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THE EFFECTS OF BLOCK SCHEDULING ON AP CALCULUS AB STUDENT ACHIEVEMENT

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THE EFFECTS OF BLOCK SCHEDULING ON
AP CALCULUS AB STUDENT ACHIEVEMENT

Larry A. Lightner

Student achievement on the AP Calculus AB Exam is always a concern for teachers and school districts that offer the exam. A factor of concern that also arises is a school's schedule. A school's schedule may have an affect on achievement. This study examines the comparison in achievement of students who take the AP Calculus AB Exam under a block schedule and a traditional schedule system. Block Scheduling is defined as a class period of 80-90 minutes with 4 periods each day, allowing a full year's curriculum to be offered in one semester. Traditional scheduling is defined as a class period of 45-55 minutes with 6-7 periods each day, resulting in most subjects being taught for an entire year. A random sample of public schools in Minnesota that offered AP Calculus AB were contacted regarding the type of schedule used and the percent of students achieving a three or higher on the AP Calculus AB Exam. Many issues came out in the responses from schools that taught under a block system. Scores on the AP Calculus AB Exam were significantly lower for students under a block system than a traditional system. Lack of student contact time, the exam date in relation to the school calendar, and retention of information problems also were mentioned as possibly affecting the scores. The results of this study may show a valid reason for further research on the topic.

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Chapter 1: Introduction

Academic achievement seems to be on the agenda of state and national legislators, and in the forefront of the media headlines every year. It has been 25 years since the 1983 publication of *A Nation at Risk*, which presented possible ways to reform the educational system due to the decline in literacy, standardized test scores and other countries surpassing the U.S. in educational achievement (The National Commission on Excellence in Education, 1983). Block scheduling was one method introduced with the hope to improve academic achievement. Some benefits were more instructional time per class period, less pressure on students, fewer classes for each student, and fewer students for each instructor. On the other hand, problems of dealing with transfer students, planning time, retention, and change in pedagogy to name a few, surfaced when block scheduling was implemented. There were many pros and cons of block scheduling which will be discussed further in this study.

The author struggled with frustrations in teaching AP Calculus AB mainly because of time constraints. The real frustrations were not necessarily the result of teaching, as much as they were the result of preparing students for the AP Calculus AB exam in the time allowed. Under the current block schedule of teaching AP Calculus AB in an 85 minute period each day for one semester, the author believed that it was very difficult to do an exemplary job of preparing students for the AP Calculus AB exam. The number of student contact minutes was far less in a semester block schedule than a traditional year-long six to seven period day of 50-55 minutes, as will be discussed in more detail in the study. Then added to the lack of contact minutes are students missing class for assemblies, vacations, and especially in spring semester, sports competitions.

Retention was another problem facing some students coming into the AP Calculus AB course. Conceivably students could go an entire school year or more without a math class and yet still satisfy the prerequisites for the course. To compound the frustration, an early May date of the exam put a great deal of pressure on both the instructor and students to prepare for the exam in less than one semester. A teacher may have students who are motivated, hard working, dedicated, and strive to succeed, but may be at a disadvantage because of the schedule they are in. All of the factors mentioned led the author to examine the affects of block scheduling on student achievement, specifically on the AP Calculus AB Exam.

The Advanced Placement (AP) program has been around since 1955 and started with 104 high schools. Advanced Placement offers students an opportunity to receive college credit by achieving a certain score on the Advanced Placement exam. The score that must be achieved varies according to the college a student is planning to attend. Students that take the AP exam usually take a specified AP course of instruction before the exam. This course offers college level rigor to high school students. The AP designation has become synonymous with high rigor and quality, which entices many districts to offer AP courses. Parents and students are also lured by the quality and rigor, and thus students often choose to enroll in AP courses.

Currently there are about 15,000 high schools participating in the program. In his 2006 State of the Union Address, President Bush stated he wanted 70,000 new Advanced Placement teachers in math and science over the next five years (Pascopella, 2006). This was a very exciting proposal. But, can classes that operate under a block schedule meet

the needs of students in an AP Calculus AB course? Student performance on the AP exam should dictate the need for a change in the delivery system.

One might question whether the AP designation is worth the frustration and/or stress that it puts on students and teachers. Many instructors, the author included, may have thought about this when written notices from the CollegeBoard were sent to all AP designated schools notifying them that an audit must be completed in order to keep the AP designation. By June 1, 2007 all AP teachers were to submit a detailed syllabus that included the AP course requirements, evidence that the CollegeBoard requirements were included in the course, resource material, teaching strategies, and samples of activities. The AP teacher and principal were also required to submit an audit form that supported the requirements being met. The AP audits needed to be approved in order to use the AP designation for the 2007-08 school year.

The CollegeBoard justified the audit by claiming the AP designation was starting to be less meaningful to colleges. They believed that quality was a concern, as well as whether some students took a course designated as AP, but the course did not have the rigor or meet the expectations required by the CollegeBoard. They questioned whether students and/or schools wanted the AP designation just for the name, and not the exam. "The AP course is listed but is not really an AP course" (Dessoff, 2007). Some students are under a lot of pressure to take AP exams, but may not be ready for them. There seemed to be a sense of urgency between the beginning of the course until the AP exam to deliver as much information as possible to students, which puts into question the quality of learning taking place.

Problem Statement

There are many applications and processes in mathematics, science, and engineering that involve rates of change, areas under curves, related rates, and how variables interact with each other. Calculus is a very powerful tool for studying these applications and processes. With the advancements of technology, such as graphing calculators and computer software, topics covered in high school calculus could be studied and investigated in more depth, and in less time. Advanced Placement programs brought opportunities for students in many disciplines, including calculus. Some schools also made changes in schedules in an attempt to improve student achievement. Along with these advancements and changes, comes a need for change in the way calculus is taught in the classroom.

Computers and graphing calculators have replaced the old cumbersome method of graphing functions by hand. Textbooks and curricula are now designed with technology in mind. Teachers have implemented changes in an effort to improve student achievement and thus help students compete in the advanced technological world of today. A school's schedule, which is outside the control of classroom teachers, is a factor that may directly affect student achievement in AP Calculus AB. Teachers of AP Calculus, who were required to switch to a block schedule, were expected to change their pedagogy to implement the requirements of the program, but were these teachers adequately prepared for the changes needed for teaching AP Calculus AB in a block system?

Questions

How many schools that offer AP Calculus AB operate under a traditional 6-7 period day and how many operate under a block schedule? How do schools that use block scheduling compare in overall student achievement on the AP Calculus AB exam to schools that use a traditional 6-7 period day? If there is a difference in the comparison of achievement, what can schools that have a history of low scores do to experience success?

Limitations

High schools in Minnesota, as well as high schools all over the United States, are very different. The differences in class size, male to female ratio, ethnicity, and social and economic background, for example, may all have an effect on achievement. The focus of this research is limited to the effects of a school's schedule on student achievement on the AP Calculus AB Exam.

Delimitations

Due to the lack of availability of data on private schools, the study is limited to public schools. There are approximately 23,445 public secondary schools in the United States, including vocational, special education, and alternative schools (National Center for Educational Statistics, 2006); therefore because of the cost and feasibility, a stratified random sample was chosen. The population was segmented to public secondary schools in the state of Minnesota that offer AP Calculus AB. This study consisted of a comparison of student achievement on the AP Calculus AB exam from a random sample of this strata. The sample included schools that offer AP Calculus AB under a block schedule as well as schools that operate under a traditional 6-7 period schedule.

Definitions of Terms

- Advanced Placement (AP) Calculus AB is defined as the Calculus course designed to prepare students for the AP Calculus AB exam. This course covers functions, graphs, limits, and topics in differential and integral calculus (CollegeBoard, May 2006, May 2007).
- There are many variations or hybrid forms of block scheduling, but for this study, block Scheduling will be defined as a class period of 80-90 minutes with 4 periods each day, allowing a full year's curriculum to be offered in one semester (also known as a 4x4 system).
- Traditional scheduling is defined as a class period of 45-55 minutes with 6-7 periods each day, resulting in most core subjects being taught for an entire year.

The author understands that the random sample chosen for this study may consist of schools that offer a hybrid form of the block schedule, and may not be aligned with the definitions stated above. The responses from schools that offer a hybrid form of the block schedule will be looked at from the standpoint of the whether AP Calculus AB is taught in a semester with 80-90 minutes, or a full year with 45-55 minute periods as defined above. The results will then be treated accordingly.

Chapter 2: Review of Literature

Introduction

This review of literature focuses on the main topic of block scheduling and its effect on student academic achievement, specifically achievement on the AP Calculus AB exam. There is not a great deal of research that strictly addresses the effects of block scheduling on student achievement. Most literature confines itself to school climate and attitude, which could have an ultimate effect on student achievement. The review will offer the argument that there is a justification for more studies on the affects of block scheduling on student academic achievement, with an emphasis on achievement on the AP Calculus AB exam.

Block Scheduling History

The increased push for education reform, the criticisms of standardized test scores, and drops in achievement are some factors that led to questions on how time was being utilized in school. One method of addressing the problem, with the hopes of increasing student achievement, was block scheduling. The main difference between block and traditional scheduling is the length of the class period. The increase in the length of the class period provided students and teachers a higher quality of instructional time, and more time to think and engage in active learning each day. Teachers have more time to complete lessons, use cooperative learning, start and finish labs, and more time to interact with students (Finkbeiner, 1998). The block schedule often allows students to take one to two additional classes per year than they would be able to take under a traditional schedule due to the fact that most classes are completed in one semester. Many proponents of block scheduling feel that there is less pressure on students as well

as teachers because of decreased class load, which makes for a more conducive learning environment. Students have fewer classes to focus on each semester, and teachers have fewer students each semester (Carter, 1999).

All of these factors mentioned led many to believe that block scheduling was an alternative method of scheduling that, if adopted, would improve student achievement (Freeman, 2001). John M. Carroll, an early proponent of extended time periods, implemented a form of block scheduling he called the Copernican Plan that included decreased class size, reduced number of classes and improved instruction. The results showed improved grades and fewer dropouts (Carroll, 1994). In two schools in Orlando, Florida, block scheduling is attributed to not only helping improve attendance and grade point average, but school climate as well (Buckmann, King, and Ryan, 1995).

Regardless of the success that Dr. Carroll reported, results on standardized tests were never mentioned. Students in a block schedule system showed improvement in grade point averages and internal test scores, but there were inconsistencies in standardized test scores and attendance (Mayers, R. Stewart, Zepeda, Sally J., 2006). Although the internal grades may have improved, they are subjective and reflect students' progress throughout the semester. The internal grades may not reflect retention issues as standardized tests do. Standardized tests are not susceptible to inflated grades or subjective grading systems. In Iowa and Illinois, 38,089 seniors that completed the ACT Assessment in 1999 participated in a study that looked at the relationship between the results of ACT scores and a school's schedule. The results showed that the type of schedule does not predict standardized test scores (Hackmann, Harmston, and Pliska, 2001).

There are many factors that pose problems in implementing a block schedule. In talking with counselors from various schools, scheduling transfer students from system to system is a problem. Students transferring from a school which operates under a traditional schedule into a school which operates under a block system may possibly be lagging behind students in the semester long course they are transferring to. That is provided the curriculum is similar, which if it were not, could even cause problems when transferring from a block to a block system or a traditional to a traditional system. Students transferring into a block system might also run the risk of having a similar course they need to transfer into not being offered the semester they are transferring. Students transferring from a block system to a traditional system may possibly, again if curriculums are similar, be further ahead than students in the year long course that they are transferring to.

Absences are another major problem schools face under a block system. In theory, if a years worth of curriculum is taught in a semester, every day a student is absent in a block system is equivalent to two days in a traditional system. In addition, when students miss multiple classes for activities and/or vacations, the classroom contact time decreases greatly. When students take courses that would be very difficult when self-taught, such as AP Calculus, the lack of instructor contact time and instruction could be very detrimental to their success in the course and on the AP exam.

Retention is also a concern for many schools. Many students cannot handle an extended class period if traditional instructional methods are utilized. Some students do not have the attention span for the extended time unless they are actively engaged in their learning, and various strategies are used. In some cases, not even being actively engaged

or varying instruction can keep their attention span for the extended period. Some question if the added minutes really equate to quality time with students. Teachers in many cases are not allowed sufficient planning time or professional development to support the change in instructional methods needed to teach effectively in a block schedule (Kramer, 1997). If a school is going to change its scheduling in an attempt to improve student achievement, there must be a change in instructional methods and organization by the classroom teacher. If these changes are not made it could have the reverse effect on student achievement (Canady & Rettig, 1995). The goals of a school making the transition to block scheduling must be clear. Students that normally are high achievers still do well in a block schedule, but those who are not high achievers do not fare well in a block system (Nichols, 2000).

AP Calculus AB Achievement

Approximately 7% of schools in the United States that offer AP classes use some form of semester block schedule (CollegeBoard, 1998). Retting stated that the College Board reports that students in a semester block schedule score lower on some AP exams than those in a year long course (Rettig, 1999). Although the CollegeBoard states that scores on the AP Calculus AB exam have improved overall since 2000 (CollegeBoard, 2007), no reference is made for specific schedule types. This study along with the research will attempt to determine the affect, if any; block scheduling has on student achievement on the AP Calculus AB exam.

Chapter 3: Results

Purpose of the Study

The intent of this study was to examine the scores on the AP Calculus AB Exam of students in Minnesota public schools and compare the achievement differences, if any, between those schools that use a block schedule format and those that use a traditional six to seven period day format. The motivation for this study was driven by the frustration of lack of time and possible retention problems that occur preparing for the AP Calculus AB exam under a block schedule. Less than desirable scores on the AP exam could jeopardize the future of a program. Most school districts are forced to be more fiscally conscientious. Although some programs and courses are being cut due to district-wide budget constraints, regardless of the number of students enrolled, others are being cut due to low student enrollment. Consistently low scores on AP exams could potentially reduce the number of students taking the courses, thus threatening the program/course existence for the future.

The AP designation is associated with high rigor and students who are high achievers. But, should the AP courses be reserved for only high achieving students? In AP Calculus AB for example, students who meet the prerequisites and have the necessary mathematical background should be able to and be encouraged to take AP Calculus AB. If a program has a history of success, students are more apt to accept the challenge. Student success is one of the most important things to the author and is taken very seriously, and in some cases personally. Student success is not limited to a letter grade. Success is also achieved when students walk out of the classroom with more knowledge

and tools which will help them succeed in successive courses and college if they choose to do so.

Most students that take an AP course take it very seriously, but when a great effort is put forth by both students and teacher, and there are still a large percentage of low scores on the AP exam, something needs to be addressed. There are the exceptions of students taking the course, not for the exam score, but for the experience of taking a more challenging course in order to better prepare themselves for the rigor of college. Those students have an admirable reason for taking the course, but they are in the minority.

Questions were raised in the author's mind about where the root of the problem was. Most teachers are always trying to improve their teaching. Are other teachers experiencing the same frustrations? Does the block system have an affect? If not, what things can be done to increase success on the AP Calculus AB exam? What are those teachers that experience success doing that others may not be? The answers to these questions could alleviate some of the frustrations experienced thus far.

The first part of this study compares the block schedule to a traditional schedule with respect to contact time and how time could affect retention. Both types of schedules were examined to determine the number of student contact minutes over a school's calendar year. This comparison was done based on data from the responses of the sample population, and the definitions of block and traditional schedules stated earlier. The author's intent was to determine how large the difference was, and if it was large enough to be considered as a factor in achievement. Figure 1 shows the comparison of student contact minutes between a school offering courses on a block schedule and a school on a

traditional schedule. A school district that has 172 student contact days and operates on a 6 period day that meets 53 minutes per day, would have 9,116 minutes of student contact time, disregarding any assemblies, pullouts, etc... Under the block schedule, a school district that has 85 minute periods and meets 86 days per semester would have 7310 minutes of student contact time. That is a difference of 1806 minutes, or approximately 30 hours of student contact time.

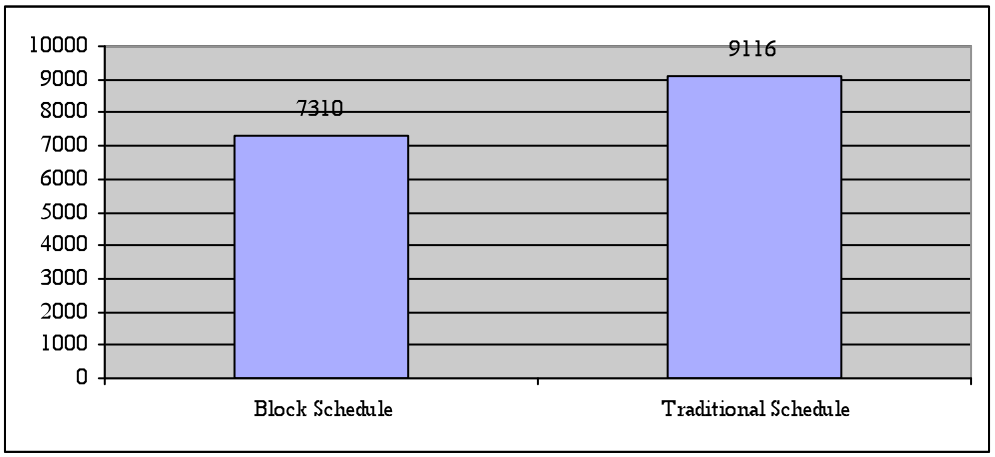

Figure 1. The comparison of the total number of instructional minutes available.

In a study done by the CollegeBoard, their results summarized that students earn higher grades in AP Calculus in a year long course under a traditional schedule, and even higher grades in a year long course that has extended time periods each day (CollegeBoard, 1998). The loss of student contact time shown is significant and could have a detrimental affect on student achievement, not only in the classroom, but on the AP Calculus AB Exam. With the extra minutes available in a traditional schedule, there may not be such a race to finish all of the material before the AP Exam. There could be more time for understanding concepts, applying concepts, activities, and investigations. There could be more time for a teacher to check for student understanding.

Not included in the time difference mentioned in the previous paragraph, is the date of the AP Calculus AB Exam, which is another factor that affects student contact time. The exam is given the first week of May (May 7 in 2008), which for some whose school year goes until the end of May, will result in a semester that is "in effect" short approximately 15 days of student contact time. Based on the previous example, for a block schedule, that equates to 1275 minutes or approximately 21.25 hours. Compared to a traditional schedule there would be 795 minutes or approximately 13.25 hours showing a vast difference in student contact time. Thus, as Figure 2 shows, the student contact time before the exam would drop to 6035 and 8321 minutes respectively, which exaggerates the difference in student contact time between the two schedules.

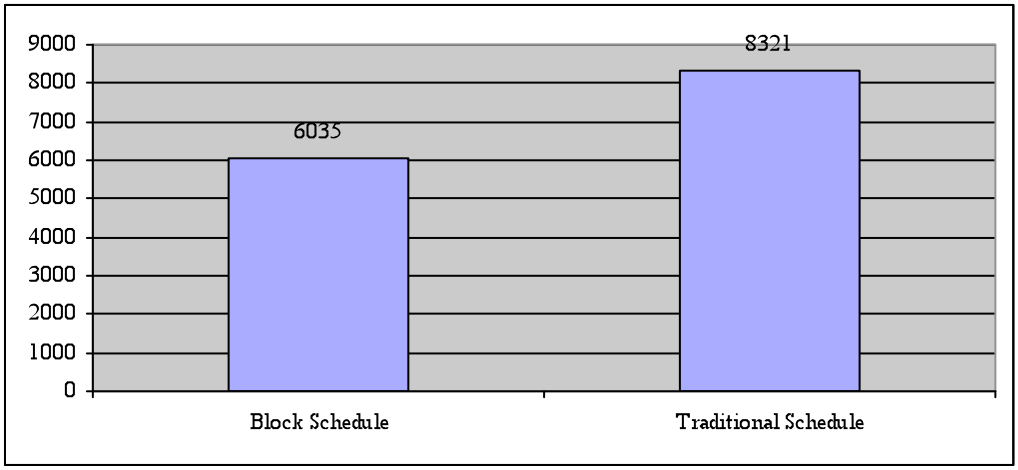

Figure 2. The comparison of minutes of student contact time before the AP Calculus AB exam.

An additional factor is memory retention of information. In a block system, some schools are forced to offer AP Calculus AB in the first semester. In this case, there would be a time span of approximately 105 calendar days between the last student contact day and the AP Calculus AB Exam. Also, in a block system, students could conceivably go one to two semesters without math before taking AP Calculus AB. For

example, students can take precalculus the fall of their junior year and not take calculus until the fall or spring of their senior year. In comparison, students under a traditional schedule will most likely take courses back to back. All of the above factors mentioned could have a great affect on retention.

Method

Of the 23,445 public secondary schools in the United States, there are approximately 850 in the state of Minnesota (National Center for Educational Statistics, 2006). In 2006, 150 of the 850 public schools in Minnesota offered the AP Calculus AB exam, and even though the number of AP Calculus AB Exams taken in public schools in the United States has increased by 54455 or 46.3 % nationally between 2001 and 2006, the mean score has decreased. In comparison, the number of AP Calculus AB Exams taken in Minnesota's public schools has increased by 711 or 23.2 % and the mean score has increased. As shown in Figure 3, students taking the AP Calculus AB Exam in Minnesota have improved their mean scores since 2001, compared to the national mean scores which have declined (see Appendix A for complete data).

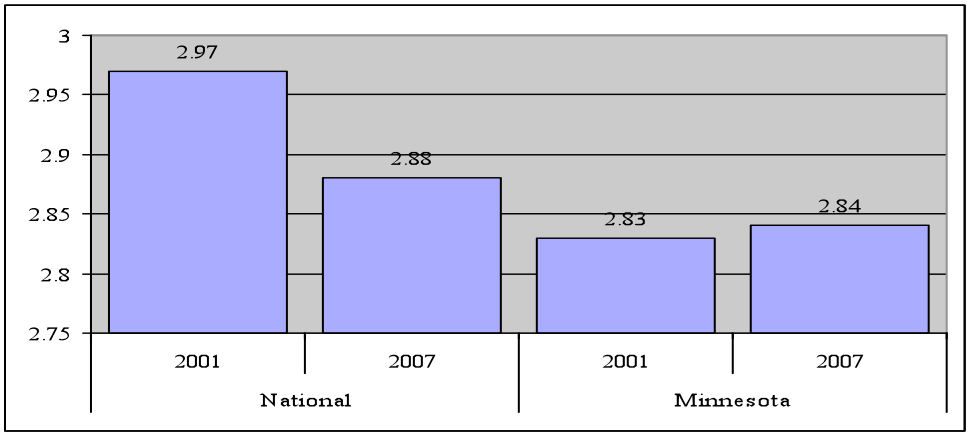

Figure 3. The mean scores of public school students on the AP Calculus AB exam in 2001 and 2007.

Although the mean scores have increased in Minnesota from 2001 to 2006, the percent of students achieving a 3 or higher on the AP Calculus AB Exam has decreased slightly. The CollegeBoard defines success on the AP exam as a grade of three or higher, and is a strong predictor of a student's success in college. Students also have an opportunity for college credit or advanced placement in college courses with a score of 3 or higher on the AP exam (CollegeBoard 2007). Nationally, there has been a significant decrease in the percent of students achieving a 3 or higher on the AP Calculus AB Exam from 2001 to 2006. Even with the factors just mentioned, Figure 4 shows that the gap in achievement has narrowed between Minnesota and the National scores since 2001 (CollegeBoard 2007).

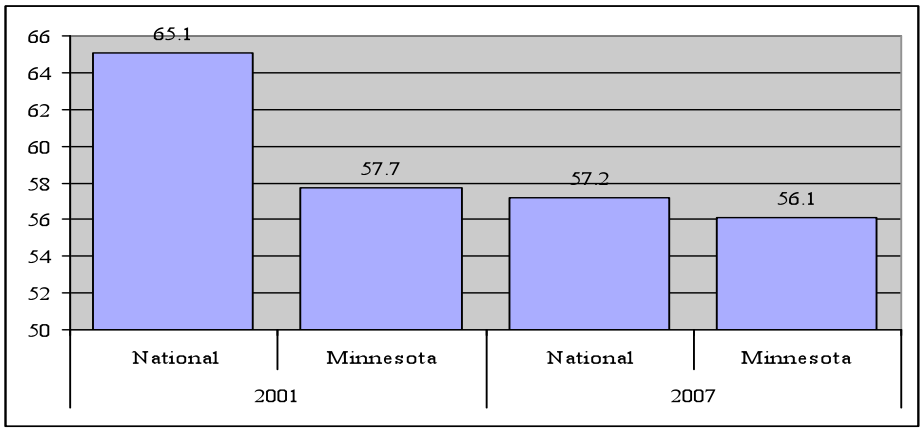

Figure 4. The percent of public school students receiving 3+ on the AP Calculus AB exam in 2001 and 2007.

A random sample of 50 public schools in Minnesota that offer AP Calculus AB were chosen and contacted for information on the type of schedule used, if they were on the block schedule system, how long they had been on the system, and the percent of students achieving a 3 or higher on the 2006 AP Calculus AB Exam. Of the 50 schools chosen, 38 responded with information (see Appendix B for complete data). All schools responded that they have been on their current system for at least 10 years. Seventeen

schools were on a block system and twenty one were on a traditional schedule. There was a vast difference in achievement reported from the schools that responded. As Figure 5 shows, mean scores for students taught under a block schedule were considerably lower than scores in a traditional schedule; a mean of 37.12% of the students in the block schedule system scored a 3 or higher on the 2006 AP Calculus AB Exam compared to mean of 75.10% of the students in a traditional schedule.

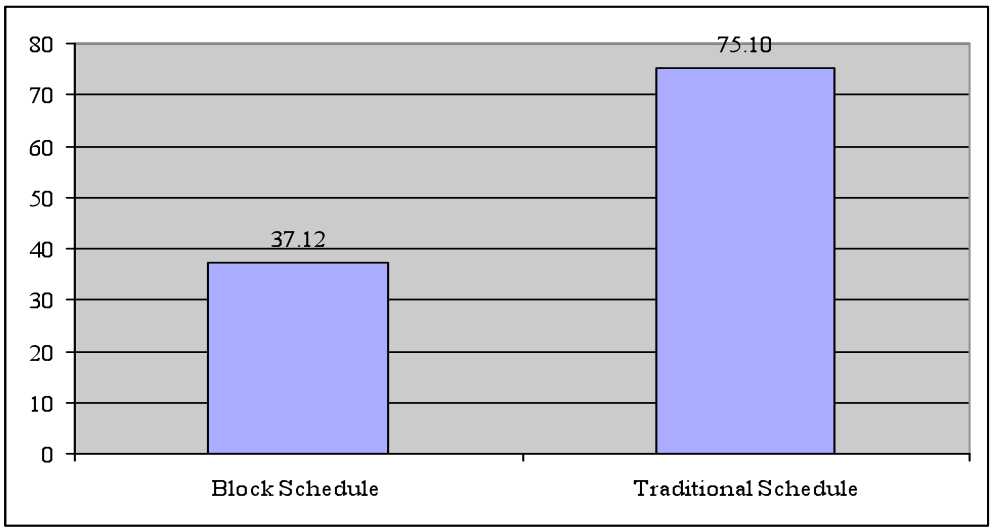

Figure 5. Mean percent of public school students who scored a 3+ on the 2006 AP Calculus AB exam.

The standard deviation for student scores in the block schedule schools sampled was 23.28% with a range of 72. The standard deviation for student scores in the traditional schedule schools was 10.03% with a range of 39. This is a significant difference in both the standard deviation and the range of scores.

Conclusion

The Schools that responded they were on the traditional schedule did not report any issues with either the total student contact time or the retention period between instructional time and the AP Calculus AB Exam. The Schools that responded they were on the block schedule system on the other hand had fairly negative views. The issue,

however, was not the schedule itself. Many responses were favorable towards the extended time per day in the classroom, but were not favorable towards the total student contact time. Some teachers found themselves "borrowing time" from other courses such as pre-calculus to fill in for extended time in the AP Calculus AB course. Many others were unable to do so and had to manage with the time they had.

Retention of information because of the time span between instruction and the AP Calculus AB Exam was also a big concern. Some schools reported a concern with the time span between mathematics offerings under the block schedule. The schools thought the one or two semester gap between math courses had a negative affect on student achievement on the AP Calculus AB Exam. An interesting result of this study pertains to the semester AP Calculus AB is taught in the block system. Four of the block schedule schools from the sample population that offered AP Calculus AB during the fall semester reported an average of 25% of their students received a 3 or higher on the exam compared to 39% for the block schedule schools that offered AP Calculus AB in the spring semester.

One district that taught AP Calculus AB in the fall semester in a block system had 81% of their students receive a 3 or higher on the exam. This score seemed unusually high compared to the rest of the respondents. The author contacted the source to determine what they did to receive such a high percentage when there was such a huge time span between the course and the exam. In this particular district, AP Calculus AB is taught in the fall and AP Calculus BC is taught in the spring. Approximately two-thirds of students that take AP Calculus AB in the fall also take AP Calculus BC in the spring. Most of the remaining one-third who do not take AP Calculus BC in the spring choose

not to take the AB exam. This skews the data a great deal. The AP Calculus BC exam has similar questions as the AB exam with additional topics that compare to a two semester college calculus course. Students that take the BC exam cannot take the AB exam the same year because there are similar questions on both exams. Students that take the BC exam receive an AB subscore in addition to their BC score. The high percentages this particular district had are attributed to their AB subscore. Again, overall scores were still lower than a traditional schedule for both, but there was a significant difference within the block system, which suggests that retention could be a problem.

A number of schools that achieved success in the block system, in addition to the one previously mentioned, were contacted to follow-up with additional questions raised by the results of this study. One question that arose was what are those schools doing correctly to experience such success? Another, if a school district were considering changing their schedule format from a traditional to a block system, what are some recommendations for AP Calculus AB? The responses all had the same underlying themes; dedication, more time, resources, and prerequisites. It all starts with the dedication of students and teachers. There is a huge commitment required by both in order to gain success on the AP Calculus AB Exam. Students are required to devote additional time outside of the regular classroom in order to succeed on the AP Calculus AB Exam. This often means Saturdays as well as time before and after the regular school day. One school runs an early class an hour before school for two weeks prior to the exam for preparation. Review sessions in one form or another occurred in every school that reported increased success. The commitments teachers made were commendable

considering the only extra compensation they received was possible higher student achievement on the exam.

The use of additional resources and supplementary material beyond the textbook was reported to be very beneficial. All schools that responded with higher than average test scores used supplementary material and resources other than those provided by the publisher of their particular textbook. Previous exams were given as practice tests, and sources recommended by the AP Collegeboard were used. The latter proved to be most useful. It was also highly recommended that students purchase exam prep materials themselves to aid in their preparation. Most schools responded that there was a very high correlation between students who used the supplemental resources on their own time and their exam scores.

The quality of mathematics preparation prior to calculus is another key factor. The follow-up responses proved to be interesting with respect to prerequisites. Most had very intensive prep courses. Strong algebra skills were very necessary. It was common, and in many cases necessary, to cover limits in precalculus in order to be ready by the exam date. In every case, where above average exam scores were reported, a course specifically designated as precalulus was required before taking AP Calculus AB, in addition to courses such as Advanced Algebra and Trigonometry; Functions, Statistics and Trigonometry (FST); and Algebra 3. Algebra 3 is a course name given by some of the schools that encompasses similar material that is covered in FST.

This study proved to be challenging and quite interesting. The results cleared up many questions the author had, and gave some valuable insight into possible solutions for some of the frustrations previously experienced. It is apparent from the results that the

author is not the only person struggling with frustrations of teaching AP Calculus AB in a block system. If solutions could be found for the main frustration of time constraint, those solutions could possibly remedy all of the other frustrations mentioned in this study. One that is beyond the control of the author is the early exam date. A solution would be a concentrated effort by AP Coordinators to lobby the Collegeboard to move the exam to a later date. Another possible solution is for students to come in before school prior to the exam for the same period of time missed because of the early date of the exam. The class could then end after the exam. This, of course, would have to be approved by the administration.

The frustrations of time constraint, urgency to cram material in before the exam, and retention could all possibly be solved by restructuring existing courses, prerequisites, and adding courses. Ideally, an actual Precalculus course could be added as a prerequisite to AP Calculus AB. Thus, the Functions, Statistics, and Trigonometry (FST) course could be restructured to focus on the advanced algebra skills that are very important for success in Calculus. Another option would be to restructure the FST course as before mentioned and extend the AP Calculus AB course to a full year. The topics in trigonometry could be covered the first quarter, and the remaining three quarters could be used to cover the AP Calculus AB requirements and prepare for the exam.

If additional courses cannot be added, the author firmly believes that teachers must work with their department to restructure courses to accommodate the time needed to prepare students. Students must be dedicated to devoting many hours outside of class to utilize the many resources available. It will also take dedication from students and the instructor to put time in before or after the regular school day prior to the exam to

prepare. The author offered a before school study session this year for a two week period prior to the exam date. Students attended this optional session as well as attending the regular class. Student response was very favorable. They responded that it was a great benefit to have the extra teacher contact time, and it helped them prepare for the exam.

The possible solutions listed, if implemented and utilized successfully, could alleviate many of the frustrations previously mentioned. The additional prerequisites would definitely aid in retention because students would be taking more math. Also, if students take the route of advanced mathematics, it would benefit them a great deal to plan their courses far enough ahead of time so they can reduce the problem of retention that is caused when they go a semester or a year or more without mathematics. The planning should not be a solution to only aid in better retention in a block system. Careful planning would be beneficial in any schedule system. Many of the frustrations can be solved through a combined effort of students, the AP teacher, the math department and administration. All of this can make an impact on student achievement on the exam, which is the ultimate goal.

The reason for this study was to determine the effects of a block system on student achievement on the AP Calculus AB exam. The results of the research and this study not only helped with possible solutions to many of the frustrations, but also provided answers to questions that were raised as a result of the frustrations. The author does believe that the block system has an effect on student achievement. The results show that. On the other hand, the results also showed that there are schools in the block system that are meeting the needs and experiencing success by implementing some of the solutions previously mentioned. With these solutions, success can be attainable for

students other than the high achieving ones that traditionally take AP Calculus AB. It will take a lot of effort to meet these needs, but it can be done.

After all of this, one may still ask if the AP designation is worth it. The author is still unsure if it is all worth it. Looking at the data, there is a great percentage of students who take the AP Calculus AB exam and still not attain a 3 or higher. The requirements and rigor are high, but that should be the case with any calculus course. The stress is tremendous. Students who traditionally take AP courses either take more than one or are taking other advanced courses. Many schools are now offering the concurrent enrollment option for college Calculus I and schools are taking advantage of that. Students do not need to pass one exam to determine college credit or not. One of our jobs as teachers is to prepare students for the rigor of college, but a course does not necessarily have to have the AP designation to accomplish this. Students can be further ahead with the college credit, but is it worth it? In the author's mind, that remains to be seen.

AP Calculus AB can be successful in a block system as well as a traditional system. If a school is considering offering AP Calculus AB, it is very important to understand what it would take to run a successful program. There would definitely need to be a change in pedagogy. As the research shows, teaching in a block is vastly different than in a traditional system. Instructional methods need to vary within each class period, and still maintain the timetable needed to prepare for the exam. This calls for staff development resources. Staff development is crucial to success not only for calculus, but any course taught in the block system. The quality of the mathematics preparation for students is also important. Restructuring prerequisite courses may be required in order for students to obtain the necessary skills to achieve success in AP Calculus in the time

allowed. If possible, additional prerequisite courses such as Precalculus would be very beneficial.

A school that is on the traditional system that is considering offering AP Calculus AB, should still keep in mind the high standards required by the Collegeboard. Time is less of a factor, but if the time is not utilized to its fullest the same frustrations with time constraints will occur. As in a block system, staff development is important, as is the quality of mathematics preparation. In both systems it takes a great deal of dedication, resources, and time. Additional resources and supplementary materials are very helpful and widely available. The AP Collegeboard has an abundance of resources available. They want students to succeed and are willing to offer much help in doing that.

This research helped the author a great deal in trying to understand and implement changes in order for students to have greater success on the AP Calculus AB exam. It has had an impact on the department because of the course changes that have already taken place, and will take place in the future. The entire school has become aware of the importance of the AP program to the students. The administration and school board also see the importance of promoting and supporting the AP program regardless of the scores or the smaller than average enrollment. The schools contacted for data requested that the results be shared with them when completed. It is the author's plan to make others aware of his research, whether it is at the Minnesota Council of Teachers of Mathematics spring conference, or other opportunities. This study showed that there may be a need for more research on the effects of a school's schedule on achievement on the AP Calculus AB exam.

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Appendix A

Data from the 2001 and 2007 AP Calculus AB Exam

2001		**Number of Exams Taken**	**Number of Students Receiving 3+**	**Percent of Students Receiving 3+**	**Mean Score**
National	All Schools	142944	90894	63.6	2.99
	Public Schools	117518	76494	65.1	2.97
Minnesota	All Schools	3614	2139	59.2	2.87
	Public Schools	3065	1769	57.7	2.83
2007					
National	All Schools	204546	119388	58.4	2.92
	Public Schools	171973	98348	57.2	2.88
Minnesota	All Schools	4426	2602	58.8	2.93
	Public Schools	3776	2119	56.1	2.84

Appendix B

Results from the Thirty-Eight Schools Questioned for this Study

Block Schedule	
High School	**Scores of 3+ (%)**
1	25
2	33
3	76
4	25
5	34
6	39
7	45
8	9
9	22
10	14
11	22
12	78
13	81
14	10
15	60
16	28
17	30
Range	**72**
Mean	**37.12**
Standard Deviation	**23.28**

Traditional Schedule	
High School	**Scores of 3+ (%)**
18	71
19	76
20	80
21	88
22	81
23	70
24	66
25	56
26	74
27	85
28	95
29	76
30	52
31	79
32	76
33	80
34	65
35	77
36	82
37	80
38	68
Range	**39**
Mean	**75.10**
Standard Deviation	**10.03**