ABSTRACT

FACTORS THAT AFFECT SUCCESS IN AP CALCULUS

By

Pamela Gene Amici

December 2014

The purpose of this study was to investigate factors that predict success in AP Calculus. The factors investigated include student study habits, such as time spent doing homework, working with a study group or tutor, phoning a friend for help, or using the Internet for help. The study also examined the classroom environment and structure and the affect of teacher knowledge and attitude on predicting success. Additionally, teacher teaching styles and teacher designed lessons that predicted success in AP Calculus were investigated. Seventy-three ($N = 73$) former students in the course participated in the study. An online survey was conducted to collect data for the study. The study used multiple regressions to analyze the student data. The results showed that, when taken together, student study habits and teacher teaching styles were two factors that were statistically significant predictors of success in AP Calculus. The study found that the Internet was a factor that predicted success of AP Calculus which was important as students become more and more wired into cell phones, tablets, and other media devices.

Conversely, the results also showed that the classroom environment and structure, teacher knowledge and attitude, and the teacher designed lessons were not statistically

significant in predicting success in AP Calculus. However, even though these were not significant statistically, the students expressed that they were very important contributors to their success. Recommendations include the application of specific study habits, teaching styles, and increase use of the Internet resources to students in school, including increased access to their various handheld devices such as cell phones and tablets.

Additionally it is recommended to continue the examination success factors in higher level math courses such as AP Calculus.

Keywords: AP Calculus, high school, teaching styles, teacher-designed lessons

FACTORS THAT AFFECT SUCCESS IN AP CALCULUS

A THESIS

Presented to the Department of Teacher Education

California State University, Long Beach

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

Option in Mathematics Education

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December 2014

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CHAPTER 1

INTRODUCTION

Background

According to the College Board 2014, an AP course in calculus is comparable to calculus courses in colleges and universities. It is expected that students who take an AP course in calculus will seek college credit, college placement, or both, from institutions of higher learning. The first AP Calculus exam was given in 1956, and the number of participating schools has grown each year. Between 1990 and 2004, the number of students taking the exam increased more than threefold, according the CollegeBoard (2014). AP Calculus is taught in all six high schools in the school district where this study was conducted. It is expected that students take math as a senior to be competitive in the college selection process, especially AP Calculus. Unfortunately, there is no such thing as a teacher guide for teaching the course. It is a college level course with college textbooks. The teachers are left on their own to come up with lessons. An integral part of any lesson plan is the factors that guide its success. There is a great need for information on these factors to improve the lessons and AP exam success.

Problem Statement

In 2013 over 280,000 students worldwide took the AP Calculus AB exam (CollegeBoard, 2014). The exam is scored on a 1 to 5 scale as follows: 5–Extremely well qualified, 4–well qualified, 3–qualified, 2–possibly qualified, and 1–no

recommendation. In 2013, only 59.3% of the students taking the exam worldwide scored a 3 or better. Out of that group 23.9% scored a 5, 18.1 % scored a 4 and 17.3% scored a 3. In the school district where the study was conducted, not including the researcher's students, 272 students took the exam. Out of that group, 17% scored a 5, 13% scored a 4 and 17 scored a 3. This means that only 47% scored a 3 or better (Collegeboard, 2014). In 2013, the teacher-researcher taught 121 students who took the AP Calculus exam with 88% scoring a 3 or better. Out of that group 40% scored a 5, 30% scored a 4 and 18% scored a 3. This teacher-researcher has been teaching AP Calculus for 18 years and has always had a pass rate much higher than the national average, which prompted the question of what were factors of success in teaching AP Calculus. Every year the College Board holds workshops for AP teachers to receive training on the material, but in all the years of attending these workshops, the teacher-researcher is of the opinion that there really was no discussion of the factors that affect students' success. Just knowing the material did not appear to be an indicator of success. Consequently, there is a need to make explicit the instructional strategies and other significant factors that contribute to successful passage of the AP Calculus exam so that other programs can share the same level of success.

Purpose of Study

The purpose of this study is to investigate factors that may affect students' success in AP Calculus. The factors investigated will include student study habits and the use of the Internet, instructor knowledge and attitude and classroom environment and structure, instructor teaching styles, and instructor designed review lessons.

Research Questions

The specific research questions are:

1. When taken together do student study habits and the use of technology predict student success in AP Calculus?

2. When taken together do instructor knowledge of the material and attitude and class environment and structure predict student success in AP Calculus?

3. When taken together do instructor teaching styles predict student success in AP Calculus?

4. When taken together do instructor designed review lessons for the AP Calculus exam predict student success in AP Calculus?

Operational Definitions

For the purpose of this study student success will be defined as earning a 3 or better on the AP Calculus exam.

Technology will be defined as the use of the Internet at home to help with completion of homework or preparing for the AP Calculus exam.

Student study habits will be defined as the amount of time spent a night studying or doing homework for the course. Study habits will, also, include phoning a friend for help on homework, meeting with a study group or tutor regularly outside of school.

Teacher knowledge will be defined as knowing the material with familiarity gained through experience.

Teacher attitude will be defined as the teacher's warmth, sense of humor and encouragement in the classroom towards the students.

Classroom environment will be defined as the cleanliness of the classroom, the decorations (math posters, posters from student projects, seasonal displays), and fellow student behavior and work habits.

Classroom structure will be defined as the assignment sheet passed out at the beginning of each chapter with all the assignments for the entire chapter. It also includes the two white boards in the classroom that have the current homework assignments posted and the quizzes and test for the current chapter posted.

Instructor teaching styles will be defined as lecture, group work, partner work, and the quality of homework assignment. The instructor lecture is defined as the teacher standing in front of the class explaining the new material. Lecture also includes doing examples on the white board in front of the classroom. Partner work will be defined as two students working together. The students are partnered up by ability, with a lower ability student sitting next to a higher ability student. The students do not know which is which. The pairs are scattered around the room so the students cannot tell which one is the high or low student. Group work is when the students put four desks together, meaning there are two low and two high students, to work on class work or homework. Quality of homework will be defined as whether the students felt the homework had an effect on success in the course.

Instructor designed review lessons will be defined as the personal lecture notes, daily warm-ups, collection of old AP free response questions, and reviews held in class for the AP exam. The students are required to take notes in a composition book starting the first week of school. The notes were written personally by the instructor and cover the entire curriculum for a full year of calculus. The students are allowed to use the notes

on quizzes. The daily warm-ups, starting 3 months before the AP exam, are given every class meeting. Each warm-up has five multiple-choice questions from very old AP exams. The students have 10 minutes to complete the warm-up and do not use a calculator. After the papers are collected the instructor explains how to do all the problems. The instructor has put together a collection of previous free response question from old AP exams. The students are assigned three each night starting 6 weeks before the exam. The students have to photocopy them, cut them out, and attach each to a piece of blank paper. The students then have to work them out showing all the steps. The following class meeting the papers are collected from all classes and then randomly distributed in a different class for scoring. The instructor works out each question and explains the scoring for each part of each question. The students are required to score the random paper they receive and have to write constructive advice at the bottom of each question to help the students have success on the AP exam. The reviews in class are defined as working out and explaining old multiple choice and free response questions. In the process of working out these problems the instructor reviews the important topics on the AP exam.

Assumptions

It will be assumed that students answering the survey are doing it willingly and are answering the questions truthfully.

Delimitations of the Study

The boundaries of the study are that, as a teacher-researcher, I only used my former students that have volunteered to participate.

Another delimitation is that although there are previous studies of success factors in math instruction (Cole & Zieky, 2001), there were no studies specific to success factors for AP Calculus.

Limitations of the Study

Limitations include the number of former students contacted *(N = 120)*. Additionally, I could not control how many students would respond to the survey; however the response rate was 61%. Further, due to the fact that the population was former students, there were no controls for gender or ethnic representation. Finally, in some cases, participating former students may not have answered all questions in the survey.

Significance of the Study

As stated above, currently, AP Calculus instructor training courses do not make explicit success factors. This study is important for teachers and for future students in AP Calculus because it is assumed that knowing what contributes to successful passage of the AP Calculus exam will benefit overall instruction and student success. Consequently, if the students are successful they will receive college credits for the course, at most universities. It is vital for instructors to know what factors will help their students be successful in AP Calculus to help drive their instruction. It is important for administrators to help them select the appropriate instructor to teach the course and to foster knowing what to evaluate for program improvement. It is also hoped that this study would contribute to forming future research agendas and educational policy choices for higher level math instruction.

The following chapter will review the research literature related to proposed factors of success in math instruction including study habits and homework, use of the Internet, teacher knowledge of the material and attitude, classroom environment and structure, teaching styles, and teacher designed lessons. Chapter 3 will discuss the research methodology including the site the subjects took AP Calculus, the selection process for the subjects, the method the data was collected from these subjects, and how the data was collected and measured. Chapter 4 presents the research results in terms of correlations that were statistically significant and those factors that did not indicate statistical significance. Chapter 5 addresses each of the proposed factors of success and discusses findings relative to their level of perceived and statistical significance with specific recommendations based on the research. Also included in the appendix section you will find the survey instrument and examples of what was used to communicate with survey participants.

CHAPTER 2

LITERATURE REVIEW

The research literature specifically reporting success factors in AP Calculus are very limited (Ubuz, 2001) but there is literature on success factors in math classes in general. The literature I reviewed addresses the factors in my research questions as they relate to any upper level math class. The following review discusses study habits and homework, use of Internet, instructor knowledge of the material and attitude, classroom environment and instruction, teaching styles, and teacher designed lessons.

Student Study Habits

For the purposes of this study, homework is defined as any task assigned by schoolteachers intended for students to carry out during nonschool hours (Cooper, Lindsay, Nye, & Greathouse, 1998). Assignments can range over all the skill areas taught in school. The purposes of homework assignments can be divided into (a) instructional and (b) noninstructional objectives (D. Epstein & Miller, 2011; J. L. Epstein & Becker, 1982; J. L. Epstein & Van Voorhis, 2001; Lee & Pruit, 1979). The most common instructional purpose of homework is to provide the student with an opportunity to practice or review material that has already been presented in class (J. L. Becker & Epstein, 1982). Preparation assignments introduce material to help students obtain the maximum benefit when the new material is covered in class (Muhlenbruck, Cooper, Nye, & Lindsay, 1999). Homework was found to be an important part of most school-aged

children's daily routine. According to the National Assessment of Education Progress (Campbell, 1996), over three-quarters of all 13-17 year olds reported doing some homework every day. Thirty-nine percent of 17-year olds reported doing more than 1 hour of homework each day. Homework likely has a significant impact on students' educational success. The impact varies from student to student, depending on how much each student is assigned or completes.

Cooper et al. (1998) conducted a review of nearly 120 empirical studies of homework's effects. Quantitative synthesis techniques were used to summarize the literature. This review included three types of studies that help answer the general question of whether homework improves students' achievement. The first type of study compared achievement of students given homework assignment with students given no homework. In 20 studies conducted between 1962 and 1986, 14 produced effects favoring homework while five favored no homework. Most interesting was the influence of grade level on homework's relation with achievement. These studies revealed that the average high school student in a class doing homework outperformed 69% of the students in a no-homework class, as measured by standardized tests or grades. Finally, Cooper found 50 studies that correlated the amount of time students spent on homework with a measure of achievement. Many of these correlations came from statewide surveys or national assessments. In all, 43 correlations indicated that students who did more homework had better achievement outcomes, while only seven indicated negative outcomes. While homework was found to be part of schooling routines, this body of research supports the notion that active engagement with homework as study habit is a positive factor in math achievement.

Use of the Internet

Math instruction has long utilized technology as a resource. Knowledge in use of technology can be particularly important for female instruction because society rewards those who develop skills related to technology (Stewart & Shillingford, 2012). Besides using the graphing calculator, there are other types of technology that can be used in the course. Pearson Education's MyMathLab (MML) is an online instructional resource program. In the classroom the instructor still lectures and introduces the basic concepts. The students spend the remaining time solving MML problems using a computer. The program provides feedback, grading and support resources including tutorials. A study held at the University of Memphis (Stewart & Shillingford, 2012) showed that the MML program helped students dramatically. The pass rate in Calculus 1 before the program was only 49% but after it rose to 72%. The program was also very successful with minorities. The university teacher stated that MML allowed her to be more of a mentor because the computer was grading the student not her. Therefore, in this limited sample, Internet resources are generally found to have a positive impact on student success with math instruction.

Instructor Knowledge of Material and Attitude

Instructor experience, background, and attitude are the biggest factors affecting the success on the AP Calculus exam. According to a study conducted in California by the Institute for Education Reform (Furry & Hecsh, 2001) experience teaching AP Calculus is more important than attending AP summer institutes or workshops in affecting the success of the course. Through experience a teacher can find strategies that are successful. It is important to use various delivery strategies to help students. The

sooner a teacher stops talking; the smoother a class will run. After explaining the day's material and/or problem for a couple of minutes, let the students get working. Putting the students into groups will minimize the times a teacher has to re-explain something; it is also a setting where students feel comfortable asking for more help if they do not understand either from the teacher or their group. It is important for the teacher during the work period to move around the room addressing student concerns immediately, speaking loud enough that other groups can hear in case they are having the same concerns.

The teacher needs to act in the interest of their students, attending to their needs on multiple levels, have high expectations and speak to the students in terms of future success. It is important to recognize that students need to feel comfortable and confident in their classroom. Teachers should act in a caring way towards their students and try to simplify calculus by making their thought processes transparent as they solve problems and pay strict attention to aligning all lessons. Teachers should also model discipline and hard work to help students understand that success can be achieved through strong commitment (Picucci, Brownson, Kahlert, & Sobel, 2000). In summary, active engagement with math concepts, small group work, and affective features of instruction on the part of the teacher were found to foster success in math achievement.

Classroom Environment and Structure

Because of the relationship between parenting style and academic outcomes, some researchers have begun to apply the same framework to the classroom to see how different classroom environments predict student success in school. When applied to the school context, studies focus on whether responsiveness, often labeled as teaching caring

or support, and demandingness, often termed teacher control or academic press, are predictive of better academic outcomes. The terms "teacher caring" and "academic press" are used to describe the two focal components of teaching style. Teacher caring is defined as warmth or the affective relationship a teacher exhibits toward a student or class of students; academic press is defined as provision of high expectations by the teacher for a student or class of students which includes classroom structure. Authoritative teaching is a style comprised of both high levels of teacher caring and high levels of academic press, authoritarian teaching is composed of high levels of academic press but relatively low levels of teacher caring, and permissive teaching is comprised of high levels of teacher caring yet relatively low levels of academic press. In most instances, the effects of teacher caring and academic press on student outcomes have been studied independently. On average, evidence suggests that teacher caring is associated with more adaptive outcomes for students. For instance, Croninger and Lee (2001) examined the effects of students' relationships with teachers on drop-out rates, and found that those students who had better relationships with teachers and reported their teachers as more caring were less likely to drop out. Crosnoe, Johnson, and Elder (2004) also detected a positive effect of relationships with teachers on students' off-track behaviors, such as repeating a grade, suspensions and expulsions. Ryan and Patrick (2001) found that teacher caring and respect predicted self-regulated learning and academic self-efficacy. Finally, Marchant, Paulson, and Rothlisberg (2001) provided evidence that teacher caring is associated with school competence and motivation among students. However, some studies have found that positive relationships with teachers and teacher responsiveness predict only motivational outcomes in the absence of achievement

gains (Gill, Ashton, & Algina, 2004) and in some instances, a highly caring climate has actually been associated with negative achievement outcomes (Phillips, 1997). Even three decades ago, Kleinfeld (1975) described a "sentimentalist" group of teachers who were warm with their students yet required little of them, which was detrimental to academic goals. Therefore, evidence has suggested that teacher caring although often predictive of positive educational outcomes may not be sufficient. Kleinfeld and others have suggested that in some cases when caring dominated teaching style, what is missing is the academic rigor necessary to drive success. The second aspect of authoritative teaching is academic press, or demandingness and high expectations for students (class structure). Phillips (1997) found that academic press was predictive of both attendance and achievement. In addition, Kaplan, Middleton, Urdan, and Midgley (2002) reported that academic press was related to both self-regulation and self-efficacy. Kleinfeld explained that demandingness, classroom structure, was necessary for most students to achieve academic gains. In summary, classroom environment and structure were found to contribute somewhat to the success in the classroom; however, there needs to be a balance between teacher caring and academic press.

Teaching Styles

A common assumption among mathematics educators is that teachers' beliefs about mathematics teaching are informed by their experiences as learners in mathematics classes (Llinares & Krainer, 2006; Stigler & Heiber, 1999; Swan, 2007). Although the majority of their education occurred in the post-National Council for Teachers of Mathematics Standards (NCTM; 1989) era, current prospective teachers may not have experienced reform-based classrooms. Stigler and Heiber (1999) reported that although

U.S. teachers claim to implement reforms recommended by NCTM and other organizations, they found little evidence of reform (p. 1). Similarly, Cohen (1990) described a teacher who agreed with the reform in California and used new materials and activities recommended by the state but continued to conduct the class in ways that discourage exploration of students' understanding (p. 3). Swan's 2007 research participants also reported that, despite holding beliefs that aligned with a view of mathematics as a connected set of related idea that should be constructed through teacher and student discussion, their predominant teaching style exhibited a transmission of knowledge approach to teaching.

Studies of secondary teachers' beliefs about teaching often compare beliefs with practice (Forgasz & Leder, 2008). Most studies of teachers' beliefs about teaching characterize these beliefs as teacher centered or student centered, although they may use terms such as "traditional" or "reform-based" (Frykholm, 1999). In traditional, teacher-centered classrooms, teachers are disseminators of knowledge and students are passive receivers of mathematical knowledge. In reform-based, or student-centered, classrooms, teachers and students collaborate in mathematical problem solving, students take some level of responsibility for their learning, and teachers facilitate learning by posing challenging questions (Raymond, 1997; Swan, 2007). One theme that emerges from the literature on teaching and classroom practice is that teaching is complex (Da Ponte & Chapman, 2006; Green, 1971). Although it is likely that prospective teachers have engaged in learning with classrooms for more than 16 years, they may not initially grasp the complexity of the many actions and decisions involved in teaching. Additionally, even though they may feel they understand the mathematical ideas they will teach, they

may have difficulty comprehending the complexity of what they consider to be elementary mathematical ideas (Borko et al., 1992). For example, Cohen (1990) observed one elementary teacher who structured mathematics instruction in ways that lowered the cognitive demand of the mathematics and inferred that this teacher believed mathematics would be easy to learn if it were taught correctly. Peressini, Borko, Romagnano, Knuth, and Willis (2004) observed that secondary mathematics teachers sometimes believe "doing mathematics means finding correct answers, quickly, using the standard procedure, and that learning mathematics means mastering these procedures" (p. 7). Therefore, teaching styles can vary between teacher-centered or student-centered instructional modes. Many teachers do not grasp the complexity of teaching math and try to simplify it too much.

Teacher Designed Lessons

The idea of writing instructional objectives that specify outcomes in terms of observable student behaviors is not a new idea. Mager and Peatt (1962) outlined the hallmarks of effective objective writing almost 50 years ago, asserting that a major learning goal should be broken into smaller learning objectives and that each objective should have three components. The first of these, they originally termed behavior (Mager & Peatt, 1962) but because some readers thought this had something to do with behaviorism or behaviorists, Mager (1997) renamed this component as performance. Performance describes what the learner is to be able to do as a result of instruction. Mager and Peatt's second characteristic of an objective refers to conditions under which the performance is expected to occur. This often includes "givens" or "limitations." Mager and Peatt's third characteristic of an objective is termed criterion, referring to

acceptable level of performance. When designing a lesson for Calculus, all three components should be included. In this study there are four different types of teacher designed lessons. The lessons include note taking, practice multiple choice questions, completing 10 years of previous AP free response questions, and learning how AP exams are scored by peer grading. The objectives for each lesson are the same with the same three components. The performance for each is to be able to use the knowledge learned on the AP exam. The conditions are while taking the AP exam. The criterion is success on the AP exam. In summary, teachers have been writing lessons plans with instructional objectives as a long standing practice; but the design of these lessons is what should be varied for success.

Summary of the Research Literature

In summary, there are a variety of factors that can affect success in AP Calculus or any math class. Each of the factors has a different impact. Study habits and homework at the high school level likely have a significant impact on a student's educational success. The use of the Internet is a new factor but appears to be having a dramatic impact on student success and will probably in the future be one of the major factors for student success. Instructor knowledge of the material and attitude goes hand in hand. The research shows that experienced teachers find strategies that promote success. Affective instruction by the teacher encourages success. Classroom environment and structure is a combination of teacher caring and high expectation by the teacher. The research shows an affective combination of both is the key for success. Teaching styles can vary from teacher to teacher but the research shows that teachers need to mix up their own methods of instruction. Too many teachers use the knowledge

approach even though they might agree with reform. Finally, teacher designed lessons need to be varied. In other words teachers actually need to design lessons with their students in mind for them to be a factor for success. In all the literature there was one common theme, the teacher and strategies used by the teacher will have the greatest affect on student success in AP Calculus.

CHAPTER 3

METHODOLOGY

This study used a survey methods approach in order to obtain the opinions of former students about what they saw that contributed to their success in the AP Calculus exam. Survey research according to (Baumann & Bason, 2004) can be used to address a variety of questions about the characteristics of educational groups. The survey method was used for this study because that is exactly what the teacher-researcher is trying to accomplish. An Internet based anonymous survey allowed the students to give information about themselves and their opinion about the effectiveness of the AP Calculus course used in this study.

Site

This study was conducted at a high school in an urban area in Southern California. The school was founded in 1895 and is the oldest high school in district. The high school was identified as a Title 1 school, and it initiated a federal magnet school program option in 1971 to draw middle class students from the suburban part of the city. Technology resources are scarce at school. The school only has two computer labs with limited Wi-Fi access. The students do not use computers in the classroom. The enrollment is close to 5,000 students with 200 faculty members and 50 staff members. The ethnicity breakdown is: 21% Asian, 28% Black, 27% Hispanic, 12% White, and 12% Filipino and other. An additional interesting fact is that this school has sent more players to the NFL than any other public high school in American and was voted the

school of the century by ESPN. Each year the school offers six AP Calculus classes, one BC Calculus and five AB Calculus. The BC Calculus class has approximately 40 students each semester. On the 2013 AP Calculus exam, the BC students earned a 97% pass rate, with 34 5's. There are approximately 185 students enrolled in the five AB Calculus classes each year, earning a pass rate of up to 92% on an average yearly basis (Long Beach Unified School District, 2014).

Subjects

The subjects in the study were former students of the teacher-researcher. They were between the ages of 18 and 24. All participants were students in Calculus AB between 2007 and 2013. A total of 120 former students were invited to participate in the study. Seventy-three *(N = 73)* students participated in the study by completing the survey. Purposive sampling was utilized to obtain a representative sample of students across gender and ethnic categories. The gender breakdown is approximately 50% female and 50% males. The ethnic breakdown of the students every year is approximately 40% Asian, 40% White, 10% Hispanic, 5% Black, and 5% Filipino and other. The subjects are all now attending a 2 or 4 year university.

TABLE 1. Participants

GENDER	Female ~50% N = 36			Male~ 50% N=37		
ETHNICITY	Asian 40% N = 29	White 40% N = 29	Hispanic 10% N = 8	Black 5% N = 4	Filipino 5% N = 4	Other >5% N = 2

Instruments Used

A technology-enhanced Internet informational survey was used to address the research questions (see Appendix D). The survey included questions that address the four research questions. The survey includes a consent form, and 19 questions. The survey also included a cover letter explaining the purpose of the study (see Appendix C) and an informed consent form (see Appendix A). The survey had 24 questions. The first two questions were the demographics for the participants. The next three questions asked for their score on the AP exam and the grade they earned in their previous math class. Questions 6-11 were regarding their study habits outside the classroom. Questions 12–16 were about the participant's opinion on the teacher's knowledge of the material, teacher's attitude, classroom environment, and the effect of the structure of the course on success in AP Calculus. Questions 17–20 were the participant's opinion on the effectiveness of the teacher's teaching style. Questions 21–24 were the participant's opinion on the effectiveness of the teacher designed lesson plans. All answers on the survey were assigned a value between 1 and 5. Due to the specific nature of the area of research, the survey was created by the teacher-researcher.

Procedure of Data Collection

The participating former students were sent an email over the summer of 2013 explaining the purpose of the thesis. The email also requested that the students send their email address if they would like to participate in a survey. The students volunteered to participate in the survey and agreed to forward the survey to other former students if the researcher did not have an email address for them. The survey was distributed to 120 students via email in January 2014. The survey request was sent to females and males

and across the ethnic spectrum of the classes. The students were asked to complete the survey within 2 weeks. At the end of 1 week, the teacher-researcher sent out a reminder to everyone about completing the survey. The completed surveys were returned to Qualtrics via the Internet. The Qualtrics program was used to organize the raw data into an Excel spread sheet.

Data Analysis

After the surveys were gathered the data was analyzed using SPSS to measure the degree of regressions. The null hypothesis was that there would be no regression between factors and success in AP Calculus. The alternative hypothesis was that there would be a regression between factors and success in AP Calculus. The independent variables for this study were student views on student study habits and use of the Internet, instructor knowledge of material and attitude, class environment and structure, instructor teaching styles, and instructor designed lessons. The dependent variable was success of the AP Calculus exam measured by the students' score on the AP Calculus exam they provided on the survey. The data was entered into a spreadsheet and then multiple regression tests were applied to identify the factors and predictors with success on the AP Calculus exam.

CHAPTER 4

FINDINGS/RESULTS

Introduction

This study was conducted using data from an online survey given to students after they completed an AP Calculus course. This study used multiple linear regressions to analyze the data. This regression informed the degree that a given factor was correlated to success, which was helpful to establish statistical significance. The study examined four main research questions. The first one examined when taken together whether study habits and use of the internet predicts student success in AP Calculus. The second one examined when taken together do classroom environment, teacher knowledge of the material, teacher attitude, and class structure predict student success in AP Calculus. The third question examined when taken together do teaching styles predict student success in AP Calculus. The fourth one examined when taken together do teacher designed lessons to review for the AP exam predicts student success in AP Calculus. The first question had five factors. The second question had four factors. The third question had four factors, and the fourth had four factors.

Correlation between Study Habits and Use of the Internet and Success in AP Calculus

A multiple linear regression test was used to answer research question 1: When taken together do student study habits and use of the Internet predict student success in AP Calculus?

This regression test was used to predict success in AP Calculus from the variables of time spent studying each night, use of the Internet for help, phone a friend for help, meeting with a study group regularly outside of class, and meeting with a tutor regularly outside of class.

The results of this test are shown in Tables 2-6.

TABLE 2. Descriptive Statistics

	Mean	Std. Deviation	*N*
scorerecode	4.5593	.81518	59
timestudy	2.31	.856	59
useinternet	2.05	.797	59
phonefriend	1.59	.673	59
studygroup	1.15	.363	59
tutor	1.12	.419	59

TABLE 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.503[a]	.253	.182	.73711

a. Predictors: (Constant), tutor, studygroup, phonefriend, useinternet, timestudy

TABLE 4. ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.746	5	1.949	3.587	.007[b]
	Residual	28.797	53	.543		
	Total	38.542	58			

TABLE 5. Coefficients

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.802	.544		8.823	.000
	timestudy	.173	.124	.182	1.398	.168
	useinternet	.269	.130	.263	2.072	.043
	phonefriend	-.391	.147	-.322	-2.664	.010
	studygroup	-.038	.268	-.017	-.143	.887
	tutor	-.472	.243	-.242	-1.941	.058

a. Dependent Variable: scorerecode

Overall, Table 4 shows that the regression was significant, $F(5, 53) = 3.587$, $p < .05$, $R^2 = .253$. Of the predictors investigated, both phone a friend ($\beta = -.322$, $t(53) = -2.664$, $p < .05$) and use of the internet ($\beta = .263$, $t(53) = 2.072$, $p < .05$) were significant (see Table 5). Time spent studying each night ($\beta = .182$, $t(53) = 1.398$, $p > .05$), meeting with a study group regularly outside of class ($\beta = -.017$, $t(53) = -.143$, $p > .05$), and meeting with a tutor regularly outside of class ($\beta = -.242$, $t(53) = -1.941$, $p > .05$), were not significant predictors of success in AP Calculus exam (see Table 5). In this test

$R^2 = .253$ which according to Cohen (1990) is a large effect size indicating that the predictors account for 25% of the variation in success in AP Calculus. Based on the 59 students a multiple regression equation could be created Y (success on AP exam) = 4.802+.173(study time per day) +.269(times on internet per week)-.391(time phone a friend per week)-.038(times meet with study group a week)-.472(times meet with tutor per week). The results show that when taken together student study habits and use of the internet do predict student success in AP Calculus. But, what is interesting is that phoning a friend, meeting with a study group or tutor regularly outside of class have a negative effect since the Pearson correlation coefficients are -.270, -.002, and -.248, respectively (see Table 6).

TABLE 6. Correlations

Correlations

		Score	timestudy	useinternet	phonefriend	studygroup	tutor
Pearson Correlation	Score	1.000	-.147	-.300	.270	.002	.248
	timestudy	-.147	1.000	.280	.159	.070	.234
	useinternet	-.300	.280	1.000	.136	-.027	-.122
	phonefriend	.270	.159	.136	1.000	-.024	.052
	studygroup	.002	.070	-.027	-.024	1.000	-.008
	tutor	.248	.234	-.122	.052	-.008	1.000
Sig. (1-tailed)	Score	.	.134	.010	.019	.494	.029
	timestudy	.134	.	.016	.114	.300	.037
	useinternet	.010	.016	.	.153	.419	.179
	phonefriend	.019	.114	.153	.	.429	.348
	studygroup	.494	.300	.419	.429	.	.477
	tutor	.029	.037	.179	.348	.477	.
N	Score	59	59	59	59	59	59
	timestudy	59	59	59	59	59	59
	useinternet	59	59	59	59	59	59
	phonefriend	59	59	59	59	59	59
	studygroup	59	59	59	59	59	59
	tutor	59	59	59	59	59	59

Correlation between Instructor Knowledge, Attitude, Class Environment and Structure and Success in AP Calculus

A multiple linear regression test was used to answer research question 2: When taken together do instructor experience, attitude, class environment and structure predict student success in AP Calculus?

The results of this test are shown in Tables 7- 10.

TABLE 7. Descriptive Statistics

	Mean	Std. Deviation	*N*
scorerecode	4.5410	.80775	61
teachknowaffectrescore	4.7705	.64274	61
teachattrescore	4.0492	.93855	61
classenvrescore	3.6066	1.09968	61
classstructrescore	4.4426	.84705	61

TABLE 8. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.279[a]	.078	.012	.80287

a. Predictors: (Constant), classstructrescore, teachknowaffectrescore, teachattrescore, classenvrescore

TABLE 9. ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.050	4	.763	1.183	.328[b]
	Residual	36.097	56	.645		
	Total	39.148	60			

a. Dependent Variable: scorerecode

b. Predictors: (Constant), classstructrescore, teachknowaffectrescore, teachattrescore, classenvrescore

TABLE 10. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.464	.993		6.508	.000
	teachknowaffectrescore	-.191	.162	-.152	-1.178	.244
	teachattrescore	-.186	.125	-.216	-1.486	.143
	classenvrescore	.082	.116	.112	.706	.483
	classstructrescore	-.125	.135	-.131	-.924	.359

a. Dependent Variable: scorerecode

Overall, Tables 7-10 show that the regression for predicting success in AP Calculus from the variables of teacher knowledge affecting success and teacher attitude and classroom environment and structure significant, $F(4, 56) = 1.183$, $p > .05$, $R^2 = .08$ (see table 8). Of the predictors investigated, none were significant in predicting success on the AP Calculus exam, teacher knowledge($\beta = -.152$, $t(56) = -1.178$, $p > .05$), teacher attitude($\beta = -.216$, $t(56) = -1.486$, $p > .05$), classroom environment($\beta = .112$, $t(56) = .706$, $p > .05$) and classroom structure($\beta = -.131$, $t(56) = -.924$, $p > .05$ (see table 9). In this test $R^2 = .08$ which according to Cohen (1990) is a small effect size indicating that the predictors account for only 8% of the variation in success in AP Calculus. The results show that when taken together, teacher attitude, knowledge of material affecting success, classroom environment and structure do not predict student success in AP Calculus. But, what is interesting is that teacher knowledge of the material affecting success, teacher attitude, classroom environment, and class structure all have a negative effect on student success since the Pearson correlation coefficients are -.174, -

.190, -.038, and -.112, respectively(see Table 10). The values are all very close to zero indicating they almost have no effect but still are negative.

TABLE 11. Correlations

Correlations

		Score	teachknowaffectrescore	teachattrescore	classenvrescore	classstructrescore
Pearson Correlation	Score	1.000	.174	.190	.038	.112
	teachknowaffectrescore	.174	1.000	.074	-.012	.037
	teachattrescore	.190	.074	1.000	.455	.098
	classenvrescore	.038	-.012	.455	1.000	.405
	classstructrescore	.112	.037	.098	.405	1.000
Sig. (1-tailed)	Score	.	.090	.072	.386	.195
	teachknowaffectrescore	.090	.	.285	.463	.390
	teachattrescore	.072	.285	.	.000	.226
	classenvrescore	.386	.463	.000	.	.001
	classstructrescore	.195	.390	.226	.001	.
N	Score	61	61	61	61	61
	teachknowaffectrescore	61	61	61	61	61
	teachattrescore	61	61	61	61	61
	classenvrescore	61	61	61	61	61
	classstructrescore	61	61	61	61	61

Correlation between Instructor Varied Teaching Styles and Success in AP Calculus

A multiple regression was conducted predicting success in AP Calculus from the variables quality of lecture, homework, partner and group work in class.

The results of the test are shown in Tables 12 – 15.

Tables 12 - 15 show, overall the regression was significant, $F(4,58) = 4.001$, $p < .05$, $R^2 = .216$ (see table 13). Of the predictors investigated individually, group work($\beta = -.32$, $t(58) = -2.46$, $p < .05$) was a significant predictor of success in AP Calculus (see table 14). Of the predictors investigated individually lecture($\beta = -.122$, $t(58) = -1.003$, $p > .05$), partner work($\beta = -.216$, $t(58) = -1.550$, $p > .05$) and homework ($\beta = .071$, $t(58)$

TABLE 12. Descriptive Statistics

	Mean	Std. Deviation	N
scorerecode	4.5556	.79874	63
lecturerescore	4.6349	.62994	63
grouprescore	2.9524	1.06904	63
partnerrescore	3.2381	1.04286	63
hwkrescore	4.3651	.74707	63

TABLE 13. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.465[a]	.216	.162	.73110

a. Predictors: (Constant), hwkrescore, grouprescore, lecturerescore, partnerrescore

TABLE 14. ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8.554	4	2.138	4.001	.006[b]
	Residual	31.002	58	.535		
	Total	39.556	62			

a. Dependent Variable: scorerecode

b. Predictors: (Constant), hwkrescore, grouprescore, lecturerescore, partnerrescore

TABLE 15. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.191	.816		7.587	.000
	lecturerescore	-.155	.154	-.122	-1.003	.320
	grouprescore	-.241	.098	-.323	-2.469	.017
	partnerrescore	-.166	.107	-.216	-1.550	.127
	hwkrescore	.076	.138	.071	.553	.582

a. Dependent Variable: scorerecode

= .553, $p > .05$) were not significant predictors of success in AP Calculus (see table 14). In this test $R^2 = .216$ which according to Cohen (1988) is a fairly large effect size indicating that the predictors account for 21% of the variation in success in AP Calculus exam scores. The results show that when taken together lecture, quality of homework, partner and group work in class do predict student success in AP Calculus. But, what is interesting is that all four have a negative effect since the Pearson correlation coefficients for each is negative, lecture(-.135), homework(-.102), group work(-.403), and partner work(-.355)(see table 15). Apparently, the group and partner work in class are having the greatest negative effect on success. The lecture and quality of homework is just slightly having a negative effect on success.

Correlation between Instructor Designed Lessons and Success in AP Calculus

A multiple linear regression test was used to answer research question 4: When taken together do instructor designed lessons predict student success in AP Calculus?

The results of the test are shown in Tables 17 – 20.

TABLE 16. Correlations

Correlations

		Score	lecturerescore	grouprescore	partnerrescore	hwkrescore
Pearson Correlation	Score	1.000	.135	.403	.355	.102
	lecturerescore	.135	1.000	-.026	.184	.254
	grouprescore	.403	-.026	1.000	.444	.184
	partnerrescore	.355	.184	.444	1.000	.383
	hwkrescore	.102	.254	.184	.383	1.000
Sig. (1-tailed)	Score	.	.145	.001	.002	.213
	lecturerescore	.145	.	.419	.075	.022
	grouprescore	.001	.419	.	.000	.075
	partnerrescore	.002	.075	.000	.	.001
	hwkrescore	.213	.022	.075	.001	.
N	Score	63	63	63	63	63
	lecturerescore	63	63	63	63	63
	grouprescore	63	63	63	63	63
	partnerrescore	63	63	63	63	63
	hwkrescore	63	63	63	63	63

TABLE 17. Descriptive Statistics

	Mean	Std. Deviation	N
scorerecode	4.5484	.80322	62
notesrescore	4.6452	.74870	62
classreviewrescore	4.3387	.80863	62
warmupsrescore	4.5161	.67123	62
tenyyrsrescore	4.7742	.52540	62

TABLE 18. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.372[a]	.138	.078	.77133

a. Predictors: (Constant), tenyyrsrescore, notesrescore, classreviewrescore, warmupsrescore

TABLE 19. ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5.443	4	1.361	2.287	.071[b]
	Residual	33.912	57	.595		
	Total	39.355	61			

a. Dependent Variable: scorerecode

b. Predictors: (Constant), tenyyrsrescore, notesrescore, classreviewrescore, warmupsrescore

TABLE 20. Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5.026	1.091		4.609	.000
	notesrescore	-.090	.140	-.084	-.643	.523
	classreviewrescore	-.269	.131	-.271	-2.050	.045
	warmupsrescore	-.136	.164	-.114	-.832	.409
	tenyyrsrescore	.361	.204	.236	1.771	.082

a. Dependent Variable: scorerecode

A multiple regression was conducted predicting success in AP Calculus from the variables, notes in composition notebook, in class reviews, daily warm-ups, and doing ten years worth of old AP exam free response questions. Overall, the regression was not significant, $F(4,57)=2.287$, $p > .05$, $R^2 = .14$ (see table 18). Of the predictors investigated classroom reviews ($\beta = -.271$, $t(57) = -2.05$, $p < .05$) was significant individually in predicting success in AP Calculus (see table 19). Of the predictors investigated, notes ($\beta = -.08$, $t(57) = -.643$, $p > .05$), warm-ups($\beta=-.114$, $t(57)=-.832$, $p > .05$) and ten years of AP exams($\beta=.236$, $t(57) =1.771$, $p > .05$) were not significant predictors of success on the AP Calculus exam (see table 19). In this test $R^2 = .14$ which according to Cohen (1990) is a medium effect size indicating that the predictors account for 14% of the variation in success in AP Calculus exam scores. The results show that when taken together notes, classroom reviews, daily warm-ups and doing 10 years worth of AP exams do not predict student success in AP Calculus. But, what is interesting is that three, notes, class reviews, and daily warms ups have a negative effect since the Pearson correlation coefficients for each is negative, -.162, -.291, -.108, respectively(see

table 20). The only one that seems to really having an negative effect, though, is in class reviews. The other two, notes in a composition notebook and daily warm ups, the Pearson correlation coefficients are close to zero which means they have little effect.. The only predictor with a positive Pearson correlation coefficient is doing ten years of old AP exams, .143 but it is not a very high value, so it really doesn't have much effect.

TABLE 21. Correlations

Correlations

		Score	notesrescore	classreviewrescore	warmupsrescore	tenyyrsrescore
Pearson Correlation	Score	1.000	.162	.291	.108	-.143
	notesrescore	.162	1.000	.310	.207	.126
	classreviewrescore	.291	.310	1.000	.246	.144
	warmupsrescore	.108	.207	.246	1.000	.382
	tenyyrsrescore	-.143	.126	.144	.382	1.000
Sig. (1-tailed)	Score	.	.104	.011	.202	.134
	notesrescore	.104	.	.007	.053	.164
	classreviewrescore	.011	.007	.	.027	.131
	warmupsrescore	.202	.053	.027	.	.001
	tenyyrsrescore	.134	.164	.131	.001	.
N	Score	62	62	62	62	62
	notesrescore	62	62	62	62	62
	classreviewrescore	62	62	62	62	62
	warmupsrescore	62	62	62	62	62
	tenyyrsrescore	62	62	62	62	62

Summary of Findings

The first research question was about study habits including use of the Internet. Study habits investigated were time spent completing homework, times a week using the internet for help, times a week phoning a friend for help, and times a week spent meeting with a tutor or study group. When taken together study habits do significantly predict success in AP Calculus. Individually phoning a friend and using the Internet have a

significant effect but study time individual or with a group or with a tutor do not significantly predict success. Investigating the Pearson correlation coefficient for each shows that phoning a friend and meeting with a tutor having a strong negative effect. The second research question was about instructor knowledge, teacher attitude, and classroom environment and structure relating success. When taken together they do not significantly predict success in AP Calculus. Individually none of them predict success, either. Investigating the Pearson correlation coefficient for each shows all have a negative effect on success, but none very strongly. The third research question was about teaching styles and success in AP Calculus. The styles specifically were teacher lecture, quality of homework assignments; partner and group work in the classroom. When taken together teaching styles do significantly predict success in AP Calculus. Group work is the only one to have a significant effect but since the Pearson correlation coefficient is -.403 it has a strong negative effect on success. The other three, lecture, partner work, and homework do not have an effect individually but they also all have a negative Pearson correlation coefficient. Partner work has a large negative value, -.355, indicating it has a strong negative effect on success. The fourth research question was about teacher designed lessons, including composition notebook, classroom reviews, daily warm-ups, and working out ten years of old AP exams. These lessons were all put together by the teacher and not from the textbook. When taken together teacher designed lessons do not have a significant effect on success in AP Calculus. Individually, only classroom reviews were significant but since the Pearson correlation coefficient was strongly negative, they had a negative effect on success. The other factors, also, had a negative effect but their

Pearson correlation coefficients were close to zero so they really didn't negatively affect success.

CHAPTER 5

DISCUSSIONS

Introduction

The data revealed that there were certain factors when taken together that affected success in AP Calculus. The study uncovered four findings based on the research questions.

Discussion on Time on Homework and Use of the Internet

The first finding was that the time spent working on homework and the use of the Internet to help complete homework had a positive effect on success in homework since they both had a positive correlation with success in AP Calculus. The mean amount of time spent on homework was between 30 and 60 minutes. The mean amount of occasions spent on the Internet for help with homework was one or two times a week (see Table 2). Phoning a friend for help with homework or meeting with a study group or tutor has a negative effect on success in AP Calculus, since they both had a negative correlation with success in AP Calculus. The mean times the students phoned a friend was between zero and one or two times a week and meeting with a tutor or study group was between zero and one or two times a week (see Table 2). These findings indicated that it was more effective for students to spend more time on homework by themselves and to refer to the Internet for help, if unable to solve a problem, over phoning a friend or meeting with a study group or tutor. This finding was supported by Cooper et al. (1998) with high school student populations showing positive correlations between homework

and achievement. The finding was further supported with regard to homework and access to the Internet by Tutkun (2011) in a study of 21,747 students from Sakarya University in Turkey, which found that the level of knowledge gained by students via the Internet during the teaching-learning process was high.

Discussion on Teacher Knowledge, Attitude, and Classroom Environment

The second finding was that when taken together the teacher's knowledge of the material, the teacher's attitude which includes warmth, sense of humor, and encouragement, the classroom environment which includes cleanliness, decorations, and other students behavior and structure of the course which includes assignment sheet and a test and homework calendar posted in the classroom had no effect on student success in AP Calculus. When looked at individually none of the factors predicted success in AP Calculus, either. However, on a scale of 1-5 with 5 being the highest correlation with success the mean scores were teacher knowledge 4.8, teacher attitude 4.0, classroom environment 3.6 and structure of the course 4.4(see Table 7). Even though these factors when taken together did not predict success the participants expressed that they felt these factors were very important. Although, it seems logical that a positive relationship with a teacher may improve student engagement, it may also be the case that engaged students draw the positive attention of teachers. Though, there is research to suggest that correlation work in the direction suggested by the model (Wang & Holcombe, 2010), a bi-directionality of effects is not only possible but, to a certain degree, likely. The interaction between a teacher and the class content involves the teacher's expertise in the subject and in an effective set of pedagogical skills. In this way, expertise refers broadly to the teacher's ability to assist students in learning about the class material, not just to

lecture about it. Additionally, Klem and Connell (2004) showed that higher engagement in thought, feeling, and action in the classroom are supported by a teacher's ability to (1) deliver quality instruction; (2) create a caring, structured learning environment; (3) have high expectations of students; (4) involve students in meaningful tasks with real-world implications; and (5) allow students to share knowledge with each other.

Discussion on Teaching Styles

The third finding was that when taken together teaching styles including lecture, group and partner work in class, quality of the homework assignments do predict success in AP Calculus. On a scale of 1-5 with 5 being the highest effect on success the mean scores were lecture 4.6, group work 3.0, working with a partner 3.2 and quality of homework assignment 4.4(see Table 12). Individually the only factor that predicted success was group work, which affected it negatively. The other factors did not individually affect success but the participants did feel they were important based on the mean score for each. These results are not surprising because the findings resonated with the teacher-researcher's classroom experience. As a matter of current practice, group work was not done very often in the classroom and the students did not feel strongly that it helped with their success. Personal experience in the classroom has borne out that the students tended to just visit and not get much work done. Conversely, the students that wanted to work became easily distracted by conversations being held around them. Consequently, the teacher-researcher has no plans to use group work in the classroom in the future.

Cole and Zieky (2001) and Tomlinson (2001) agreed that a mix of teaching styles contributed positively student success particularly with regard to the unique learning

characteristics of each student, differentiation in curriculum development, instructional delivery, and assessment. These components of teaching style must occur to facilitate meaningful and effective instruction not only for students perceived as disabled, at risk, or gifted, but also allegedly average students.

Although the findings did not support group work, the practice of cooperative learning is supported in the field by a rich research base (Sapon-Shevin, 1994) giving evidence for its power to enable students to address their learning according to their own strengths. A more nuanced understanding of the findings in this study includes the success factor of partner learning, which functions to build relationships and enhances engaged learning time.

Finally, evidence of the social, instructional, and cost benefits of tutoring are abundant (LaPlant & Zane, 2002; McMaster, Fuchs, Fuchs;& Compton, 2002). Good and Brophy (1997) suggested that the quality of instruction delivered by student tutors (partners) may be superior to that of adults for at least three reasons: students use more age-appropriate and meaningful language and examples; having recently learned what they are to teach, they are familiar with their tutee's potential frustrations; and, they tend to be more direct than adults.

Discussion on Teacher Designed Lessons

The fourth finding was that when taken together the actual teacher designed lessons including notes, in class reviews, daily warm-ups, and doing ten years of previous AP exams did not predict success in AP Calculus. One student that responded to the survey sent a personal email stating "I took your survey but I wanted to let you know that I still have my composition book from AP Calc AB. I'm 6 years out of high school and

have used it as recently as 2 months ago. Thank you for providing such a valuable resource". The participants also felt strongly that reviewing in class was critical for success, including daily warm-ups and doing old free response questions. On a scale of 1-5 with 5 being the highest correlation on success the mean scores were notes 4.6, in class reviews 4.3, daily warm-ups 4.5 and doing ten years of old AP exams 4.8(see Table 17). Even though when taken together or individually these factors did not predict success the means indicate the students felt very strongly that these factors did relate to success. Teachers have a significant role on student achievement. The individual classroom teacher has even more correlation on student learning in school. The question is "What can teachers do to enhance students' achievement?" Teachers should know, respect, and care for their students, use a variety of instructional strategies, be aware of individual differences, motivate students very well, be a role model, prepare lesson plans, have good communication skills, use homework effectively, practice fairness, and let students gain responsibility (Korkmaz, 2007). Educators need to also recognize the power of emotion to increase retention, and plan classroom instruction accordingly. Effective teachers, without knowing the neurological basis of the effect emotion has on learning, often design ways to make what students are studying more meaningful and emotional (Wolfe & Lupart, 2001).

Implications

There are many implications from this study for students, teachers and administrators. First, students should be encouraged to spend 30 to 60 minutes a night on homework. The participants felt the quality of homework was the most important. The assignments must be designed to enhance the classroom activity and able to be completed

in under 60 minutes. If they need help, they should try the Internet before phoning a friend. Study groups and hiring a tutor do not seem to help predict success. These findings also indicate that it would be helpful for a school to consider having increased access to the Internet for students to use in class. Second, teachers should know the material and have a positive attitude in the classroom even though the study didn't find that it predicted success, the students strongly felt it did which in turn makes a successful classroom. Third, the structure of the class (assignment sheet and a test and homework calendar posted in the classroom) and the actual classroom environment (cleanliness, decorations, student behavior) did not predict success but the students feel it is important so it should be taken into consideration when setting up a course. Fourth, administrators should take the results into consideration when assigning teachers to teach the course. The study found that a variety of teaching styles including lecture, group and partner work, and the quality of the homework assignment is important for success. The teacher given this teaching assignment must understand how important all of these factors are in predicting success and try a variety of teaching styles. The study found that the participants felt well thought out and planned lectures that created good notes were very important. It is important for the teacher to understand the material and explain it in class so the students understand. Just assigning the material is not enough.

Recommendations for Practice

According to the College Board in 2013, over 280,000 students actually took the AP Calculus AB exam. This number does not include the students enrolled in the course that did not take the exam. In the researcher's school approximately 30% of the students in the course each year do not take the exam. The reason for most of them is that they do

not feel they will pass. If this pattern is true nationwide then approximately 120,000 students did not take the exam. The purpose of the course is for students to take the exam and receive college credits. Therefore, it is recommended that teachers of AP Calculus consider, if not successful, including a variety of teaching styles and lessons. It is also recommended they know the material which will be reflected in the classroom a variety of ways. It is also recommended they have a structured classroom environment that promotes success. The results of this study should be shared with other AP course instructors and other math teachers. At the regional AP workshops, there should be sessions on strategies for success not just sharing the topics that will appear on the actual exam. Instructors need examples of methods for teaching the material that will help the students to learn and understand the material.

Recommendations for Further Study

It is recommended that researchers continue to investigate factors that affect success in AP Calculus by extending the study to include students from other schools in this school district and then to students across the country. While this study focused on quite a variety of factors, it could be broke down by gender, race, or social economic background. It is also recommended that the factors studied should be studied in predicting success in other math classes. In future studies the study should have a larger random sample, possibly including students from different regions with different educational background. The sample should also include students that had different AP Calculus instructors.

Generalizability of the Study

The study did not include all students that have taken the course with the researcher. The results were limited to the students who volunteered to respond to an online survey. Also, based on the data, most of the participants that responded to the survey scored between a 4 and 5 on the AP exam. Even though this is the mean score for the researcher's students, it would be very beneficial to have more of a variety of scores. It is also a limitation that the study was limited to one school in one specific urban region, Long Beach, and was limited to 73 students. Therefore, these results may or may not apply to all AP Calculus students in all regions. Most of the students, 75%, were Asian or White. Thus, these results may or may not apply to all AP Calculus students of all ethnicities and social economic backgrounds.

APPENDICES

APPENDIX A

CONSENT TO PARTICIPATE IN RESEARCH

APPENDIX A

CONSENT TO PARTICIPATE IN RESEARCH

Factors that Affect Success in AP Calculus

You are asked to participate in a research study conducted by Pam Amici, BA in Mathematics, from the Teacher Education Department at California State University, Long Beach. The results will contribute to a thesis. You were selected as a possible participant in this study because you are a former student of mine in AP Calculus and you are at least 18 years old.

PURPOSE OF THE STUDY

This study is designed to investigate factors that affect success in AP Calculus. The results will be beneficial to present and future teachers of this course.

PROCEDURES

If you volunteer to participate in this study, you will do the following things:

Click the link at the end of this consent form and fill out the survey. Please return within one week. The estimated time to complete the survey is 20 minutes.

POTENTIAL RISKS AND DISCOMFORTS

There are minimal risks associated with completing this survey. The minimal risks are breach of confidentiality and pressure/coercion to participate. The survey is anonymous.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

The benefits of this research are great for future students and teachers of AP Calculus. The results will be published. There are no personnel benefits for the participants except the satisfaction in helping future students or teachers.

PAYMENT FOR PARTICIPATION

There will be no payment for participation in this survey.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. I cannot guarantee confidentiality; confidentiality will be maintained to the degree permitted by the technology used; no guarantee can be made regarding the tracking or interception of responses by any third party. Your responses will be anonymous to me and I will not know who participated who did not participate. I will not have any link between responses from the participants and their identity.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. Participation or non-participation will not affect your standing in college or any other personal consideration or right you usually expect. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances a rise which in the opinion of the researcher warrant doing so.

IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Pam Amici at (562) 591-0581 ext 5428 or Dr. An at 562-985-1143.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact the Office of University Research, CSU Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840; Telephone: (562) 985-5314 or email to irb@csulb.edu.

CONSENT OF RESEARCH SUBJECT

I understand the procedures and conditions of my participation described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I may download a copy of this form.

☐ To indicate consent to participate in the survey, hold down the ctrl button and click this box to advance to the survey.

APPENDIX B

EMAIL TO STUDENTS REQUESTING PARTICIPATION IN SURVEY

APPENDIX B

EMAIL TO STUDENTS REQUESTING PARTICIPATION IN SURVEY

Hi,
I hope you have had a great and relaxing summer. I am writing a thesis paper on Characteristics of a Successful AP Calculus Classroom and would love your feedback to a survey. If you are willing to participate, please send me your email so I can send you the survey. If you can't, I understand. Thanks!

Ms. Amici

Please send your email address to:Pamela.Amici@student.csulb.edu

APPENDIX C

EMAIL TO STUDENTS THAT GAVE ME THEIR EMAIL

APPENDIX C

EMAIL TO STUDENTS THAT GAVE ME THEIR EMAIL

Hi,

Thank you for giving me your email address and expressing an interest in participating in this survey. Please open the attachment for the informed consent form. At the end of the consent form will be a link to the survey. Thank you again for your time and honesty.

Pam Amici

https://csulb.qualtrics.com/SE/?SID=SV_9phg8EtRYzBLf49.

APPENDIX D

SURVEY

APPENDIX D

SURVEY

Factors That Affect Success in AP Calculus

1. What is your gender?

   - Male
   - Female
   - Decline to answer

2. What is your race?

   - White
   - Hispanic
   - Black
   - Asian
   - Other
   - Decline to answer

3. If you took the AP Calculus AB and/or BC exam, what was the higher score?

   - 5
   - 4
   - 3
   - 2
   - 1
   - Did not take the exam
   - Decline to answer

4. If you took precalculus the year before taking calculus, what was the grade you earned 2nd semester? If you did not take precalculus skip to the next question.

   - A
   - B
   - C
   - D
   - F
   - Decline to answer

5. If you took Intermediate Algebra/Trigonometry the year before taking calculus, what was the grade you earned 2nd semester?

- A
- B
- C
- D
- F
- Decline to answer

6. How much time on the average did you spend a night studying or doing homework for the course?

- 0 - 30 min
- 30 - 60 min
- 60 - 90 min
- 90 – 120 min
- More than 120 min
- Decline to answer

7. Did you use the internet to help with homework? If so, how many times a week?

- No
- Yes, 1 or 2 times a week
- Yes, 3 or 4 times a week
- Yes, 5 or more times a week
- Decline to answer

8. Did you phone friends for help with homework? If so, how many times a week?

- No
- Yes, 1 or 2 times a week
- Yes, 3 or 4 times a week
- Yes, 5 or more times a week
- Decline to answer

9. Did you have a study group you met with regularly outside of school? If so, how many times a week?

- No
- Yes, 1 or 2 times a week
- Yes, 3 or 4 times a week
- Yes, 5 or more times a week

- Decline to answer

10. Did you have a tutor you met with regularly outside of school? If so, how many times a week?

- No
- Yes, 1 a week
- Yes, 2 times a week
- Yes, 3 or more times a week
- Decline to answer

11. Did the use of your graphing calculator in the classroom help you understand the material?

- Yes
- No
- Decline to answer

Please answer the following questions (12 – 16) on a scale of 1 – 5 with 5 being the highest and NA means decline to answer.

12. Did the teacher seem to have knowledge of the material?

- 5
- 4
- 3
- 2
- 1
- NA

13. Did the teacher's knowledge of the material affect your ability to learn the material?

- 5
- 4
- 3
- 2
- 1
- NA

14 How important was the teacher's attitude (warmth, sense of humor, encouragement, etc) in your success in AP Calculus?

- 5
- 4

- 3
- 2
- 1
- NA

15. How important was the classroom environment (cleanliness, decorations, other students behavior, etc) in your success in AP Calculus?

- 5
- 4
- 3
- 2
- 1
- NA

16. How important was the structure (homework board, assignment sheet, test calendar, etc) of the class to your success in AP Calculus?

- 5
- 4
- 3
- 2
- 1
- NA

For questions 17 – 20, please select on a scale of 1 – 5, with 5 being highest, how much the following teaching styles had an effect on your learning and NA indicates decline to answer.

17. Lecture

- 5
- 4
- 3
- 2
- 1
- NA

18. Group Work

- 5
- 4
- 3

- 2
- 1
- NA

19. Partner Work

- 5
- 4
- 3
- 2
- 1
- NA

20. Quality of homework assignment

- 5
- 4
- 3
- 2
- 1
- NA

The following questions are in reference to preparing to take the AP exam. Please use a scale of 1 – 5, with 5 being the highest and NA indicates decline to answer.

21. How helpful was your composition notebook (if you took them)?

- 5
- 4
- 3
- 2
- 1
- NA

22. How helpful were reviews in class?

- 5
- 4
- 3
- 2
- 1
- NA

23. How helpful were daily warm-ups of old multiple choice questions?

- 5
- 4
- 3
- 2
- 1
- NA

24. How helpful was it doing the last 10 years of free response questions?

- 5
- 4
- 3
- 2
- 1
- NA

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