are slightly better predictors of achievement" than SAT scores (p. 9).

Potolsky, Cohen, and Saylor (2003) looked at the current nursing shortage, focusing on means of retaining first-year nursing students in baccalaureate programs.

Tutoring programs and prerequisite grades were examined as a predictor of success in nursing school. The authors found the tutoring program did not show a significant link to academic performance. Prerequisite science course grades, however, emerged as a reliable indicator of achievement in the small sample of 37 students. They recommended using more stringent entry requirements to ensure success of admitted students.

Equity in Advanced Course Enrollment

The College Board, which administers the Advanced Placement program, is committed to all students having access to the rigorous curriculum provided by Advanced Placement courses. According to the College Board, all students who show interest and are willing to accept the challenge of Advanced Placement courses should be given consideration for admission to courses. The College Board has recommended the elimination of barriers that restrict enrollment for members of groups that have been historically underrepresented in the Advanced Placement program (College Board, 2002).

DiMartino and Miles (2004) viewed heterogeneous groups as key to student success. "Whenever possible, students should spend significant parts of their school day in heterogeneous groups so that they learn to see themselves as important members of this diverse group" (p. 47). They indicated that to promote student achievement a school must also promote equity. "Strategies that perpetuate inequity promote disillusionment, distrust, and disengagement" (p. 48).

Goldschmidt and Wang (2003) found a significant racial gap in course consumption at the 11th grade level when compared with 8th grade enrollment. Caucasian and Asian students were well represented, but African American and Hispanic students are underrepresented. They found a small gender gap in enrollment that carried over

from middle school into high school. These inequities were amplified by tracking students into low-, middle-, and high-ability groups. The achievement gap was not explained away by prior achievement alone; other factors influenced the students' high school achievement.

Finn, Gerber, and Wang (2002) reviewed practices that encouraged or discouraged advanced math course enrollment. The authors used data from 305 public high schools to identify courses taken, determine the correlation between course offerings and school demographics, and determine the impact of course offerings and graduation requirements on courses actually taken by students. They found there was virtually no relationship between course offerings and school demographics. There was some significance to the poverty level of the school and years of math taken by students. Graduation requirements were similar in most low- and high-poverty schools; they concluded the discrepancy must be in how students are selected or assigned to particular courses. More rigorous graduation standards at some schools translated into an increased enrollment in advanced courses by all subgroups of students.

Solorzano and Ornelas (2004) examined the access and availability of Advanced Placement courses for Latino and African American students. The authors focused on three areas: school practices that maintain discrimination in Advanced Placement access, student and parent response to these practices, and school reforms that can help eliminate these practices. They began by looking at recent Supreme Court cases dealing with using race in the college admissions process and the role of Advanced Placement courses in the admissions and placement process. They went on to examine several high schools in the Los Angeles area, both suburban and inner city, for racial inequity in Advanced

Placement enrollment. In most cases, white students made up a substantially larger percentage of Advanced Placement enrollment when compared with the total school population. Recommendations to alleviate these inequities in high schools included increased access to qualified teachers, eliminating tracking, intensive academic support, and creating a college-bound culture. Recommendations to improve access to college admission for minority students included using broader factors like advanced course GPA, eliminating Advanced Placement courses from the criteria and admission officers pressuring high schools to offer a rigorous curriculum for all students.

Ndura, Robinson and Ochs (2003) examined the Advanced Placement enrollment statistics for minority students and factors affecting their enrollment in courses. The study was performed in a district of eight high schools. The authors first reviewed the historical background of the need for a more rigorous curriculum in high schools. Using data from 2001, they reported approximately 70% of U.S. high school graduates enroll in some form of post-secondary program and only 50% of students enrolling in a four-year college graduate with a degree. The primary reason for lack of college completion was students not being prepared by high schools for the rigors of college coursework. Minority groups showed disproportionately low enrollment in Advanced Placement courses, with the exception of Asian/Pacific Islander students. Parents and teachers were determined to be the most influential people when students make decisions on course enrollment. The study also looked at household income related to Advanced Placement enrollment and found there is a positive relationship between the two. Hispanic and Native American groups had the lowest percentage of parents with professional or highly-skilled jobs, and also had the lowest Advanced Placement enrollment.

Corcoran (2007) investigated student characteristics and the disproportionately low number of Hispanic and African American students enrolling in Advanced Placement courses. Corcoran's qualitative analysis listed three common reasons students do not take Advanced Placement courses, "self-doubt of one's own abilities, lack of motivation, and lack of credentials" (p. 91). Students reported they would be more likely to enroll in Advanced Placement courses if they could motivate themselves to do it and could increase their confidence in their own abilities.

Curriculum Tracking of Students

Tracking, or ability grouping, was defined by Oakes (1987) as "the grouping of students by presumed ability or achievement into a series of courses with differentiated curriculums" (p. 131). Yonezawa, Wells and Serna (2002) suggested that "course-by-course ability grouping [leads to] de-facto tracking" (p. 63). This de-facto tracking in schools with policies of openness often stemmed from hidden barriers to course choice. "Information was distributed unevenly from educators to students; educators responded selectively to students' requests for higher placements; and students encountered hidden prerequisites when exercising their 'options'" (p. 46). Students were often placed in special programs, either accelerated or remedial, at the elementary level. The attitudes students and their teachers developed early in their educational career tended to continue through high school. "Students who are labeled as gifted in elementary school develop a habitus of entitlement. They, unlike the students with leveled aspirations, see high-track classes as their destiny" (p. 52). Peer groups also affected course choices by students. Students formed friendships within the ability group and tended to choose classes that these friends chose. Students that attempted to break out of their ability group reported

"being ostracized by their peers" (p. 54). DiMartino and Miles (2004) report three reasons that perpetuate tracking, "first it creates greater efficiency and ease for teachers; second, students learn better and feel more positive about themselves; and third, it lessens the sense of failure for slower students" (p. 46).

Attewell (2001) claimed schools limit advanced courses to students that are sure to succeed. The reason behind these policies was "school staff are convinced that their school's reputation affects the ability of their strongest students to gain admission to the most sought-after colleges" (p. 291). Students also "avoid courses that may lower their GPAs" (p. 291), with math and science courses typically being the avoided courses.

In *Breaking Ranks II* (NASSP, 2004), the National Association of Secondary School Principals (NASSP) provided strategies to ensure schools serve every student. Personalizing students' educational planning was suggested as the key to increased student achievement and success. Strategies for accomplishing this included creating smaller units within the high school, limiting teacher contact to no more than 90 students each term, and developing flexible scheduling practices to better meet students' academic needs. NASSP also advised against tracking and ability grouping, recommending regular collaboration amongst staff to address the needs of all students.

Enrollment Guidelines Used by Schools

Klopfenstein (2003) found schools must "inevitably decide which students are allowed into these rigorous and fast-paced classes" (p. 42). Requiring all students to take Advanced Placement coursework caused frustration for students and watering down of the content. Other schools used a single criterion, such as GPA or standardized test scores, to determine eligibility. Most schools fell somewhere between these two

extremes. Klopfenstein (2003) reported the College Board, which administers the Advanced Placement program, believes schools should "open their programs to any student willing to take on the challenge" (p. 43). Recommendations included considering "enrollment criteria for Advanced Placement students and ensure that it includes multiple measures of achievement and motivation. Goal-oriented, motivated students with relatively low test scores are likely to gain more from the program than unmotivated students with high test scores" (p. 47).

Potter and Morgan (2000) described a school that implemented several steps to improve both enrollment and success in Advanced Placement courses. Beginning in middle school there was intense counseling for students and parents on the need to take rigorous courses. A tutoring program was available for all students in the high school, regardless of the courses they are enrolled in. Curriculum between courses was aligned and scheduling set up to provide a seamless flow from class to class. Weekly progress was reported back to parents and students in Advanced Placement courses. All students were advised on the expectations of Advanced Placement courses and given a ten-day window in which to drop the course. A dedicated testing coordinator freed up teachers, administrators and counselors to focus on students. Special PSAT/ACT preparation was included in all English and math courses. The district paid for all Advanced Placement training. The results were impressive. Out of nearly 1100 Advanced Placement tests taken by 900 students, 70% score 3 or above (Potter & Morgan, 2000).

Adlai Stevenson High School is a comprehensive high school in suburban Chicago, Illinois, with an enrollment of over 4,000 students. The school has been repeatedly awarded for excellence in education by the United States Department of

Education. The school has a completely open enrollment philosophy and attempts to give every student an Advanced Placement opportunity before graduation. Administration is pushing for Advanced Placement coursework as a graduation requirement. All students enrolled in Advanced Placement courses are required to take the Advanced Placement examination. The school pays for testing for students with a documented financial hardship (Personal communication with Dr. Eric Twadell on October 27, 2004). More than 20 Advanced Placement classes are available and Stevenson regularly leads the Midwest region in Advanced Placement participation and has ranked in the top five worldwide. Data on the school website shows that 1,211 students took Advanced Placement exams (27% of total enrollment), 87% of whom received a score of three or better (Adlai E. Stevenson High School, 2004).

A review of neighboring school districts' high school course catalogs reveals similarities in course enrollment criteria for math and science courses. The Olathe School District lists prerequisite course completion for advanced math and science course enrollment but does not require a specific grade in the prerequisite course. None of the comparable courses to those reviewed in this study require a teacher recommendation for enrollment (Olathe School District, 2015). The DeSoto School District also lists prerequisite course completion for advanced math and science course enrollment but does not require a specific grade in the prerequisite course. None of the comparable courses to those reviewed in this study require a teacher recommendation for enrollment (DeSoto School District, 2015). The Blue Valley School District similarly lists prerequisite course completion for advanced math and science course enrollment but does not require a specific grade in the prerequisite course. The Blue Valley School District, however, does

require teacher input for three advanced math courses. The only Blue Valley math course listing a teacher recommendation as a prerequisite for enrollment is Honors Accelerated Pre-Calculus BC. Advanced Placement Calculus BC and Honors Multivariable Calculus both list teacher consultation as a prerequisite to enrollment (Blue Valley School District, 2015). The Turner Unified School District is most varied in their prerequisite criteria and most similar to the focus district of this study. The criteria used for course enrollment were developed after a longitudinal study was completed to compare nationally-normed standardized test scores, Kansas Assessment Program scores, and course performance (Personal communication with Paul Colwell on October 7, 2015). Turner Unified School District requires a specified performance level in five science courses and four math courses. Teacher recommendation is a factor, either as a specified prerequisite or as a method to circumvent the prior course performance, in several courses in the program of study. It was also noted seven courses across all curricular areas require a 3.0 grade point average (Turner Unified School District, 2015).

Summary

This study was designed to determine the accuracy of advanced course prerequisite performance in predicting the future success of students in advanced math and science coursework. This chapter reviewed current literature relating to access to advanced high school courses. The information was organized into sections reviewing the history of honors courses and the Advanced Placement program, the importance of advanced coursework, the use of Advanced Placement and other measures to rank and compare schools, qualitative and quantitative research regarding predicting success in advanced high school coursework, racial equity in advanced high school coursework,

tracking of students into curriculum paths, and common practices related to advanced course enrollment. Keys points are summarized here. Klopfenstein (2003) recommended considering multiple measures when reviewing student enrollment in advanced coursework. "Goal-oriented, motivated students with relatively low test scores are likely to gain more from the program than unmotivated students with high test scores" (p. 47). Palin (2001) demonstrated GPA had a greater effect on predicting success on Advanced Placement tests than PSAT scores. Yonezawa, Wells and Serna (2002) reported ability-grouping as pervasive even as early as elementary school, and that many high schools with open enrollment policies for advanced coursework maintain hidden barriers. Schools with successful open enrollment policies for advanced courses focused their resources on teacher training, vertical curriculum alignment, and tutoring programs. Chapters three, four, and five provide an overview of the study methodology, study results and interpretation, and recommendations for further research.

Chapter Three

Methods

The purpose of this study was to determine the difference in advanced math and science course performance between students who met the listed prerequisite to enrollment and those who did not meet the listed prerequisite to enrollment. The purpose of this chapter is to review the research design, population and sample, sampling procedures, instrumentation, measurement, validity and reliability, data collection procedures, data analysis and hypothesis testing, and limitations of the study.

Research Design

This research study was designed using quantitative, quasi-experimental methods. The independent variable was performance in prerequisite courses, categorized into those who met the prerequisite course performance level for enrollment in an advanced math or science course and those who did not meet the prerequisite performance level. The dependent variable in this study was performance in high school advanced math and science courses. The quantitative method of chi-square tests of independence was used for each course pairing to determine the difference between students who met the prerequisite course performance level for enrollment in an advanced math or science course and those who did not meet the prerequisite performance level. Chi-square testing was used due to the categorical nature of semester course grades. Chi-square testing "compares the proportions actually observed in a study to the proportions expected by chance, to see if they are significantly different" (Lunenburg & Irby, 2008, p. 78).

Population and Sample

The population of interest in this study was students attending high school in the Shawnee Mission School District. The sample from the population under examination in this study was students who completed an advanced math or science course with a prerequisite course and performance level in the prerequisite course for enrollment in the advanced course from the 2010-2011 school year through the 2014-2015 school year. These courses and their prerequisite information can be found in Table 2 on page 6.

Sampling Procedures

Purposive sampling was used to obtain the participants for this study. Purposive sampling, according to Lundberg & Irby (2008), "involves selecting a sample based on the researcher's experience or knowledge of the group to be sampled" (p. 175). The sample for this study was high school students who completed an advanced math or science course with a prerequisite course and performance level in the prerequisite course for enrollment in the advanced course listed in the 2015-2016 Shawnee Mission School District High School Program Planning Guide. The sample of students was gathered from five academic years from 2010-2011 through 2014-2015.

Instrumentation

Course grades were used as the measurement of student performance in advanced courses and the prerequisite courses. Course grades are primarily a reflection of student mastery of the course objectives. Course grades can, however, incorporate other factors, which vary between teachers and schools. These factors include homework policies related to completion versus correctness, late work policies, and test correction options. Fall semester grades were used as a measure of students' overall performance in both the

prerequisite course and the advanced course. Fall semester course grades are used in the enrollment process and course recommendation process for the subsequent school year.

Advanced math and science courses studied in this research were chosen based on the courses having prerequisites listed with a performance level in the 2015-2016 Shawnee Mission School District High School Program Planning Guide (SMSD, 2014). The math courses reviewed were Algebra 2 Honors, College Algebra/Trig (known in the Shawnee Mission School District as Precalculus prior to the 2014-15 school year), Differential Equations Honors, Geometry Honors, Precalculus Honors, and Statistics Honors/Advanced Placement. The science courses reviewed were Biology 2 Honors/Advanced Placement, Chemistry 2 Honors/Advanced Placement, Environmental Education 1, and Environmental Education 2.

Measurement

Course letter grades were used to measure student performance. Prerequisite performance was separated into two categories, those who met the listed criteria and those who did not. Prerequisite information is listed in Table 2. Course grades are reported by teachers in the Shawnee Mission School District on a nine-week basis. Course grades are determined by student achievement of course objectives and instructional expectations. The 18-week semester grade is used to determine the awarding of credit for the course. Year-long courses, which included all courses in this study, receive two semester grades. Each of these semester grades also included a comprehensive final exam which accounts for 10-20% of the semester grade. Credit for the year-long courses is determined independently each semester (SMSD, 2014a).

Math course grades used in this study were Algebra 1 first semester grade, Algebra 2 first semester grade, Algebra 2 Honors first semester grade, College Algebra/Trig first semester grade (known in the Shawnee Mission School District as Precalculus prior to the 2014-15 school year), Differential Equations Honors first semester grade, Geometry Honors first semester grade, Precalculus Honors first semester grade, and Statistics Honors/Advanced Placement first semester grade.

Science course grades used in this study were Biology 1 first semester grade, Biology 2 Honors/Advanced Placement first semester grade, Chemistry 1 first semester grade, Chemistry 2 Honors/Advanced Placement first semester grade, Environmental Education 1 first semester grade, and Environmental Education 2 first semester grade.

Validity

Internal validity is defined by Gall, Gall and Borg (2005) as "the extent to which extraneous variables have been controlled and thus the level of certainty that the experimental treatment has a causal influence on the dependent variable" (p. 252). The choice of semester course grades for instrumentation in this study provides a relatively consistent measure of student performance. There was, however, some slight variation in how course grades were calculated from teacher to teacher. Using geometry as an example, the weighting of homework versus assessment varied slightly between teachers and buildings. Teacher syllabi pulled from the Teacher Pages section of the Shawnee Mission School District website showed classroom assessments ranged from 75-80% of the pre-final exam semester grade and homework ranged from 20-25% of the pre-final exam semester grade. Final exam weighting for geometry was consistent within the five high schools, however, ranged from 10-15% (SMSD, 2015).

External validity is defined by Gall, Gall and Borg (2005) as "the extent to which the experimental findings can be generalized beyond the research sample to other groups" (p. 252). The Shawnee Mission School District is a large suburban school district consisting of a diverse student population. The sample for this study was representative of the district as a whole. Variations between teacher grading procedures could affect the generalization of the results to other settings.

Reliability

Reliability of a measurement tool is defined by Gall, Gall and Borg (2005) as "the degree that it is free of measurement error" (p. 139). Inter-rater reliability factors into course grades. Classroom-level decisions related to grading practices, as noted above, could affect the reliability the course grades used in this study.

Data Collection Procedures

Permission was obtained from the Shawnee Mission School District director of research and assessment to conduct the study using district archival data. Data was extracted by the Shawnee Mission School District research and assessment department from the district's student information system for the schools years from 2010-2011 to 2014-2015. The data were anonymized by the district before being provided to the researcher. Data provided included student ethnicity, race, gender, math and science course consumption, and semester course grades.

Data Analysis and Hypothesis Testing

The research questions guiding this study focused on the predictive ability of prerequisite course grades on students' advanced course grades. The following research questions, hypotheses, and statistical tests were used in the data analysis.

RQ1. To what extent is there a difference in first semester course grades in advanced mathematics courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

H1. There is a difference between student semester grades in Algebra 2 Honors for those who earned a letter grade of B or better in Geometry Honors and those who did not.

H2. There is a difference between student semester grades in College Algebra/Trigonometry for those who earned a letter grade of B or better in Algebra 2 and those who did not.

H3. There is a difference between student semester grades in Differential Equations Honors for those who earned a letter grade of B or better in Calculus 3 Honors and those who did not.

H4. There is a difference between student semester grades in Geometry Honors for those who earned a letter grade of B or better in Algebra 1 and those who did not.

H5. There is a difference between student semester grades in Precalculus Honors for those who earned a letter grade of B or better in Algebra 2 Honors and those who did not.

H6. There is a difference between student semester grades in Statistics Honors/Advanced Placement for those who earned a letter grade of B or better in Algebra 2 and those who did not.

To test each hypothesis (H1-H6), first semester course grades from the selected advanced math courses were compared against the two categories for prerequisite completion (students who met prerequisite performance level and students who did not

meet prerequisite performance level). A chi-square test of independence was completed for each pair of courses to compare students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria. A significance level of 0.05 was set for all hypothesis testing.

RQ2. To what extent is there a difference in first semester course grades in advanced science courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

H7. There is a difference between student semester grades in Biology 2 Honors/Advanced Placement for those who earned a letter grade of B or better in Biology 1 and those who did not.

H8. There is a difference between student semester grades in Chemistry 2 Honors/Advanced Placement for those who earned a letter grade of B or better in Chemistry 1 and those who did not.

H9. There is a difference between student semester grades in Environmental Education 1 for those who earned a letter grade of C or better in Biology 1 and those who did not.

H10. There is a difference between student semester grades in Environmental Education 2 for those who earned a letter grade of C or better in Environmental Education 1 and those who did not.

To test each hypothesis (H7-H10), first semester course grades from the selected advanced science courses were compared against the two categories for prerequisite completion (students who met prerequisite performance level and students who did not meet prerequisite performance level). A chi-square test of independence was completed

for each pair of courses to compare students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria. A significance level of 0.05 was set for all hypothesis testing.

Limitations

Roberts (2004) defined limitations as areas the researcher has little or no control over. The relationship between prerequisite course grades and subsequent advanced course grades could include unknown variables not controlled for in this study. Classroom-level decisions surrounding grading policies could have an effect on course grades.

Summary

This chapter provided an outline of the study methodology used in determining the relationship between advanced coursework grades and prerequisite coursework grades for high school students in the Shawnee Mission School District from the 2010-11 school year to the 2014-15 school year. Chi-square tests for independence were used to determine the difference in advanced coursework performance between students meeting the criteria for enrollment in the advanced course and those who did not meet the criteria and gained admittance via other means. Chapters four provides the research study results and discussion. Chapter five provides interpretation of the results and recommendations for further research.

Chapter Four

Results

The purpose of this study was to determine the difference in advanced math and science course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment. The purpose of this chapter is to review the descriptive statistics of the courses reviewed and review the results of hypothesis testing used to address the research questions.

Descriptive Statistics

The sample from the population under examination in this study was students who completed an advanced math or science course with a prerequisite course and performance level in the prerequisite course for enrollment in the advanced course from the 2010-2011 school year through the 2014-2015 school year. These courses and their prerequisite information can be found in Table 2 on page 6.

The sample contained 14,144 students who completed one or more of the advanced math or advanced science courses reviewed in this study. A review of the demographic makeup of the sample revealed 81.7% of the students were white, 6.3% were Hispanic, 4.7% were Asian, 3.8% were of multi-racial, 2.8% were black, and 0.7% other races. These percentages reflect an unduplicated count of students who took one or more of the courses being reviewed. The gender makeup of the sample was 51.6% female and 48.4% male. Overall population demographics of the school district studied can be found in Table 1 on page 2.

Hypothesis Testing

A chi-square test of independence was completed for each pair of courses to compare advanced math and advanced science course grades of students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria. The observed frequencies were compared to those expected by chance. First semester course grades from the selected advanced math courses were compared against the two categories for prerequisite completion (students who met prerequisite performance level and students who did not meet prerequisite performance level). The expected frequency assumption, which requires five or more expected events in the calculation, was violated on some analyses. In these cases, the variable of advanced course grade categories was collapsed into successful completion of the advanced course and unsuccessful completion of the advanced course. Successful completion was defined using the course's prerequisite performance level. A significance level of 0.05 was set for all hypothesis testing.

The research questions guiding this study focused on the predictive ability of prerequisite course grades on students' advanced course grades. The following research questions, hypotheses and statistical tests were used in the data analysis. Results of the hypothesis testing are presented below.

RQ1. To what extent is there a difference in first semester course grades in advanced mathematics courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

H1. There is a difference between student semester grades in Algebra 2 Honors for those who earned a letter grade of B or better in Geometry Honors and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 229.13$, $df = 4$, $p < .001$. The null hypothesis is rejected. See Table 4 for the observed and expected frequencies. The observed frequencies for students who earned an A in the Algebra 2 Honors course and who had met the criteria for enrollment (n = 693.00) were higher than the expected frequency (n = 647.66). The observed frequencies for students who earned a B in the Algebra 2 Honors course and who had met the criteria for enrollment (n = 749.00) were higher than the expected frequency (n = 733.15). The observed frequencies for students who earned a C in the Algebra 2 Honors course and who had not met the criteria for enrollment (n = 55.00) were higher than the expected frequency (n = 21.87). The observed frequencies for students who earned a D in the Algebra 2 Honors course and who had not met the criteria for enrollment (n = 26.00) were higher than the expected frequency (n = 5.52). The observed frequencies for students who earned an F in the Algebra 2 Honors course and who had not met the criteria for enrollment (n = 9.00) were higher than the expected frequency (n = 1.42). These results indicated students who met the enrollment criteria performed better in the Algebra 2 Honors course.

Table 4

Observed and Expected Frequencies for Hypothesis 1

Algebra 2 Honors Grade		Geometry Honors Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	693.00	4.00
	Expected	647.66	49.34
B	Observed	749.00	40.00
	Expected	733.15	55.85
C	Observed	254.00	55.00
	Expected	287.13	21.87
D	Observed	52.00	26.00
	Expected	72.48	5.52
F	Observed	11.00	9.00
	Expected	18.58	1.42

H2. There is a difference between student semester grades in College Algebra/Trigonometry for those who earned a letter grade of B or better in Algebra 2 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 217.8$, $df = 4$, $p < .001$. The null hypothesis is rejected. See Table 5 for the observed and expected frequencies. The observed frequencies for students who earned an A in the College Algebra/Trigonometry course and who had met the criteria for enrollment (n = 262.00) were higher than the expected frequency (n = 215.18). The observed frequencies for students who earned a B in the College Algebra/Trigonometry course and who had met the criteria for enrollment (n = 594.00) were higher than the expected frequency (n = 520.93). The observed

frequencies for students who earned a C in the College Algebra/Trigonometry course and who had not met the criteria for enrollment (n = 179.00) were higher than the expected frequency (n = 137.16). The observed frequencies for students who earned a D in the College Algebra/Trigonometry course and who had not met the criteria for enrollment (n = 110.00) were higher than the expected frequency (n = 60.11). The observed frequencies for students who earned an F in the College Algebra/Trigonometry course and who had not met the criteria for enrollment (n = 46.00) were higher than the expected frequency (n = 17.85). These results indicated students who met the enrollment criteria performed better in the College Algebra/Trigonometry course.

Table 5

Observed and Expected Frequencies for Hypothesis 2

College Algebra/Trig Grade		Algebra 2 Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	262.00	16.00
	Expected	215.18	62.82
B	Observed	594.00	79.00
	Expected	520.93	152.07
C	Observed	428.00	179.00
	Expected	469.84	137.16
D	Observed	156.00	110.00
	Expected	205.89	60.11
F	Observed	33.00	46.00
	Expected	61.15	17.85

H3. There is a difference between student semester grades in Differential Equations Honors for those who earned a letter grade of B or better in Calculus 3 Honors and those who did not.

The expected frequency assumption was violated in the chi-square analysis, as well as having observed values of zero, preventing calculation of the test statistic. See Table 14 in Appendix D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Differential Equations Honors course grades into categories of successful completion, which was defined as a grade of A or B, and unsuccessful completion, which was defined as a grade of C, D or F. The expected frequency assumption was also violated in this analysis, which could compromise the results; however, the observed frequencies were not zero and the test statistic was calculated. The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 87.8$, $df = 1$, $p < .001$. See Table 6 for the observed and expected frequencies of the collapsed categories. The observed frequencies for students who were successful in the Differential Equations Honors course and who had met the criteria for enrollment (n = 240.00) were higher than the expected frequency (n = 233.53). The observed frequencies for students who were unsuccessful in the Differential Equations Honors course and who had not met the criteria for enrollment (n = 7.00) were higher than the expected frequency (n = 0.53). These results indicated students who met the enrollment criteria performed better in the Differential Equations Honors course.

Table 6

Observed and Expected Frequencies for Hypothesis 3 (Collapsed Categories)

Differential Equations Honors Grade		Calculus 3 Honors Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
Successful (A or B)	Observed	240.00	10.00
	Expected	233.53	16.47
Unsuccessful (C, D or F)	Observed	1.00	7.00
	Expected	7.47	0.53

H4. There is a difference between student semester grades in Geometry Honors for those who earned a letter grade of B or better in Algebra 1 and those who did not.

The expected frequency assumption was violated in the chi-square analysis, as well as having observed values of zero, preventing calculation of the test statistic. Collapsing the frequencies into fewer categories did not alleviate the inability to calculate the test statistic. See Table 7 for the observed and expected frequencies. Only one student was allowed to take Geometry Honors who had not met the criteria for enrollment. This student received a D for Geometry Honors.

Table 7

Observed and Expected Frequencies for Hypothesis 4

Geometry Honors Grade		Algebra 1 Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	10.00	0.00
	Expected	9.82	0.18
B	Observed	23.00	0.00
	Expected	22.59	0.41
C	Observed	19.00	0.00
	Expected	18.66	0.34
D	Observed	3.00	1.00
	Expected	3.93	0.07
F	Observed	0.00	0.00
	Expected	0.00	0.00

H5. There is a difference between student semester grades in Precalculus Honors for those who earned a letter grade of B or better in Algebra 2 Honors and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 128.5$, $df = 4$, $p < .001$. The expected frequency assumption was violated in this analysis. See Table 15 in Appendix D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Precalculus Honors course grades into categories of successful completion, which was defined as a grade of A or B, and unsuccessful completion, which was defined as a grade of C, D or F. The results of the χ^2 test of independence indicated a statistically significant difference between the observed and

expected values, $\chi^2 = 72.0$, $df = 1$, $p < .001$. The expected frequency assumption was met in this analysis. The null hypothesis is rejected. See Table 8 for the observed and expected frequencies of the collapsed results. The observed frequencies for students who were successful in the Precalculus Honors course and who had met the criteria for enrollment (n = 1182.00) were higher than the expected frequency (n = 1159.07). The observed frequencies for students who were unsuccessful in the Precalculus Honors course and who had not met the criteria for enrollment (n = 32.00) were higher than the expected frequency (n = 9.07). These results indicated students who met the enrollment criteria performed better in the Precalculus Honors course.

Table 8

Observed and Expected Frequencies for Hypothesis 5 (Collapsed Categories)

Precalculus Honors Grade		Algebra 2 Honors Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A or B	Observed	1182.00	24.00
	Expected	1159.07	46.93
C, D or F	Observed	201.00	32.00
	Expected	223.93	9.07

H6. There is a difference between student semester grades in Statistics Honors/Advanced Placement for those who earned a letter grade of B or better in Algebra 2 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 13.2$, $df = 4$, $p = 0.01$. The expected frequency assumption was violated in this analysis. See Table 16 in Appendix

D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Statistics Honors/Advanced Honors course grades into categories of successful completion, which was defined as a grade of A or B, and unsuccessful completion, which was defined as a grade of C, D or F. The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 5.99$, $df = 1$, $p = 0.01$. The expected frequency assumption was met in this analysis. The null hypothesis is rejected. See Table 9 for the observed and expected frequencies of the collapsed results. The observed frequencies for students who were successful in the Statistics Honors/Advanced Placement course and who had met the criteria for enrollment (n = 210.00) were higher than the expected frequency (n = 201.95). The observed frequencies for students who were unsuccessful in the Statistics Honors/Advanced Placement course and who had not met the criteria for enrollment (n = 27.00) were higher than the expected frequency (n = 18.95). These results indicated students who met the enrollment criteria performed better in the Statistics Honors/Advanced Placement course.

Table 9

Observed and Expected Frequencies for Hypothesis 6 (Collapsed Categories)

		Algebra 2 Grade	
Statistics Honors/AP Grade		Met Criteria (B or better)	Did Not Meet Criteria
A or B	Observed	210.00	34.00
	Expected	201.95	42.05
C, D or F	Observed	83.00	27.00
	Expected	91.05	18.95

RQ2. To what extent is there a difference in first semester course grades in advanced science courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

H7. There is a difference between student semester grades in Biology 2 Honors/Advanced Placement for those who earned a letter grade of B or better in Biology 1 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 12.4$ $df = 4$, $p = 0.01$. The expected frequency assumption was violated in this analysis. See Table 17 in Appendix D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Biology 2 Honors/Advanced course grades into categories of successful completion, which was defined as a grade of A or B, and unsuccessful completion, which was defined as a grade of C, D or F. The expected frequency assumption was also violated in this analysis, which could compromise the results; however, the observed frequencies were not zero and the test statistic was calculated. The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 3.98$, $df = 1$, $p = 0.05$. The null hypothesis is rejected. See Table 10 for the observed and expected frequencies of the collapsed results. The observed frequencies for students who were successful in the Biology 2 Honors/Advanced Placement course and who had met the criteria for enrollment (n = 74.00) were higher than the expected frequency (n = 71.11). The observed frequencies for students who were unsuccessful in the Biology 2 Honors/Advanced Placement course and who had not met the criteria for enrollment (n =

7.00) were higher than the expected frequency (n = 4.11). These results indicated students who met the enrollment criteria performed better in the Biology 2 Honors/Advanced Placement course.

Table 10

Observed and Expected Frequencies for Hypothesis 7 (Collapsed Categories)

		Biology 1 Grade	
Biology 2 Honors/AP Grade		Met Criteria (B or better)	Did Not Meet Criteria
A or B	Observed	74.00	2.00
	Expected	71.11	4.89
C, D or F	Observed	57.00	7.00
	Expected	59.89	4.11

H8. There is a difference between student semester grades in Chemistry 2 Honors/Advanced Placement for those who earned a letter grade of B or better in Chemistry 1 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 30.1$ $df = 4$, $p < .001$. The expected frequency assumption was violated in this analysis. See Table 18 in appendix D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Chemistry 2 Honors/Advanced Placement course grades into categories of successful completion, which was defined as a grade of A or B, and unsuccessful completion, which was defined as a grade of C, D or F. The expected frequency assumption was also violated in this analysis, which could compromise the results; however, the observed frequencies were not zero and the test statistic was

calculated. The results of the χ^2 test of independence indicated no statistically significant difference between the observed and expected values, $\chi^2 = 3.56$, $df = 1$, $p = 0.06$. The null hypothesis is accepted and hypothesis eight is rejected. See Table 11 for the observed and expected frequencies of the collapsed categories. These results indicated students who met the enrollment criteria performed similarly to those who did not meet the enrollment criteria in the Chemistry 2 Honors/Advanced Placement course.

Table 11

Observed and Expected Frequencies for Hypothesis 8 (Collapsed Categories)

		Chemistry 1 Grade	
Chemistry 2 Honors/AP Grade		Met Criteria (B or better)	Did Not Meet Criteria
A or B	Observed	348.00	11.00
	Expected	345.07	13.93
C, D or F	Observed	73.00	6.00
	Expected	75.93	3.07

H9. There is a difference between student semester grades in Environmental Education 1 for those who earned a letter grade of C or better in Biology 1 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 219.6$, $df = 4$, $p < .001$. The null hypothesis is rejected. See Table 12 for the observed and expected frequencies. The observed frequencies for students who earned an A in the Environmental Education 1 course and who had met the criteria for enrollment (n = 289.00) were higher than the expected frequency (n = 230.79). The observed frequencies for students who earned a B

in the Environmental Education 1 course and who had met the criteria for enrollment (n = 698.00) were higher than the expected frequency (n = 634.67). The observed frequencies for students who earned a C in the Environmental Education 1 course and who had not met the criteria for enrollment (n = 180.00) were higher than the expected frequency (n = 162.65). The observed frequencies for students who earned a D in the Environmental Education 1 course and who had not met the criteria for enrollment (n = 165.00) were higher than the expected frequency (n = 85.59). The observed frequencies for students who earned an F in the Environmental Education 1 course and who had not met the criteria for enrollment (n = 66.00) were higher than the expected frequency (n = 30.22). These results indicated students who met the enrollment criteria performed better in the Environmental Education 1 course.

Table 12

Observed and Expected Frequencies for Hypothesis 9

		Biology 1 Grade	
Environmental Education 1 Grade		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	289.00	11.00
	Expected	230.79	69.21
B	Observed	698.00	127.00
	Expected	634.67	190.33
C	Observed	525.00	180.00
	Expected	542.35	162.65
D	Observed	217.00	154.00
	Expected	285.41	85.59
F	Observed	65.00	66.00
	Expected	100.78	30.22

H10. There is a difference between student semester grades in Environmental Education 2 for those who earned a letter grade of C or better in Environmental Education 1 and those who did not.

The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 21.2$ $df = 4$, $p < .001$. The expected frequency assumption was violated in this analysis. See Table 19 in appendix D for the observed and expected frequencies. The chi-squared test of independence was recalculated after collapsing the Environmental Education 2 course grade categories into successful completion, which was defined as a grade of A, B or C, and unsuccessful completion, which was defined as a grade of D or F. The expected frequency assumption was also violated in this analysis, which could compromise the results; however, the observed frequencies were not zero and the test statistic was calculated. The results of the χ^2 test of independence indicated a statistically significant difference between the observed and expected values, $\chi^2 = 19.6$, $df = 1$, $p < .001$. The null hypothesis is rejected. See Table 13 for the observed and expected frequencies of the collapsed categories. The observed frequencies for students who were successful in the Environmental Education 2 course and who had met the criteria for enrollment (n = 170.00) were higher than the expected frequency (n = 165.34). The observed frequencies for students who were unsuccessful in the Environmental Education 2 course and who had not met the criteria for enrollment (n = 6.00) were higher than the expected frequency (n = 1.34). These results indicated students who met the enrollment criteria performed better in the Environmental Education 2 course.

Table 13

Observed and Expected Frequencies for Hypothesis 10 (Collapsed Categories)

		Environmental Education 1 Grade	
Environmental Education 2 Grade		Met Criteria (C or better)	Did Not Meet Criteria
A, B or C	Observed	170.00	4.00
	Expected	165.34	8.66
D or F	Observed	21.00	6.00
	Expected	25.66	1.34

Summary

Chapter four reviewed the research questions and outcomes of hypothesis testing related to the difference in advanced math and science course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment. Chi-square tests of independence were completed to analyze each hypothesis. Chapter five presents interpretation of the results, implications for school leaders, and recommendations for future research.

Chapter Five

Interpretation and Recommendations

The first chapter of this research study introduced the background, purpose, and significance of the study. Chapter two contained a review of literature on the history of honors courses and the Advanced Placement program, the importance of advanced coursework, the use of Advanced Placement and other measures to rank and compare schools, qualitative and quantitative research regarding predicting success in advanced high school coursework, racial equity in advanced high school coursework, tracking of students into curriculum paths, and common practices related to advanced course enrollment. Chapter three provided an outline of the study methodology used in determining the relationship between advanced coursework grades and prerequisite coursework grades for high school students. Chapter four provided the results of hypothesis testing related to the research questions. Chapter five provides a review of the problem, purpose, research questions, methodology, and major findings of the study. In addition, findings related to relevant literature on predictors of academic success, implications for actions, and recommendations for future research are addressed.

Study Summary

Overview of the Problem. Many schools require students to complete prerequisite courses prior to enrollment in advanced courses in high school. Many of these courses include ambiguity in the form of a teacher or counselor recommendation being an option in overriding the listed prerequisite course or performance level. Table 2 on page 6 lists the courses of interest in this study and their prerequisites. The problem

this study sought to clarify was the accuracy of these prerequisites as predictors of success when persuasive students and their parents can circumvent them.

Purpose Statement and Research Questions. The purpose of this study was to determine the difference in advanced course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment. The questions the researcher sought to answer were:

RQ1. To what extent is there a difference in first semester course grades in advanced mathematics courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

RQ2. To what extent is there a difference in first semester course grades in advanced science courses between students who met the listed enrollment criteria and those who did not meet the listed enrollment criteria?

Review of the Methodology. This study was designed to compare student performance in advanced courses with their performance in the listed prerequisite course. This research study was designed using quantitative, quasi-experimental methods. The population for the study was students from the six high schools of the Shawnee Mission School District enrolled in advanced math and science courses with prerequisites to enrollment. The sample of the population for this study was high school students who completed an advanced math or science course with a prerequisite course and performance level in the prerequisite course for enrollment in the advanced course listed in the 2015-2016 Shawnee Mission School District High School Program Planning Guide. The sample of students was gathered from five academic years from 2010-2011 through 2014-2015. The independent variable was performance in prerequisite courses,

categorized into those who met the prerequisite course performance level for enrollment in an advanced math or science course and those who did not meet the prerequisite performance level. The dependent variable in this study was performance in high school advanced math and science courses. Chi-square tests of independence were used to compare the variables for ten sets of courses.

Major Findings. Multiple chi-square tests of independence were conducted to determine the difference in advanced mathematics and advanced science course grades between students who met the listed criteria for enrollment and those who did not meet the listed criteria for enrollment. The detailed results of the chi-square analysis of the ten hypotheses can be found in chapter four. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Algebra 2 Honors course. There was a statistically significant result indicating students who met the enrollment criteria performed better in the College Algebra/Trigonometry course. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Differential Equations Honors course; however, this result could be compromised due to violation of the expected frequency assumption during the chi-square analysis, even after collapsing the dependent variable from five to two categories. The test statistic could not be calculated for students in Geometry Honors due to the extremely low observed frequencies. Collapsing the frequencies into fewer categories did not alleviate the inability to calculate the test statistic. Only one student was allowed to take Geometry Honors who had not met the criteria for enrollment. This student received a D for Geometry Honors. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Precalculus

Honors course; however, it should be noted the test was conducted after collapsing the dependent variable from five to two categories to prevent violation of the expected frequencies assumption. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Statistics Honors/Advanced Placement course; however, it should be noted the test was conducted after collapsing the dependent variable from five to two categories to prevent violation of the expected frequencies assumption. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Biology 2 Honors/Advanced Placement course; however, this result could be compromised due to violation of the expected frequency assumption during the chi-square analysis, even after collapsing the dependent variable from five to two categories. There was a statistically significant result indicating students who met the enrollment criteria performed similarly to those who did not meet the enrollment criteria in the Chemistry 2 Honors/Advanced Placement course; however, this result could be compromised due to violation of the expected frequency assumption during the chi-square analysis, even after collapsing the dependent variable from five to two categories. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Environmental Education 1 course. There was a statistically significant result indicating students who met the enrollment criteria performed better in the Environmental Education 2 course; however, this result could be compromised due to violation of the expected frequency assumption during the chi-square analysis, even after collapsing the dependent variable from five to two categories.

Casual inspection of the advanced mathematics and advanced science course grades show over half of the students not meeting the enrollment criteria were still successful in Differential Equations Honors, Statistics Honors/Advanced Placement, Chemistry 2 Honors/Advanced Placement and Environmental Education 1. All of the courses reviewed, except Geometry Honors, revealed students who did not meet the enrollment criteria yet still earned a grade of A in the advanced course.

Findings Related to the Literature

The College Board (2002) recommends "all students who are willing to accept the challenge of a rigorous academic curriculum should be given consideration for admission to Advanced Placement courses" (p. i). Adelman's (1999 and 2006) longitudinal studies of students from middle school to college found the rigor of a student's high school curriculum outweighs the effects of socioeconomic status on bachelor's degree completion. Adelman (1999) reported completing one mathematics course above the level of Algebra 2 "more than doubles the odds that a student who enters postsecondary education will complete a bachelor's degree" (p18). Klopfenstein (2003), however, found that schools must "inevitably decide which students are allowed into these rigorous and fast-paced classes" (p. 42). Requiring all students to take advanced coursework can cause frustration for students and watering down of the content. Some schools use a single criterion, such as GPA or standardized test scores, to determine eligibility. Most schools fall somewhere between these two extremes. The current study reviewed information from the Shawnee Mission School District, which uses prior course grades as enrollment criteria for ten advanced mathematics and advanced science courses. Students meeting the enrollment criteria were found to perform better in the advanced courses than those who did not. There were, however, students who were successful in their advanced

mathematics or advanced science course even though they did not meet the enrollment criteria. Numerous studies report on the importance of the individual teacher in this success. Chen (2005) found "the adolescents' self-perceived academic support from parents and especially teachers are powerful predictors of their own perceived levels of academic engagement and achievement" (p. 114). Archambault et al. (2012) reported "the more teachers maintain high expectations and the more efficacious they feel in helping their students succeed, the more students' achievement increase over the year" (p. 324). These studies, along with the current study, continue to emphasize the importance of avoiding a one size fits all model of enrollment criteria for advanced coursework.

Conclusions

Access to advanced coursework in mathematics and science is critical to ensuring students are both college and career ready. The purpose of this study was to review the predictive ability of enrollment criteria on advanced mathematics and science course performance. This sections reviews implications for action and recommendations for further research as it relates to the findings of this study.

Implications for Action. School leaders must be equipped to guide parents and students. Prerequisites to course enrollment are necessary for general guidance of students into a proper curricular sequence. All but two of the hypotheses tested indicate students meeting the listed enrollment criteria performed better in the advanced mathematics or science course than those who did not meet the enrollment criteria. Students, however, change significantly over time with relation to their goals and perception of the importance of school for their future. For each of the courses reviewed in this study, with the exception of Geometry Honors, there were students who did not

meet the enrollment criteria yet were still successful in the advanced course. It is critical for parents, students, teachers and school leaders to work together to give students a chance to prove themselves in advanced coursework, whether they have met the enrollment criteria or not. These conversations need to be driven by the school using multiple measures of student performance as opposed to a one-time snapshot of student performance that could set them on a low-rigor track for their educational career. This recommendation echoes the College Board's equity statement, "all students who are willing to accept the challenge of a rigorous academic curriculum should be given consideration for admission" (College Board, 2002, p. i). Opening advance mathematics and science course enrollment opportunities to students who have not typically performed well in math or science requires support and professional development for teachers instructing the advance courses. The role of the teacher in supporting students new to advanced coursework is critical in the success of these students.

Recommendations for Future Research. This study sought to add to the current literature and research on predicting success in advanced mathematics and advanced science coursework, along with providing guidance towards increasing opportunities for students to enroll in advanced mathematics and advanced science courses. The following are recommendations to extend and enhance this study.

First, a qualitative study is needed investigating the effect of student attitudes for students who did not meet the enrollment criteria could enhance the ability to guide students. Determining why students were successful even though they did not meet the enrollment criteria is crucial.

Second, further study is needed of grading practices and their consistency between teachers and across schools. Additional reflection on the data shows wide variety in the numbers of each grade mark given for the advanced courses. For example, 29.0% of students in the study sample attending one school earned a grade of A in their advanced course, while 39.9% of students in the study sample attending a different school earned a grade of A in their advanced course.

Third, an extended study on the teacher-student relationship in advanced mathematics and science courses could provide guidance related to opening enrollment and creating opportunities for support for students in historically under-represented groups. Additional reflection on the data shows 34.7% of white students earned a grade of A in their advanced course, while 24.2% of Hispanic students and 16.7% of black students earned a grade of A in their advanced course. A clearer picture of this relationship could provide insight for teacher development and clarify any potential bias against these groups of students.

Concluding Remarks. Advanced mathematics and advanced science coursework provides students a window of opportunity into high-demand and high-paying careers. Findings from this study indicate the reviewed courses' prerequisites listed in the Shawnee Mission School District High School Program Planning Guide are, for the most part, accurate in predicting success in advanced coursework in mathematics and science. It is the belief of this author, however, that students, regardless of prior grades, must be given every opportunity to enroll in and experience advanced coursework if they have the desire to attempt it. The goal of advanced coursework for all students must be supported with staff development. The majority of staff development time has been spent helping

teachers serving the lowest-performing students and helping these students meet proficiency on state assessments. School leaders must not forget to focus staff development on helping advanced course teachers support students who are not typical advanced students. School leaders and counselors need to work with students on motivational factors, including students' self-disqualification due to perceived lack of skills or peer-group factors. Schools must engage in a cultural shift to support these students and help them find success.

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Appendices

Appendix A: Shawnee Mission School District Research Approval

Shawnee Mission School District
Guiding Students to Success

INDIAN CREEK TECHNOLOGY CENTER
Assessment & Research
4401 West 103rd Street
Overland Park, KS 66207-3618
Telephone 913-993-8658

SHAWNEE MISSION SCHOOLS

FORM B
Project Screening Action – District Level

To: Ryan Flurry

From: Dr. Dan Gruman
Director of Assessment & Research

Date: 3/6/2015

Project Title: Predictors of Success in High School Advanced Math and Science Coursework

Your research project has been reviewed and the project has been:

x approved

_____ not approved

_____ conditional approved based in changes to be made

Clarification/Comments:

Work with Dan Gruman to obtain the archival data requested for this study.

This project has been assigned the following number for identification purposes:

Project Number: 2015_10_RF

Please submit a copy of the completed project to our office.

If further clarification is needed concerning this action, please contact:

Dr. Dan Gruman (dangruman@smsd.org)
Director of Assessment & Research
Shawnee Mission School District
Indian Creek Technology Center
4401 W 103rd St
Shawnee Mission, KS 66207
(913) 993-8658

Appendix B: Baker University IRB Form

BAKER UNIVERSITY

Date:_____

SCHOOL OF EDUCATION
GRADUATE DEPARTMENT

IRB PROTOCOL NUMBER _____
(IRB USE ONLY)

IRB REQUEST
Proposal for Research
Submitted to the Baker University Institutional Review Board

I. Research Investigator(s) (Students must list faculty sponsor first)

Department(s) **School of Education Graduate Department**

Name	Signature	
1. Dr. Harold Frye	_____,	Major Advisor
2. Margaret Waterman	_____,	Research Analyst
3. Jim Robins		University Committee Member
4. Christy Ziegler		External Committee Member

Principal Investigator: Ryan Flurry
Phone: 816-679-6459
Email: ryanflurry@gmail.com
Mailing address: 7333 Falmouth
Prairie Village, KS 66208

Faculty sponsor: Dr. Harold Frye
Phone: 913-344-1220
Email: harold.frye@bakeru.edu

Expected Category of Review: _X_Exempt ____Expedited ____Full

II: Protocol Title

"Predictors of Success in High School Advanced Math and Science Coursework"

Summary

The following summary must accompany the proposal. Be specific about exactly what participants will experience, and about the protections that have been included to safeguard participants from harm. Careful attention to the following may help facilitate the review process:

In a sentence or two, please describe the background and purpose of the research.

The purpose of this study was to determine the difference, if any, in advanced course performance between students who met the listed prerequisite to enrollment and those who do not meet the listed prerequisite to enrollment. The sample for the study comes from students enrolled in advanced math and science courses in a large suburban school district.

Briefly describe each condition or manipulation to be included within the study.

The independent variable for this study will be semester course grades in courses which are prerequisites to advanced course enrollment. Students who met the prerequisite performance level for the advanced courses will be compared with those so did not using a chi-square analysis.

What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy.

The dependent variable for this study will be achievement in advanced math and science courses as measured by semester course grades.

Will the subjects encounter the risk of psychological, social, physical, or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

The subjects will not encounter any psychological, social, physical, or legal risk.

Will any stress to subjects be involved? If so, please describe.

The subjects will not be exposed to any stress.

Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

The subjects will not be deceived or misled in any way.

Will there be a request for information that subjects might consider to be personal or sensitive? If so, please include a description.

Information from the student management system will be used for this research study and students will not be directly interviewed or surveyed. Information to be extracted from the student management includes gender, ethnicity, race, course consumption, and course grades. The district assessment and research department will anonymize the data with a randomly generated identification number for each student. The researcher will not be able to connect data provided with specific individuals.

Will the subjects be presented with materials that might be considered to be offensive, threatening, or degrading? If so, please describe.

The subjects will not be presented with materials that might be considered to be offensive, threatening, or degrading.

Approximately how much time will be demanded of each subject?

No additional time will be demanded of each subject. The information to be analyzed will be gleaned from the district's student information system.

Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

The subjects in this study are or were high school students in the district who enrolled in advanced science or math courses between the 2010-11 school year and the 2014-15 school year. Subjects will not be contacted or solicited for the study.

What steps will be taken to ensure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

Student subjects will not be contacted for this study.

How will you ensure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

Student subjects will not be contacted for this study and therefore a written consent is not necessary.

Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

No identifying data will be made part of any permanent record associated with this study. The district assessment and research department will anonymize the data with a randomly generated identification number for each student.

Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher or employer? If so, explain.

No identifying data will be made part of any permanent record associated with this study. The district assessment and research department will anonymize the data with a randomly generated identification number for each student.

What steps will be taken to ensure the confidentiality of the data?

All data used by the researcher will be stripped of student identifying information. The district assessment and research department will anonymize the data with a randomly generated identification number for each student.

If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks involved in the study. Benefits to this study are to increase the body of research in this area. The findings could assist in decision making with regards to student course enrollment and encouraging a rigorous course selection.

Will any data from files or archival data be used? If so, please describe.

Archived data from the district's student management system will be used. Information to be extracted from the student management includes gender, ethnicity, race, course consumption, and course grades. The district assessment and research department will anonymize the data with a randomly generated identification number for each student. The researcher will not be able to connect data provided with specific individuals.

Appendix C: Baker University IRB Approval

BAKER UNIVERSITY
Own Confidence

Baker University Institutional Review Board

October 13, 2015

Dear Ryan Flurry and Dr. Frye,

The Baker University IRB has reviewed your research project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at CTodden@BakerU.edu or 785.594.8440.

Sincerely,

Chris Todden EdD
Chair, Baker University IRB

Baker University IRB Committee
Verneda Edwards EdD
Sara Crump PhD
Erin Morris PhD
Scott Crenshaw

Appendix D: Additional Data Tables

Un-collapsed frequency tables for chi-square tests violating expected frequency assumption

Table 14

Observed and Expected Frequencies for Hypothesis 3

Differential Equations Honors Grade		Calculus 3 Honors Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	197.00	4.00
	Expected	187.76	13.24
B	Observed	43.00	6.00
	Expected	45.77	3.23
C	Observed	1.00	5.00
	Expected	5.60	0.40
D	Observed	0.00	2.00
	Expected	1.87	0.13
F	Observed	0.00	0.00
	Expected	0.00	0.00

Table 15

Observed and Expected Frequencies for Hypothesis 5

Precalculus Honors Grade		Algebra 2 Honors Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	638.00	2.00
	Expected	615.09	24.91
B	Observed	544.00	22.00
	Expected	543.97	22.03
C	Observed	170.00	18.00
	Expected	180.68	7.32
D	Observed	28.00	12.00
	Expected	38.44	1.56
F	Observed	3.00	2.00
	Expected	4.81	0.19

Table 16

Observed and Expected Frequencies for Hypothesis 6

Statistics Honors/AP Grade		Algebra 2 Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	55.00	4.00
	Expected	48.83	10.17
B	Observed	155.00	30.00
	Expected	153.12	31.88
C	Observed	66.00	17.00
	Expected	68.70	14.30
D	Observed	15.00	8.00
	Expected	19.04	3.96
F	Observed	2.00	2.00
	Expected	3.31	0.69

Table 17

Observed and Expected Frequencies for Hypothesis 7

Biology 2 Honors/AP Grade		Biology 1 Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	21.00	1.00
	Expected	20.59	1.41
B	Observed	53.00	1.00
	Expected	50.53	3.47
C	Observed	35.00	4.00
	Expected	36.49	2.51
D	Observed	19.00	1.00
	Expected	18.71	1.29
F	Observed	3.00	2.00
	Expected	4.68	0.32

Table 18

Observed and Expected Frequencies for Hypothesis 8

Chemistry 2 Honors/AP Grade		Chemistry 1 Grade	
		Met Criteria (B or better)	Did Not Meet Criteria
A	Observed	195.00	4.00
	Expected	191.28	7.72
B	Observed	153.00	7.00
	Expected	153.79	6.21
C	Observed	63.00	2.00
	Expected	62.48	2.52
D	Observed	8.00	4.00
	Expected	11.53	0.47
F	Observed	2.00	0.00
	Expected	1.92	0.08

Table 19

Observed and Expected Frequencies for Hypothesis 10

Environmental Education 2 Grade		Environmental Education 1 Grade	
		Met Criteria (C or better)	Did Not Meet Criteria
A	Observed	60.00	0.00
	Expected	57.01	2.99
B	Observed	74.00	3.00
	Expected	73.17	3.83
C	Observed	36.00	1.00
	Expected	35.16	1.84
D	Observed	16.00	5.00
	Expected	19.96	1.04
F	Observed	5.00	1.00
	Expected	5.70	0.30