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A Case Study on the Effects of 4/4 Block Scheduling on Achievement in Mathematics Based on State Standardized Testing in Pennsylvania for High School Students

William Anthony Parks
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A CASE STUDY ON THE EFFECTS OF 4/4 BLOCK SCHEDULING ON
ACHIEVEMENT IN MATHEMATICS BASED ON STATE STANDARDIZED
TESTING IN PENNSYLVANIA FOR HIGH SCHOOL STUDENTS

A Dissertation

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Doctor of Education

William Anthony Parks

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December 2013

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Title: A Case Study on the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

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In the 1990's there was a movement by high schools to change from a traditional scheduling format to a block scheduling format (Canady & Rettig, 1995) in an effort to improve student achievement. Reports such as *A Nation at Risk* and *Prisoners of Time* indicated time was an important factor (NCEE, 1983; NCTL, 1994). While the concept of school schedules that reduce the load of teachers and students, allow for depth of instruction, and enable teachers to utilize varying instructional strategies contained great vision, it may potentially hinder achievement of students in some subject areas. In areas such as mathematics, retention can be impacted by the spacing effect theory, which can be critical to learning (Rohrer & Taylor, 2006).

This case study examined student achievement in a school district in northeastern Pennsylvania which used the 4/4 block schedule in two high schools and changed to a hybrid schedule allowing students to take mathematics all year on a traditional schedule, based on course difficulty level, in an effort to raise student achievement. Student achievement data from the Pennsylvania System of School Assessment (PSSA) and the Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) assessments were analyzed. Additionally, three administrators were interviewed and two focus groups were conducted with 15 mathematics instructors to determine whether significant changes in student achievement followed the change in scheduling format.

The findings of this study indicated that statistically significant growth occurred in student achievement in mathematics following the change to a schedule having math classes all year. Each high school showed significant growth for applied-level students and one high school showed significant growth with college preparatory students as well. The findings also indicated that instructional strategies and assessment practices can have an impact on the ability of students to retain content and skills by spacing the presentation/practice over time. Just like instruction and supervision, scheduling should not be a one-size-fits-all approach. Schools must consider the implementation of a school schedule that promotes effective instruction and assessment connected to corresponding subject areas, facilitates presentation/practice which are spaced appropriately, and differentiated to meet the needs of students.

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CHAPTER 1

INTRODUCTION

Introduction to the Study

School accountability has become the educational and political catch phrase of the 21st century. Politicians, in an effort to get elected, have begun to make educational achievement one of the major platforms on which they run to get elected. With the promise of better schools and higher achieving students comes the need to fulfill that promise by putting legislation into motion that ensures the need for schools to answer the call for better instruction, more productive graduates, and more literate citizens.

This focus on school accountability has resulted in the most recent legislation called the “No Child Left Behind Act of 2001” (NCLB). The US Department of Education (2004) states that NCLB is a reauthorization of the Elementary and Secondary Education Act of 1965 which was the first piece of federal legislation enacted allowing the federal government to have a voice in educational policy, which since the inception of our Constitution has been a function of the states and local municipalities. The federal government has told states they must set up a system of school accountability that ensures school success in order to continue to receive federal funding earmarked for education.

The state of Pennsylvania (PA) answered this call by utilizing the State System of Assessment (PSSA), which had been developed, revised, and continuously improved in the 1990’s, as the sole means by which to judge the achievement of students in “reading, writing, and arithmetic” moving forward into the 21st century. Since the inception of NCLB, schools in PA have had to show improvement each year in each of the focused

subjects or they would be required to submit a school improvement plan addressing the identified needs of the district.

Studies done prior to NCLB, as a result of governmental research into the educational practice and procedure, have suggested that how time is utilized within a school day should be a focus for school improvement. It was out of this study, *A Nation at Risk* (1983), and another study, *Prisoners of Time* (1994), that the idea of block scheduling began to unfold. Block scheduling takes the time spent in a school day with the traditional 7-8 period day running all year, and redistributes the classes to meet 90 minutes per day for half the number of days as a traditional schedule. Four by four (4/4) block scheduling is arranged so that a student takes four courses at a time for 90 minutes per day for half of the school year and thereby modeling a college-type schedule, this schedule is also called semestering. Alternating block (A/B) scheduling allows students to take four courses per day for alternating days, but the classes run for the length of the school year (Canady & Rettig, 1995). According to the research of many authors, study teams, and educators, there are both advantages and disadvantages to the block scheduling format. In this new world of accountability based on high-stakes testing, the question that faces educators today is whether there are inconsistencies in performance among students who take mathematics courses on a block schedule. The current study will focus on this question as it relates to mathematics content.

There are many advantages cited by researchers of block scheduling which have made this strategy spread so rapidly throughout the past 30 years. Some of the most documented advantages are the ability for teachers to use more varied instructional practices (Knight & DeLeon, 1999; Veal & Flinders, 2001; Zepeda & Mayers, 2001;

Hurley, 1997b; Staunton, 1997), reduced stress for teachers and students (Zepeda & Mayers, 2001; Marchant & Paulson, 2001; Hurley, 1997b; Staunton, 1997; Rettig & Canady, 2001), fewer discipline referrals (Marchant & Paulson, 2001; Evans, Rice, & McCray, 2002; Zepeda & Mayers, 2001; Rettig & Canady, 2001), and better rapport between teachers and students (Veal & Flinders, 2001; Hurley, 1997a; Hurley, 1997b). Advantages cited with moderate frequency are that teachers have time to deliver more depth of instruction (Zepeda & Mayers, 2001; Hurley, 1997a; Marchant & Paulson, 2001), an improved school climate (Marchant & Paulson, 2001; Knight & DeLeon, 1999), increased student and staff attendance (Zepeda & Mayers, 2001; Rettig & Canady, 2001), decreased failure rates in courses (Zepeda & Mayers, 2001; Rettig & Canady, 2001), and increased graduation rates due to early graduation (Hurley, 1997a; Rettig & Canady, 2001). “There are problems and issues with block schedules just as there are with all schedules, but the preponderance of evidence, both anecdotal and empirical, is positive” (Rettig & Canady, 2001, p. 78).

Many of the same research teams found that the advantages to block scheduling also included disadvantages which have led to schools not accepting the block schedule, moving away from it, or modifying it to fit their needs. The most frequent disadvantage cited is that there seems to be lower long-term retention in subject areas that require sustained practice to retain skills such as mathematics (Marchant and Paulson, 2001; Knight & DeLeon, 1999; Trenta and Newman, 2002; Evans, Rice, & McCray, 2002; Lawrence and McPherson, 2000; Thomas, 2001). Other more common disadvantages include teacher lack of using varied instructional strategies (Marchant and Paulson, 2001; Hurley, 1997a; Knight & DeLeon, 1999; Slate & Jones, 2000), the magnification of

absences (Marchant and Paulson, 2001; Hurley, 1997a; Gruber & Onwuegbuzie, 2001; Hurley, 1997b), and a host of problems revolving around the utilization of class time (Marchant and Paulson, 2001; Hurley, 1997a, Hurley, 1997b, Thomas, 2001).

In addition, some less common concerns were lack of attention (Marchant and Paulson, 2001), more homework assigned in each class (Marchant and Paulson, 2001), balancing of difficulty and sequencing of courses across semesters (Hurley, 1997a), too much time between courses (Hurley, 1997a, Staunton, 1997), and lower grade point averages (Thomas, 2001). What is interesting to note is that many of the advantages noted in some research are disadvantages in other research which illustrates just how difficult it can be to determine any causal factors behind the ability of students to retain the skills and knowledge they have learned.

The most cited disadvantage within the literature is the long-term retention of material in subjects that require more expertise of skill and whose very nature is that one concept builds upon the next, For this reason, studies devoted specifically to mathematics achievement are included in this study as well as those which simply highlight advantages and disadvantages of the scheduling models in general. Wronkovich, Hess, & Robinson (1997) describe a study which focused on the ability of mathematics students to pass standardized tests for College Placement in Ohio and Alderman (2000) details a study of Standards of Learning Tests for graduation from high school in Virginia. Each of these studies focused on the differences between achievement with the 4/4 format of scheduling and the traditional method of scheduling. In both studies, the students who had taken mathematics classes on the traditional schedule outperformed those on the 4/4 schedules. Another study was detailed by Arnold (1998) and was a doctoral dissertation

comparing the outcomes of student achievement based on traditional or A/B block schedule. His findings were that the achievement levels had no meaningful differences when these two types of schedules were studied. His results suggested that students who take mathematics classes for the entire school year continued to have the same results regardless of whether they had 45 minute classes every day or 90 minute classes every other day.

Statement of the Problem

High school students who took their mathematics courses on the 4/4 block scheduling model were experiencing low achievement in performance levels as evidenced by results in state and/or district standardized testing. Since mathematics is a subject that requires skills to be practiced regularly in order to retain and later build upon that knowledge, it may be necessary to have mathematics classes that meet all year long to aid students in maintaining proficiency.

Purpose of the Study

The purpose of this case study was to report on the changes that occurred as a result of transforming the mathematics schedule from a block schedule format to a traditional format. While many studies have shown that block scheduling has been effective in increasing student achievement in many subject areas, the results were inconclusive in mathematics. Some studies have actually shown that students who take mathematics on the 4/4 block scheduling format have had negative results due to the increase of time that may occur between courses. This study investigated what correlation, if any, existed between the type of schedule utilized and the achievement of

students on state and local mathematics assessments who have taken mathematics courses on such scheduling models.

Theoretical Basis for the Study

The so-called “spacing effect,” as it is termed by many (Underwood, 1961; Hintzman, 1974; Dempster, 1988; Dempster & Farris, 1990; Rohrer & Taylor, 2006), is the effect that massed practice (MP) versus distributed practice (DP) has on long-term retention. This idea is often coupled with studies of how long-term retention is affected by overlearning. While each topic remains distinct, they each focus on the effect particular methods of presentation and practice have on the ability of the mind to recall cognitive tasks of both verbatim recall and conceptual natures. “Thus, every additional problem done for the sake of overlearning is one less problem devoted to the principle of spaced practice” (Rohrer, Taylor, Pashler, Wixted & Cepeda, 2005, p. 372).

The studies on memory that undergird the spacing effect date as far back as 1885 when Ebbinghaus began his studies on memory which were later recognized formally by the publication of Jost’s Law in 1897. This law ushered in a host of new studies on the spacing effect into the 1920’s (Dempster, 1988). Benton Underwood (1961) then bore the torch through the 50’s and 60’s which culminated with the results of his ten year study published in *Psychological Review*. This was where the two key variables DP and MP are recognized and become common vocabulary in all later retention studies of distributed practice and massed practice. Hintzman (1974) describes two successive presentations of material as P_1 and P_2 and explains the effect that occurs if a long-term retention test is given following the two presentations. “When the $P_1 - P_2$ interval is short, retention is poorer than when the $P_1 - P_2$ interval is long” (p. 78). In other words,

the longer the space of time between presentations of material, the better that students are able to maintain the skills and knowledge they have acquired. This spacing effect appears to exist in virtually all memory tasks, whether auditory or visual, as reported by several studies in his article.

As studies continued on the effects of the way that both presentations and practice of data are spaced, each one came to the same conclusion. Massed practice/presentation has better results on a shorter retention interval (RI) and distributed practice/presentation is more beneficial for a longer RI. The longer one needs to retain information, the more necessary it is for the presentations to be distributed rather than massed. In fact, massed presentations seem to be about half as valuable as spaced presentations and the difference becomes even more pronounced as the incidence of the repetitions increases. People tend to forget less when there is more time to digest and practice between presentations which cause the space of time between the presentations to be of utmost importance in its benefit to students (Rohrer & Taylor, 2006; Dempster, 1988; Pavlik & Anderson, 2005).

Most of the earlier studies, those prior to 1990, focus primarily on the ability of the mind to recall facts based on the number of seconds between presentations and with retention intervals of one week or less. The more recent studies have determined much more long-term retention such as several weeks to one year to multiple years. Studies have shown that a month of spacing between presentations allows for about three-times as much value to the student as a day between presentations (Pashler, Rohrer, and Cepeda, 2006). The overwhelming majority of these studies dealt with paired words and vocabulary lists; not until 2006 was a study done which focused on the effect of spacing on more conceptual tasks, especially the learning of mathematics. “It appears the

benefits of distributed practice and overlearning are especially unclear for mathematics because, to our knowledge, no previously published experiment has used a mathematics task rather than motor tasks” (Rohrer & Taylor, 2006, p. 1212).

Research Questions

The questions this study will seek to answer are:

1. What conditions existed that led this particular school district to investigate the need for a change in scheduling format?
2. What were the perceptions of teachers and administrators in regard to changes in instructional technique and student achievement as a result of the change in scheduling format?
3. Were there any changes on PSSA and NWEA student achievement data that correlated with the introduction of full-year classes for applied-level and college preparatory mathematics courses?

Overview of Methodology

This study was a case study of one school district, containing two high schools, whose mathematics program, traditionally a 4/4 block schedule, was altered to allow students to take mathematics courses for the entire school year in 45 minute classes as well as other students who continued to utilize the 4/4 block schedule for 90 minutes in selected classes. Both high schools decided to implement a full-year model for all of their applied-level mathematics classes in Algebra 1, Geometry, and Algebra 2 beginning in the 2006-2007 school year. One high school also extended this model to all college preparatory mathematics classes beginning in the 2008-2009 school year, while the other high school remained in the 4/4 model in all college preparatory mathematics classes.

The student data were examined overall as well as separated into two subgroups based on level of mathematics course in which they were enrolled, applied-level or college preparatory. The students in the applied-level mathematics classes in each school had data available from the full-year scheduling model for four school years; their data were compared to archival data of students who only had the 4/4 block format. The students in college preparatory classes in one high school remained in the block format and those in the other high school changed to full-year. The data from each high school were then compared after two years of implementation.

Data for both groups were collected from student results each year on district Measure of Academic Progress (MAP) testing and the 11th grade results of the PSSA test. Teachers, from both schools, who have taught under both scheduling formats, were interviewed to determine which model they believed to be more conducive to achievement mathematically and the reasons why they felt that to be the case. The data were compared both quantitatively and qualitatively, to determine which type of scheduling model resulted in the higher levels of student achievement in mathematics.

The student incentive involved with making the results more reliable is that students in this school district had personal accountability for outcomes on the testing. Students who were not proficient on the PSSA exam in their 11th grade year needed to take a remedial mathematics class in their senior year in lieu of another elective and retake the mathematics test during their senior year. The school policy (Policy 217 – Graduation Requirements) also stated that students could not graduate without achieving a score of proficient or higher on the PSSA exam, the senior retake, an alternative district

assessment, the MAP test, or by remediating and testing proficiently on each assessment anchor as outlined by the state standards.

Interviews were also completed with three administrators, the assistant superintendent for curriculum and instruction and the principal from each high school to determine the conditions that existed which resulted in the implementation of the modified schedule and their observations of changes resulting from the modified schedule in terms of instructional practice and student achievement. Fifteen teachers were also interviewed using two focus groups, one for each high school. The teachers interviewed had had experience teaching on both scheduling formats and were asked questions regarding instructional practice and student response facilitated by each schedule as well as which schedule they felt enabled better student achievement. Finally, policies, student handbook, and program of studies were reviewed to uncover any additional information related to the achievement of students.

Significance of the Study

Educational research, in general, tends to be inconclusive and the causes behind the emergence of data are very often difficult to identify. While certain studies would suggest that proficiency of students is a causal relationship to factors within the school and school district, other studies could say that the cause is another variable altogether (Lagemann, 2000). There are many factors that contribute to the achievement of students including but not limited to, the teachers the students have, the methods by which the mathematics is taught, cultural biases and traditions, transiency of the population, and professional development of instructors. It is important to recognize that the purpose of this study was to focus on whether there was a correlational relationship between the

schedule by which the mathematics courses were delivered and the achievement levels demonstrated by the students.

The goal of this investigation was to examine the phenomenon which has been created by the implementation of block scheduling. While many embraced the concept of 4/4 block scheduling in many different subject areas (Canady & Rettig, 1995, Hurley, 1997a, 1997b; Staunton, 1997, Knight & DeLeon, 1999; Veal & Flinders, 2001; Evans, Rice, & McCray, 2002), it may not have been the best model to use in preparing students mathematically, especially where accountability was measured by high stakes achievement tests. The ultimate solution to the problem may be a schedule which seeks to incorporate both a full-year element coupled with a block element within the same master schedule to maximize the advantages of each and to address the specific needs based upon the teachers, students, subject area, and difficulty level. The former studies sought to explore the effects of an entire school changing to the block schedule for all subjects and all difficulty levels rather than implementing a schedule which targeted the specific areas in need of change. They reported on whether the change was positive or negative in terms of generalities with specificities interwoven into the findings. This study was unique in that it investigated a single school district which made the change entirely to a new scheduling format by introducing a hybrid schedule meant to harness the benefits of block scheduling for certain subjects, difficulty levels, and groups of students while also attempting to address the needs created by block scheduling especially pertaining to the low to middle achievers in mathematics. The changes investigated by this study were still being utilized by both schools at the time of this report.

Definitions

4/4 block schedule: “(also known as 4X4, intensive scheduling, semestered, or accelerated plan) Four classes meet every day for ninety minutes for ninety days, then four new classes meet every day for ninety minutes for ninety days. This model is the most popular in use” (Arnold, 1998, p. 13).

A/B block schedule: (also known as alternating day) Classes meet every other day for 80-100 minutes for the entire 180-day school year. Half of a student’s classes meet on Day 1. The other half meet on day 2 and so on (Arnold, 1998, p. 13).

Achievement: The extent to which a person or group has acquired certain skills or information.

Applied-level classes: Those mathematics classes scheduled for students at the lowest levels of achievement within the realm of the regular-education program. In some schools, this may be termed business-level. Most students within this program have future plans to enter directly into the work force or to enter the military and the program prepares them to do so (Program of Studies for Case Study School District).

Block scheduling: “An extended classroom learning period, generally between 85 to 100 minutes. This schedule also decreases the number of classes that students take and that teachers teach each day” (Jenkins, Queen, and Algozzine, 2002, p. 196).

College-preparatory classes: Those mathematics classes scheduled for students at the medium levels of achievement within the realm of the regular-education program. Most students within this program have future plans to attend college and the program prepares them to do so (Program of Studies for Case Study School District).

Measure of Academic Progress (MAP): A computer-based assessment at the district level which is used as a pretest and posttest for each mathematics or English class that a student takes. The assessment levels the questioning based on how a student performs on prior questions to get an accurate grade level equivalency (NWEA, 2004).

No Child Left Behind (NCLB): A reauthorization of the Elementary and Secondary Education Act (ESEA) of 1965. This is federal legislation that has given states the responsibility of ensuring that all students are reaching a higher level of proficiency in mathematics, reading, writing, and science. This legislation also keeps states accountable in the areas of highly-qualified educators, student attendance, and dropout rates (USDOE, 2004).

Pennsylvania System of School Assessment (PSSA): A system of tests aligned to a given set of standards and anchors that measure the proficiency of students as they exit grades 3-8 and 11 until the 2010-2011 school year. The students were assessed in reading, writing, and mathematics. Beginning with the 2010-2011 school year, the Keystone exams replaced the 11th grade PSSA exams for mathematics, reading, writing, and science (PDE, 2011).

Proficiency level: The percentage of students from a particular class found to be advanced or proficient on the PSSA exams (PDE, 2011).

Proficiency: A benchmark set by the state to determine adequate achievement by students on the PSSA exams (PDE, 2011).

Retention interval: The length of time a student is able to maintain the skills and knowledge learned as evidenced by assessment data (Underwood, 1961).

Traditional schedule: A single period schedule consisting of seven or eight classes daily, varying between 40-55 minutes each (Arnold, 1998).

Assumptions

There are several assumptions which were made in this study due to the study being restricted to two schools within the same school district. Each of the schools had common curricula for each of the mathematics courses the students took. Each of the schools had professional development plans which were planned and coordinated by the same department. The school district also utilized the same graduation requirements for proficiency and offered both tutoring and remedial classes to students who fell short of proficiency. The overall assumption was that due to the nature of so many commonalities and strides by the school district to keep the two high schools consistent in expectations, many of the potential variables which could have impacted the results of the study were assumed to be neutralized.

Delimitations

In completing this study there were some areas where the study was bounded and thereby prevented the results of the study to be generalizable outside the realm of the school district being studied or another district with similar features and needs. One boundary inherent in this study was the small window of achievement data available to the researcher which were specific to the difficulty levels of the classes. With both applied-level and college preparatory data, there were boundaries with how many years were available with which to compare changes in order to draw conclusions. With applied-level data, there was only one year of student achievement results prior to the implementation of the modified schedule and with college preparatory data there were

only two years of data beyond the point where the modified schedule was implemented for High School A. with which to compare the achievement scores following the implementation.

This case study was small-scale only including one school district and a limited quantity of teachers and administrators. There were only 15 teacher participants in the focus groups from an available 35 high school mathematics teachers district-wide. These limited groups were due to the limited qualifications placed on the department chairs to find teachers who had taught on the block and traditional schedules as well as availability of those teachers for the one day when the focus group was held for their school. The number of administrators was also limited to the three who were the most instrumental in the process of making the change to the modified schedule.

While the qualitative nature of the interviews and focus groups echoed much of what had already been written about the effects the block schedule may have on mathematics instruction in accordance with the spacing effect, the staff and administration chose this method of scheduling in the hopes that it would produce better achievement results. Since the collection of teacher data was not a random sampling of teachers, but teachers could choose whether or not to participate could have drawn only those teachers who were in favor of the move to traditional scheduling and thereby not a true cross-section of the entire mathematics department. Other factors that might contribute to this bias could be the fact that the researcher was an employee of the school district at the time the focus group data were collected. Though the attempt was made to neutralize this bias by having a third party collect the teacher responses as well as

providing anonymity for the staff, the teachers' perceptions and responses potentially could have been guarded due to the nature of this phenomenon.

Scope

The scope of this study is limited to the school district in which the study was conducted, but could have further reaching implications to other high schools in Pennsylvania who use the block schedule to instruct their students in mathematics. As administrators decide how to set up their master schedules, they may take the principles uncovered in this case study to make decisions regarding what method of scheduling to use with their mathematics classes. Some variables which are not addressed in this study are teacher preparation, instructional style, professional development, and curricular program.

It is also important to acknowledge that the Pennsylvania Department of Education no longer utilizes the PSSA exam for 11th grade students, however, the implications of this study continue to be relevant in the new age of Common Core State Standards and Keystone exams. These new assessments continue to be criterion referenced based on a given set of standards and end of year Keystone exams mirror the results of NWEA MAP assessments found in this study which are also end of course assessments rather than assessments of longitudinal skills. (PDE, 2011)

Summary

It was the intent of this study to determine if there were meaningful differences in mathematics achievement between students on a 4/4 block schedule and those on a full-year, traditional schedule. An expressive, thorough study of the policy, perceptions, and data associated with school schedules that facilitate mathematics instruction all year may

uncover meaningful implications to stakeholders who are capable of making educational change necessary to allow proficiency to be a realistic objective for all students.

The purpose of this study was to discover if there were meaningful differences in the ability of students to retain the skills and knowledge acquired in mathematics classes based on 4/4 block scheduling and or a full-year model of instruction. School accountability brought on by legislation at both the federal and state levels have indicated a need for school districts to ensure that student achievement is increasing annually. One of the suggestions made by proponents of school reform was to utilize the school day more effectively and to alter the way that instructional time was employed, hence the emergence of the block schedule. While there were advantages and disadvantages to this method of instruction, schools began to utilize block scheduling, based on the work of Canady and Rettig (1995), as a means by which to reorganize the time spent in a school day in an effort to positively impact student achievement. Following the reauthorization of the ESEA known as “No Child Left Behind” in 2001, at least one school district in Pennsylvania which has utilized the block schedule has found that their students are not performing as well on the examinations focused on school accountability as they are on class performance and in-class assessments, thus this study.

A theory that emerged in 1961 by Underwood, called the spacing effect, may in fact be the explanation as to why students on a block schedule do not seem to perform as well on tests requiring long-term retention of both content and skills as they do with short term assessments such as unit tests and other classroom assessments. Briefly, the spacing effect suggests that the longer the required retention interval to maintain knowledge and skills the more spaced the presentation of the material needs to be as well as the practice

that goes with the presentation. The goal of this study was to determine whether there were meaningful differences in student achievement as a result of making a change to the schedule on which mathematics classes are instructed. The next chapter will examine the literature detailing advantages and disadvantages of block scheduling, the relationship between block scheduling and mathematics instruction, the theory of the spacing effect, and implications that the spacing effect may have on the scheduling of mathematics classes to facilitate effective instructional practice.

CHAPTER 2

REVIEW OF THE LITERATURE

There are many variables that play a role in the levels of proficiency that students achieve. It has been proposed that the research of education cannot even be called a science due to the difficulty in regulating those variables.

Neither singular in focus nor uniform in methods of investigation, education research grew out of various combinations of philosophy, psychology, and the social sciences, including statistics. The variety that has characterized educational scholarship from the first, combined with the field's failure to develop a strong, self-regulating professional community, has meant that the field has never developed a high degree of internal coherence. (Lagemann, 2000, p. ix)

As Lagemann (2000) describes, the research of education seems not to be respected, nor appreciated by all, especially by those in the field of scientific research. The mere difficulty of narrowing causal relationships to specific implementations of strategy, creativity, and ground-breaking discoveries presents a cognitive dissidence too complex to understand even for the most liberal of researcher.

The purpose of this study is to report on the effectiveness of the 4/4 block scheduling model as it pertains to progress in student achievement levels in moving from one mathematics class to the next. While many studies have shown that block scheduling has been effective in increasing student achievement in certain subject areas, the results are inconclusive in mathematics. Some studies (Gruber & Onwuegbuzie, 2001; Evans, Rice, & McCray, 2002; Lawrence & McPherson, 2000) have actually shown that students who take mathematics on the 4/4 block scheduling format have had negative results due

to the increase of time that may occur between courses. This study sought to determine if there were meaningful differences in mathematics achievement on standardized assessments between students on 4/4 block scheduling and those who are educated all year long in a more traditional format.

This review of literature contains the criteria for selecting the literature, provides a background and history to block scheduling as well as itemizing the advantages and disadvantages associated with the block scheduling format. In addition, it will discuss national and state requirements of mathematics and the criteria necessary to show proficiency according to both NCLB and state standards as well as a theoretical framework giving insight as to how students learn best and the effects that gaps of learning may have on long-term retention of concepts. Literature for the methodologies will be briefly discussed as a prelude to chapter 3. Finally, the literature will be evaluated to summarize the research, identify strengths and weaknesses, and indicate gaps and saturation points.

Criteria for Selecting the Literature

The literature selected for review for this study includes journal articles, reports, books, and research studies. All selections were written by leaders and experts in the fields of education and psychology or research teams formulated for the purpose of evaluating existing educational models or a particular initiative in educational reform.

General Historical Basis for the Topic

Accountability in Education

As federal and state standards for student achievement become more stringent, the need to ensure that student instructional time is maximized becomes imperative. Schools

are now being held to a higher level of accountability due to federal legislation that has been enacted, the No Child Left Behind Act of 2001 (NCLB). The US Department of Education (2004) states that this Act is a reauthorization of the Elementary and Secondary Education Act of 1965 which was the first piece of federal legislation enacted allowing the federal government to have a voice in educational policy. Since the inception of the US Constitution, educational policy has been a function of the states and local municipalities. The standards for the state of Pennsylvania mirrored the federal legislation by incorporating a state system of standardized testing called the Pennsylvania System of School Assessment or PSSA exam which was the standard for demonstrating proficiency in 11th grade until the 2010-2011 school year, when it was replaced by the Keystone exam (PDE, 2011).

The Pennsylvania Department of Education (2011) states the PSSA exam was designed to test all students in Pennsylvania schools in the areas of mathematics and reading in grades 3-8, and 11 as well as writing in grades 5,8, and 11, and science in grades 4, 8, and 11. Schools must have shown that 100% of their students had achieved a proficient score on all areas of the exam by the year 2014 or be eligible for five different levels of school accountability for school improvement. Schools were given several benchmarks they must have achieved in each of the years leading up to 2014 which represented an average increase in student achievement of 10% over the previous year. Schools that did not meet the benchmark percentages must have presented formal improvement plans to the state of Pennsylvania each year to show that the school district was taking appropriate measures to ensure that students were being educated in accordance with best instructional practice. The 2010-2011 school year was the last year

that students took the PSSA in 11th grade as PDE replaced the 11th grade PSSA in all subjects with the Keystone exams. The Keystone exams are now given as end of course exams for Algebra 1, Biology, and English Literature. Rather than students needing to demonstrate proficiency on the 11th grade PSSA, they must demonstrate proficiency on the Keystone exam at the time the corresponding coursework is taken as a graduation competency assessment program (PDE, 2011). This legislation and accountability, as well as articles and publications, such as *A Nation at Risk* (1983) and *Prisoners of Time* (1994) have described the educational system in America to be marginal, at best, compared to the rest of the world. These sentiments caused school districts and administrators to look for ways to improve instruction and educational programming.

Educators responded to the NCLB legislation by looking for ways to restructure the way in which education is delivered in an effort to accentuate the amount of time that students are actively engaged in meaningful instruction. Two such areas of focus for educators are the school calendar year and the time scheduled for classes (Lawrence & McPherson, 2000). When looking at the time scheduled for classes, many high schools went to a block scheduling format in an effort to make the most of the school day.

One suggestion of the studies prior to NCLB was to address the length of time that students are instructed and thereby change the workload of teachers and students in an effort to provide more intensive time devoted to a smaller number of courses at one time (NASSP, 1996). The developers of this new style scheduling, called 4/4 block scheduling, failed to see that the reduction in workload per semester would cause gaps in the continuity of instruction in all subject areas. These gaps, while unrecognizable in subjects where material does not build on previous knowledge, are accentuated in

subjects where repetition and continuous practice are necessary to maximize retention, namely foreign language and mathematics (Marchant & Paulson, 2001).

History of Block Scheduling

In 1983, the National Commission on Excellence in Education released a report entitled *A Nation at Risk* which caused Americans to begin to question the educational effectiveness of our school systems (Lawrence & McPherson, 2000). Since this time school districts have sought ways to make improvements to education by thinking outside the normal parameters. The goal that school boards, educational consultants, and administrators have had in their search is to make the most of the limited time that students are able to be educated by altering the schedule that guides the instructional day. Lawrence & McPherson (2000) also point out that “the National Education Commission on Time and Learning (1994) published a report addressing national concerns regarding allocations of time and use of the school day for instructional purpose” (p. 178) entitled *Prisoners of Time* where utilization of time in a school day was identified as the variable most in need of change to affect the reform sought by legislators and the Commissions developed by them to study our educational system for effectiveness.

In addition to legislation guiding the move for school transformation, schools have tried to implement best practice in instruction by following the suggestion of educational researchers. In Cawelti’s report on high school restructuring (as cited in Jenkins, Queen, & Algozzine, 2002), which drew from the recommendations of these studies of usage of time, it was suggested that there are actually five major components of school reform, including curriculum/teaching, school organization, community outreach, technology, and monetary incentives which were needed to ensure that students are

prepared for the future challenges of the world. Additionally, Cawelti analyzed school organization more specifically to arrive at ten separate elements included in the transformation of the school organization to affect change. Those elements included “shared school governance, site-based management, teacher-team responsibilities, transition to upper grades, teacher-advisee system, school-within-a-school, block schedule, total quality management, divisional organization, and extended school year” as cited by Jenkins, Queen, and Algozzine (2002, p. 196). These ideas were then further structured into an argument for transforming the school schedule as a means by which schools may be able to reorganize their overall structure to afford teachers the time to utilize a variety of instructional strategies in order to get beyond the single most prevalent instructional technique at the time, the lecture (Canady & Rettig, 1995).

Block scheduling is the term used to describe the restructuring of the school day in an effort to take full advantage of the time allotted to educators to instruct students. Many educators feel that the traditional schedule, which has students taking eight different classes for 45 minutes each all year long, does not give ample time to allow students and teachers to explore topics in depth. For this reason, block scheduling has been instituted to revitalize education and to incorporate various learning styles (Canady & Rettig, 1995).

While there are several types of block scheduling methods, the most popular is the 4/4 method, which is the method to be examined in this case study. This method allows students to take only four classes in each semester of the school year for approximately 90 minutes each. Students take four classes in the fall semester and four classes in the spring semester, hence the “4/4” designation. Another method of block scheduling

allows for modification to this structure by alternating the day as opposed to the semester. In this structure, called the Alternating Block, or A/B model, the students take four 90-minute courses on one day and four different 90-minute courses the next day for the entirety of the school year. Though there are other methods which include different variations to time and length of semester, these are the most common (Marchant & Paulson, 2001).

Advantages of Block Scheduling

Canady and Rettig (1995), who have been proponents of changing the way in which time is organized within a school day, have suggested that changing the schedule on which courses are taught can help schools to intensify the learning experiences of their students, allowing them to complete more courses in preparation for the college years, and thereby promoting improvement in the overall academic achievement of students. Their book, *Block Scheduling: A Catalyst for Change*, details alternative types of block schedules by presenting descriptions of how schedules can be created as well as demonstrating the effects that such scheduling changes may have on both teachers and students. They suggest that alterations to the school schedule allow teachers to utilize more varied methods of instruction, to provide more depth of instruction, to promote the acceleration of upper-level students, to enable better course grades, and to facilitate better rapport between staff and students.

Canady and Rettig (1995) give instructions to administrators enabling them to reorganize the time frames upon which their school schedules are built to foster improved instruction and promote higher student achievement. The theories they present are built upon the commissioned studies of *A Nation at Risk* (1983) which offered many

recommendations for better utilization of time within the school day and more focused attention on the core academic subjects and *Prisoners of Time* (1994) which suggested the use of block scheduling as a means by which to increase the achievement of students and better student learning.

Canady and Rettig (1995) also discuss the problems that exist with the high school schedule in the traditional format and offer several suggestions as to how the school day can be rearranged. Possibilities for scheduling include the 4/4 semester plan, the alternate-day block schedule, or more intensive schedules, such as the quarter-on/quarter-off plan, the trimester model, and the Copernican Plan. Additionally, they suggest there are better ways to develop varying instructional terms within the 180-day school year and suggestions for how to blend scheduling models are provided in the sixth chapter. Finally, the book contains resources which can be used to carve time for teacher planning and professional-development opportunities as well as instructional strategies and tips for staff to use in the classroom to make better use of the longer amounts of time in any one school day.

Canady and Rettig's (1995) book was one of the first resources for administrators seeking to restructure their school day to promote higher student achievement and better school climate. It not only made suggestions to educators about ways to restructure their school day, it was a blueprint that schools could follow chapter by chapter, as indicated in the book summary above, to implement a new schedule, train staff on instructional practice within that schedule, and ways to make adjustments for potential pitfalls they may encounter along the way. Following its publication and the resulting implementation in schools across the nation, studies were conducted which tested the

theories against actual pragmatic results. Some studies yielded primarily a list of advantages while others were primarily disadvantages, however, most yielded a little of both. In this section, studies are included to demonstrate that the advantages proposed by Canady and Rettig (1995) were realized by some districts who utilized the block scheduling format as a way to make improvements to their overall school climate.

Hurley (1997a) conducted a study in western North Carolina where 37 students from five high schools that had implemented 4/4 block schedule were interviewed to ascertain their feedback based on their experiences. The students interviewed represented a cross-section of all five schools, whose enrollments ranged from 350 to 768 and whose academic interests were vocational, college preparatory, or unfocused. Each interview took approximately 30 minutes and was recorded and transcribed. In the analysis of the student responses, several advantages were outlined by the students as a result of the move to the block from traditional format. The interview questions were divided into three categories for discussion as follows: academics, cocurricular activities, and early graduation.

In terms of academics, the students felt they were getting better grades, they had more time for in-depth discussion, they were able to receive more attention from the teacher, the school day was less hectic, and each semester presented a fresh start. As far as cocurricular activities, the students felt that the block schedule afforded them the time to be involved in cocurricular club activities during the school day which improved the climate of the school and made coming to school more exciting because of more opportunities to participate in something that you enjoy. Finally, the 4/4 block schedule was instrumental in affording students the ability to graduate early by completing their

high school requirements by the middle of their senior year and, in some cases, preventing an otherwise despondent student from dropping out of school altogether. This advantage was met with mixed reactions from teachers compared to students who felt that high school should continue to be a four year experience rather than three and a half years. The researcher then gave suggestions to school districts as to guidelines for graduation and minimal requirements during the senior year should they feel this in conflict to their mission as a school district. In addition to the reactions of students to the new form of scheduling, Hurley also interviewed teachers to get their perceptions about the advantages and disadvantages of the block schedule.

Hurley's (1997b) second phase of the study in western rural North Carolina included interviews of 31 teachers who had taught in the block schedule for three semesters. The teachers interviewed were a cross-section of all the teachers from five rural high schools ranging in enrollment from 350 to 768. The teachers were chosen by their school representative to the state teachers' association to participate in the study to ascertain their reactions to the new four-period schedule (4/4). The study involved 30 minute interviews of teachers from the same five high schools as in his earlier study (Hurley, 1997b). The interviews were recorded and transcribed word for word to allow for summary and analysis of the teachers feedback.

Of the 31 teachers interviewed, 17 found the schedule to be an improvement over the traditional six to seven period day. Overall, the teachers liked having fewer students each semester, more planning time, fewer classes to prepare, and a more relaxed schedule. The teachers mentioned such advantages as improved working conditions stemming from a reduction in teacher workload, more opportunities to enrich students

and utilize more “hands-on” activities, improvement of relations with students, more time for one-on-one instruction, a wider variety of curricular options available to students, and more opportunity for both teachers and students to focus due to four periods as opposed to six or seven. Other advantages cited included the ability of students to take advantage of more electives being offered. In summary, the new schedule increased the number of courses that students were able to take while relaxing the school day at the same time. The schedule provided for more class activity options, more enrichment opportunities, and better relationships between teachers and students.

Another teacher study was conducted by Staunton (1997) which discussed the results of a 50 question survey given to teachers from four high schools in a suburban school district in California, actual numbers of sample size and population are not included in this study. The teachers were surveyed using a five-point Likert scale asking them to rate, from strongly disagree to strongly agree, their observations of the impact the time allocation had made to the psychological, economic, and structural realities of the classroom (p. 74). The study sought to find any differences which resulted from the change to block scheduling in terms of instructional practices, assessment technique, social interaction, curriculum, and school management.

Since the Likert scale ranged from 0-4, any responses with a mean value higher than 2 were leaning toward the agree range and any responses with a mean value less than 2 were leaning toward the disagree range. Based on the mean values displayed in the results of the survey, the teachers taking this survey reported that block scheduling offered a wide variety of advantages including facilitating new instructional strategies and delivering content differently (Mean = 3.259), encouraging teachers to attempt new

methods of assessment (Mean = 2.689), reduction of stress levels for teachers and students (Mean = 3.385), and that teachers are more relaxed as well as the students (Mean = 3.126). This meant that teachers saw less disciplinary problems and disruptions outside of the classroom due to a more relaxed climate in the classroom. Teachers also felt that curriculum was covered in less breadth, but with greater depth than the traditional schedule (Mean = 1.859 and Mean = 2.659 respectively). Comparatively speaking, the block schedule seemed to be preferred over the traditional schedule based on the mean rating of 3.104. The strongest results came from the teachers who had taught in the block format for four or more years showing satisfaction with 38 out of the 50 survey questions. While this study focused primarily on the perceptions of teachers in regard to block scheduling, other evidence suggested that the perceptions of parents and students were also positive in regard to the changes brought on by schedule reform.

Knight and DeLeon (1999) used a case study research design to study high school students, teachers and parents from a suburban high school in the southwestern United States. The study focused on the perceptions of students and parents to the block scheduling format, to compare the academic performance of students in block schedule classes to those in traditional classes, and to investigate the similarities and differences of instructional methods of teachers based on type of schedule. The participants in the study were 10 teachers and approximately 400 randomly selected students in 30 classes from different subject areas, only one of which was a mathematics class, to comprise the experimental group. The comparison group was composed of the same 10 teachers and approximately 250 students who were in the same classes on the traditional format and matched by ability level to the block scheduled counterparts. In addition, approximately

25 parents of students in block classes were randomly selected to participate in focus group interviews.

The students participating in the block schedule were surveyed as to the difficulty, challenge, pace, their study habits, their involvement, and the learning environment. Students were also asked to rate their satisfaction with the block schedule. Randomly-selected students from this group additionally participated in focus group interviews as to their success, comparison of block to traditional classes, and advantages and disadvantages of block scheduling. Parent focus groups were patterned in much the same manner as the student focus groups. Parents were asked to respond to questions about their understanding of the block schedule, perceptions of their child's success, comparison of block to traditional, and the advantages/disadvantages of the block schedule. Each teacher was also observed in both the block and traditional classes to determine if there were differences in teaching behaviors based on the scheduling format.

The results of the study showed that students on the block schedule generally performed better academically than those in the traditional classes although the results were not delineated by subject area, but rather as a comprehensive reporting. Students perceived that they used better study habits, were more engaged and interested in class activities, learned more, and received more attention from the teacher. The classroom observations, however, did not support the perceptions of the students. While teachers did teach differently on the block and the traditional formats, there was not the variance in instructional methods to the degree that was expected by Knight and DeLeon (1999).

The findings of the parent interviews showed that the views of the parents were primarily positive, all parents but one said they would encourage their child to take

another course on the block schedule due to more time available to interact with the teacher and the other students in class, but they did share concerns about the pressure placed on students due to the acceleration of the content presentation.

While the study focused on students from all ability levels, the research questions they intended to answer did not specifically identify any particular ability levels to be investigated. However, in their conclusions, the authors made a point to report specifically about AP students after making the general statement that students in block scheduled classes outperformed those in traditional classes. The authors reported that despite positive outcomes in tests and grades within classes, the students in advanced placement classes perceived the class on the block schedule to not be effective in preparing them for the AP exam. The researchers also reported that the results on the AP exams verified the students' perceptions in that the students in traditional classes outperformed the students in the block classes at the AP level. In other words, the block schedule was better for students for a short time frame, but not as effective for retaining the information until the end of the year when the AP exams were taken. In addition to better test grades within classes, block scheduling also affords teachers the opportunity to provide a variety of instructional strategies as revealed in the next study.

A case study investigating the effects of block scheduling on school climate and instructional practice was completed by Veal and Flinders (2001) using a high school in the Midwest which had a population of 1800 students. The population was mostly Caucasian and combined both urban and rural areas of the county. The school developed a schedule where all courses were offered in both block and traditional formats except for performing arts. Students were randomly selected to participate in one scheduling format

or the other, but all students were participants. Teachers were chosen based on volunteering or by being asked to choose a schedule type by the principal.

The method of the study involved quantitative data collected from Likert-type surveys distributed to students, teachers and parents. The study also included qualitative data taken from teacher, student and parent surveys, teacher interviews, classroom observations, and written documents such as lesson plans and class handouts. Quantitative data showed significant differences in four areas including changes in teaching methods, opportunities for reflection, relationship with students, and levels of anxiety. Results showed that the teachers utilized more varied instructional strategies when given the additional time afforded by the block schedule. The teachers also noted a change in the pace of their teaching as they now had to cover a year's worth of material in a semester and therefore had to sacrifice some material in order to ensure the most necessary information was mastered during the course. The criteria for exclusion of material became chapters at the end of the text, items not assessed on state exams, and material not needed for other courses, all of this material was tough for teachers to let go.

In terms of anxiety, teachers reported higher anxiety levels due to lack of time for planning and the increase in the pace of instruction. Students and parents also realized the stress as they noted teachers seeming to be confused and disorganized due to trying to pack the content of two days into one block period. This finding was expected based on their research as an "acclimation component of already teaching within the schedule format" (Veal & Flinders, 2001, p. 23). The results showed a positive impact on teacher-student relationships as teachers were juggling less students at one time and the teacher spent twice as much time each day with those same students. Some argued negatively

that the pressure of trying to cover more material and larger classes sizes adversely affect how well a teacher is able to get to know students. Finally, the reflection time that was hopeful from the change in schedule proved to be almost impossible due, in large part, to the time necessary to plan for a variety of learning opportunities and the pace of instruction mentioned earlier. In their final summary, Veal and Flinders (2001) report that one of the primary implications for the study was to uncover the need for more variety in instructional practice, but that the district needs to make both content and curricular decisions about material needing to be covered in each course to make this plan a success. The following study also supports the ability to provide varied instructional strategies as afforded by the block scheduling format in addition to other factors aimed at improved school climate.

Another study demonstrating the advantages of block scheduling was conducted by Evans, Rice, and McCray (2002) who did a study of three school districts in New Jersey who were utilizing 4/4 block scheduling in their high schools. One school was urban, one suburban, and one rural. They conducted personal interviews and focus groups with teachers, students and parents to gather their feedback on progression toward expected outcomes as well as determining the extent to which the goals desired by the alteration of the schedule had been achieved, however, exact numbers in terms of sample size and population are not given. Based on their review of literature, the study expected five possible outcomes from this work including changes in instructional approaches used by teachers, changes in the curriculum experience by students, improved student achievement, improvement in student behaviors, and teacher, student, and parent satisfaction with the scheduling initiative.

In their conclusions, teachers did report that more than half of the class time in any one day could be used for other methods besides lecture, the students seemed to be more settled in class, the longer class periods enabled more expansion of lessons, more independent student projects as well as time for presentation, teachers had a better knowledge of students, and the scheduled lightened both the load of students and the teachers. Students were also positive in their responses citing more opportunities for variety of courses, higher teacher expectations, fewer classes to focus on, teacher availability during class to answer questions, and more time to address difficult assignments comprehensively. Finally, the results of parent focus groups yielded similar positive comments as did the teachers and students including that students seemed to be learning more, were involved in a greater variety of learning activities, they seemed to know their teacher and course requirements better, they were more productive and being held to higher expectations. The writers' indicate that the majority of teachers, students, and parents are satisfied with their school's implementation of block scheduling and the resulting curriculum changes.

Based on their studies and those conducted by other researchers, Rettig and Canady (2001) remarked that the majority of parents, administrators, students, and teachers are pleased with the results of the block, that block scheduling facilitates the utilization of varied instructional methods in the classroom, it allows teachers to go deeper into curricular material with students, accelerated students are able to further their learning by replicating a higher-education schedule, students achieve better grades in courses they take on the block schedule, the rapport of teachers and students is better due to reduced stress levels, there are fewer discipline referrals, and student and teacher

attendance have improved. In addition, it was noted that grade point averages have increased, failure rates have declined, there has been more course completion, and graduation rates have increased.

The additional studies included in this section also demonstrated evidence that other schools and districts have experienced the same advantages to block scheduling as were both speculated and evidenced in the works of Canady and Rettig (1995, 2001). While much of the research shows positive results when a block schedule is implemented, there are also negative effects that have been seen in some of the same studies (Hurley, 1997a, 1997b; Staunton, 1997, Knight & DeLeon, 1999; Veal & Flinders, 2001; Evans, Rice, & McCray, 2002;). As noted by Canady and Rettig (2001), “There are problems and issues with block schedules just as there are with all schedules, but the preponderance of evidence, both anecdotal and empirical, is positive” (p. 78). The next section of this literature review will shed light on some of the “problems” to which Canady and Rettig refer by examining disadvantages encountered by some of the studies conducted at schools and districts who chose to implement the block schedule.

Disadvantages of Block Scheduling

The following research suggests that block scheduling may have a neutral or negative impact on academic achievement or may take a negative toll on the overall instructional effectiveness in schools which utilize this system for the scheduling of courses. Some of the negative reports include a lack of attention or engagement by students, less long-term retention of learned skills and material, poor utilization of class time, teacher lack in using varied instructional strategies, too much time between mathematics courses, and the magnification of absences. Many of the studies in the

previous section, which were primarily positive in nature regarding the reasons for schools to move to a block schedule also found some results that brought into question whether block scheduling is a “one-size fits all” solution to the utilization of time in a school day or whether other factors should be considered in determining how such a schedule should be developed to achieve success. This section will highlight those aspects of previous studies investigated as well as examining new studies where block scheduling produced more significant negative effects.

Marchant and Paulson (2001) researched students’ perceptions of the block schedule based on five different academic profiles related to grades, satisfaction of achievement, attributions of success to effort or ability, attributions of achievement to scheduling, and attitudes toward school. They studied 2191 high school students from middle to upper class suburban high schools in the Midwest. The students were given a survey to complete during study hall and 40 of these students were then asked to participate in a focus group to identify strengths and weaknesses of block scheduling in a focus group format.

The results of the study found that students in block scheduling, as opposed to traditional scheduling, felt they had significantly higher academic achievement. In addition, they reported that block scheduling has had a positive impact on perceptions of other areas of school functioning such as school climate, management of classwork, and discipline. The students in this study were polled as to what elements of block scheduling they appreciated. Among the positive comments were the day goes faster, you can cover a lot more, it is good for labs, allows for more in-depth conversation, and less pressure with homework. Furthermore, it was learned that the high to average

achievers who believed in the importance of education and were satisfied with their achievement had the “highest levels of school functioning and the highest support for block scheduling” (Marchant & Paulson, 2001, p. 14).

This study also found various negative pieces of feedback describing areas where students feel block scheduling falls short. The responses included lack of attention, inability to concentrate, the need to have mathematics and music every day, teachers trying to cover so much that learning becomes overwhelming, a rise in the homework assigned in each class, trouble with time management, difficulty with making up work missed on an absence, and lack of instructional variety. “Lower achievers had the least support for block scheduling, the worst teacher relations, and the worst perceptions of student behavior” (Marchant & Paulson, 2001, p. 14). These students also had the most difficulty succeeding within the realm of the block schedule. The results of the study showed that there was a need to have more professional development for the staff as well as more support for students to help them to be more successful. While Marchant and Paulson (2001) were the among the earliest to devote a larger part of their research report to the disadvantages encountered under the block scheduling format, they were certainly not the first to notice that the change to scheduling format came with some pitfalls.

Hurley’s (1997a) student study also discussed some disadvantages to block scheduling from the student perspective. The primary negative effect of the block was that some classes were too long as the teacher spent the majority of the 90 minutes in lecture mode and the “bad” classes had become “really bad” when they were held for 90 minutes. Students cited problems with the balancing of semesters, in that one semester may be really difficult while the other much easier as opposed to maintaining a level of

balance throughout the year. Students reported the possibility of having a full year hiatus between courses of subjects that require the layering of knowledge and skill to succeed at the subsequent levels such as mathematics or foreign language. They noted that teachers try to cram too much into one class period and that absences were harder to make up. These sentiments are consistent with some of the findings of Marchant and Paulson (2001), while not to the same degree, as they mentioned the magnification of absences, being overwhelmed with too much material each day and time gaps between courses, namely mathematics.

Hurley's (1997) teacher interviews also uncovered some disadvantages reported by the teachers in the interviews. Fourteen teachers mentioned that the block schedule had no effect or negative effects with respect to aiding the instructional practices. In fact, "several disadvantages directly contradict the advantages" (Hurley, 1997b, p. 58). One disadvantage cited is that students do not have as much homework due to getting the work done in class, reducing the amount of time spent on instruction. Another disadvantage was that the teacher actually had less time to cover the required material of the course, this was especially true of classes which had end-of-the-course or state-mandated standardized tests. An uneven schedule in each semester was another disadvantage causing semesters which are either too light or too heavy with core vs. elective classes. Student absenteeism played another role as those students who miss a class fall further behind than if the class period was 45 minutes. The final teacher concern was the effect the block schedule played on the senior year with students graduating early, or not taking classes seriously as they do not need the credits to graduate. Staunton's (1997) study detailed earlier also revealed that mathematics and

foreign language teachers were resistant to the change to block scheduling due to the lack of meeting everyday as indicated by their free response statements on the survey.

Once again indications of connectivity were seen with the findings of Marchant and Paulson (2001) with respect to long-term retention of knowledge and skill, magnification of absences, hiatus between classes, unbalanced schedules, lack of variance in instructional practice, and less curriculum covered. These same themes seem to emerge in each of the studies reviewed. Knight and DeLeon's (1999) study additionally suggested that oftentimes teachers did not provide the appropriate instructional strategies to accommodate a longer instructional period. They seemed to rely on a same-length presentation of material followed by long periods of sustained seatwork causing classes to seem like extended study halls. The other negative aspect reported by Knight and DeLeon in the realm of varied instruction was that the premise of less content with more learning becomes simply less content and less learning. Many teachers in the block schedule continued to use the lecture method or resort to it after the block schedule was implemented. These findings were also consistent with what Marchant and Paulson (2001) found in terms of lack of instructional variety.

In the study by Evans, Rice, and McCray (2002), there were also some disadvantages to the block schedule revealed by teachers, parents and students though overall the results were positive. Teachers reported difficulties with providing substitutes enough material to last the extended class period should students finish early as well as difficulty for students to recover following absences, especially extended ones. The students shared problems with having enough activities provided by teachers to keep them engaged, substitute teachers and worksheets, and boredom being doubled. Finally,

parents noted issues with student motivation and frustration due to longer periods, limited time to socialize due to less time in hallways, and concerns that students are not being challenged enough with their course work on a block schedule. These findings reverberate the findings of Marchant and Paulson (2001) indicating lack of attention, inability to concentrate, lack of instructional variety to keep students engaged, and the magnification of absences.

In a report presented by Trenta and Newman (2002), a longitudinal study was done with 500 students, from a small midwest city in Ohio, who had taken courses on a 4/4 block schedule for zero to three years. The district provided transcript data for 125 students from the classes of 1997, 2000, 2001, and 2002. The class of 1997 had 0 years on the block schedule, the classes of 2000 and 2001 each had 3 years on the block schedule, and the class of 2002 - the year of the study – had only two full years at the time the data were taken. The data from the records were analyzed for statistical significance using a Pearson correlation and 2-tailed Sigma test based on four factors: grade point average, attendance, ACT test scores, and Ohio Proficiency Test (OPT) scores.

The findings of the study showed that students who used a block schedule, which had been in operation for four years, had a positive and significant relationship with respect to grade point averages in all four major subjects and a positive, non-significant relationship existed with respect to cumulative GPA. This was the first area reported and the one that brought the most promise for proponents of the block schedule. The remaining three areas indicated that block scheduling had either a neutral or negative effect on the variables being examined. With respect to ACT scores, the data showed a

slight decrease in ACT scores with the 1997 group being the highest of all three groups, while the research proved the decline to not be statistically significant, at best it demonstrated the block schedule to have a neutral effect on ACT scores while potentially indicating a negative correlation.

In terms of attendance, a positive correlation existed between block scheduling and absences which occurred in grades 9 and 12 while a negative correlation existed between block scheduling and absences which occurred in grades 10 and 11. The only correlation that showed statistical significance was that which occurred in 11th grade. Finally, the results of the OPT showed a slightly negative correlation with reading, citizen, and science tests, science being the largest, and a slightly positive correlation for mathematics and writing with writing being the largest. Mathematics was almost completely neutral. None of the correlations showed statistical significance, but science was the closest with a factor of .062. The mathematics tests did have an outlier in the data in terms of the results of the group from 2002 who only had the two years of data. The three previous years showed slight increase in 2000 over 1997, followed by a slight decrease in 2001, and then a sharp decrease even below the initial year in 2002 indicating that long term retention of knowledge and skill may be problematic. Ultimately, the board of education of the school district in the study decided to continue with block scheduling for at least one more year. In this study, the results of student achievement on end of course exams seemed to be a neutral, especially in terms of mathematics. In the next study, it was determined that students on a traditional schedule actually performed better on end of course exams than did their counterparts in block scheduled classes.

In a causal/comparative study conducted by Lawrence and McPherson (2000), the research compared the test scores of students on a traditional schedule with those who were on a 4/4 block schedule based on North Carolina's End-of-Course Assessments for Algebra 1, Biology, English 1, and US History. This study focused on high school students from two high schools in southeastern North Carolina who were the first in the county to adopt the block scheduling format. The study used cluster sampling to compare two years of "traditional" data with three semesters of block data to draw conclusions. Data were available from 2,706 students on the traditional schedule and 2,053 students on the block schedule when combined for all four subject areas.

The findings showed that in each of the four subject areas tested, students on a traditional schedule scored significantly better than those on block scheduling based on the results of the t-test. The results reported mean and standard deviation of percentage of proficiency for each of the four subject areas and disaggregated based on schedule type. Each of the subject areas reported traditional findings followed by block findings. For Algebra 1 the mean percentage proficient was 54.20 on the traditional format versus 48.22 on the block. For Biology, it was 39.00 versus 34.78 respectively. For English 1, the percentage proficient was 47.47 for traditional versus 38.67 on the block and for US History the mean was 47.47 versus 39.68 respectively. In their conclusions, Lawrence and McPherson (2000) suggest that more research must be conducted in order to find scheduling formats that will "more adequately meet the needs of teachers and students since block scheduling does not meet all desired outcomes" (p. 182). Once again, there is indication that long-term retention of knowledge and skills may be affected by the type of

schedule on which the courses were taken as was indicated by Marchant and Paulson, (2001).

Thomas (2001), in an editorial report after reviewing multiple research studies, identified some of the problems indicated by other studies as a result of the move to the block scheduling format stating “some schools are quietly falling off the bandwagon, disheartened, and discouraged. For these schools, the reform that promised solutions from fewer disciplinary problems to higher academic performance failed to deliver” (p. 74). Studies cited by Thomas (2001) showed that while some schools are seeing narrow margins of success with grade point averages due to changes in scheduling from traditional to block, other schools are seeing no significant differences in grades, and still others are experiencing the reverse effect, students on the block schedule are performing lower than students in traditional schedules on state exams. It would seem that Thomas’ findings have merit in light of the studies detailed in this section which identified similar conclusions based on the disadvantages realized by making the change to or remaining with the block schedule as the only means by which students take their classes in a school.

While there were many types of disadvantages cited in the studies examined here, there is one area which emerged from the list connected to the issue of school accountability which was the catalyst to the original block scheduling movement. That issue is the indication that perhaps students on the block schedule are not able to retain the information and skills seemingly mastered, as indicated by higher grade point averages, for longer periods of time, as indicated by lower achievement on state tests,

college entrance exams and AP exams, specifically in the area of mathematics as was indicated in several studies.

The next two sections of this literature review delve more specifically into the effect of block scheduling specifically on mathematics achievement and what theoretical framework suggests the reason why short term results are positive, but long term results are not. These sections seek to explain the potential phenomenon with learning that is created by presenting and practicing the same amount of material over the shorter interval of a semester, the basis of the 4/4 block scheduling system, than what would be true if such courses were taken on a traditional schedule throughout the entire school year.

Mathematics Achievement on the Block

The studies from the previous section discussed the disadvantages associated with block scheduling, among them were several indicating the potential for either neutral or negative results in mathematics achievement (Marchant and Paulson, 2001; Lawrence and McPherson, 2000; Trenta and Newman, 2002; Hurley, 1997a; and Staunton, 1997). These indications brought a focused attention to the issue of mathematics as it pertains to taking mathematics classes on the block schedule versus taking the same courses on the traditional, full-year format. For this reason, more studies were sought to further investigate the effects that occur on mathematics achievement when courses are taken on the block schedule versus traditional schedule.

Wronkovich, Hess, and Robinson (1997) completed a study that focused primarily on the effects of block scheduling on mathematics achievement as evidenced by results on Ohio Colleges Early Mathematics Placement Test (EMPT) and qualitative feedback from both teachers and students. The teachers and students involved in the study were

enrolled in college preparatory mathematics classes from two suburban Ohio school districts and each used a different scheduling format. In one school district, the students took Algebra 1, Geometry, and Algebra 2 on the traditional format receiving 135 hours of instruction over 180 school days. The second school district actually used a modified block schedule which allowed for students to take courses on either the traditional format or the 4/4 intensified block format. The study focused on the students in the second school who received 135 hours of instruction in the same three subjects on an intensified semester block format (also known as 4/4 block scheduling). The findings of the study were based on overall student achievement on the EMPT for students entering college from each of the school districts, although exact numbers of students are not included in the report. Additionally, the research team felt it important to go beyond the quantitative data to learn more about teacher and student impressions of the block schedule by using surveys with ten teachers and 164 students.

While the actual statistical results of the quantitative data are not included in the report, the study found that those who took their mathematics classes in the traditional format fared better than those who took their mathematics classes in the intensified block format on the EMPT. This conclusion was based on a correlation between the scores achieved on this test of college-level mathematics aptitude and the program by which they were prepared for college suggesting that the mode of schedule may have an impact on their success in college-level mathematics classes. “It may be inferred that students who study mathematics in a block schedule format are at a disadvantage when competing against students who have studied mathematics under traditional formats” (Wronkovich, Hess, and Robinson, 1997, p. 35).

In addition to the quantitative data, the results from the surveys gave more insight into the impressions of staff and students who had been involved in mathematics courses taken on the 4/4 block schedule. Teacher results based on their comments showed four trends indicating concerns over covering all the material, gaps in the mathematics learning process, holding the attention of students for 90 minutes, and the need for assimilation time between practice sessions. From the student data, three major trends also emerged: more mathematics classes were possible under the block format, concern over the pace of intensified classes, and more interesting and enjoyable classes in the block. These data suggest that the block seems to work better for aggressive mathematics students who want to take more mathematics classes. The data also uncovered questions as to whether the same amount of material is covered and understood in the block as in the traditional format. While the block class presentations seem to be more appealing to students, they have concerns over whether they have mastered the material using this format and the quantitative data obtained in this study would suggest they did not master the material as well.

In a study conducted by Kramer (1997) to investigate the effects of block scheduling and its effect on mathematics instruction, the findings were based on a literature review, published articles from a variety of sources, and attendance at two sessions on block scheduling sponsored by the Maryland Council of Teachers of Mathematics. In addition, the author contacted key researchers on the topic of scheduling and achievement as well as teachers and administrators from around the United States and Canada who utilize block scheduling in their schools and classrooms. From these sources, Kramer performed an evaluation of block scheduling and its effects on

mathematics instruction in order to get an idea of how the teaching may be different, but also how students achieve who take mathematics in the block. Kramer's findings showed both academic and non-academic effects of block scheduling. The academic effects included a decrease in failure and dropout rates, changes in instructional practice, and achievement on standardized tests measuring long-term retention of knowledge and skills.

This discussion will narrow Kramer's results to simply look at the findings that were related to achievement under the 4/4 block schedule. Kramer cited several studies focusing primarily on achievement data, but not all of these studies reported specifically about mathematics. This discussion focuses only on the studies in Kramer's work which reported specifically on mathematics results. Raphael and Wahlstrom (as cited by Kramer, 1997) investigated the effect of students in Ontario who took courses using the semestered block schedule (another name for the 4/4 block schedule). They used data from the Second International Science Study (SISS) and the Second International Mathematics Study (SIMS) of students who took classes on the 4/4 block schedule versus those who took courses on the traditional format in biology, chemistry, physics, and grade 12/13 mathematics. The results showed that in every subject area, the students from the traditional schedule outperformed those on the block schedule with statistically significant differences in both areas of mathematics:

Bateson (as cited by Kramer, 1997) also did a study of science achievement in British Columbia. The data were based on a matrix-style test given to all 30,116 tenth grade students within the province who took the provincial science assessment. The percentage of students who took science on the traditional format was 64.9, 28.3 percent

on the block format and the remaining 6.8 percent did not take science during the year of the assessment. The results of this study were that students in traditional courses scored significantly better than students in 4/4 block schedule in all six areas tested, in fact, follow up investigation revealed that traditional students outperformed block scheduled students on all 120 test questions.

Marshall et al. (as cited by Kramer, 1997) replicated Bateson's study, but also included mathematics results with the science scores. They used the 1995 Mathematics and Science Assessments to extend the results to mathematics students in addition to science students to see if those results would be consistent to the findings of Bateson in relationship to science. In their study, 29,183 students took the grade 10 science test of which 64 percent took science on a traditional schedule, 28 percent on the 4/4 block schedule, and eight percent on a quarter-block plan (not addressed in this study). There were also 24,520 students who took the grade 10 mathematics test of which 67 percent took mathematics courses on the traditional schedule, 26 percent on the 4/4 block schedule, and 7 percent on the quarter-block plan. "In both subject areas, all-year students outperformed the block-scheduled students, who in turn scored higher than quarter plan students" (p. 29). In each of the mathematics studies cited by Kramer (1997), the top scorers on tests of mathematics achievement were those who took mathematics courses on a traditional schedule, rather than those who took courses on the block schedule format with the following reported results for mathematics. All-year students scored the highest on 74 of the 80 items, semestered students scored highest on 3 items, and quarter students scored the highest on 3 items. While the actual scores and significance are not included with the findings, these results do suggest the need to study

the impact on mathematics achievement further to discover the actual impact a scheduling format may have on the data.

In a doctoral study performed by Arnold (1998), 11th grade students were studied as to their achievement on the Virginia Tests of Achievement and Proficiency (TAP). This statewide study took the results of all 11th grade students on the TAP test, based on which schedule the individual schools utilize as a scheduling format. For the purpose of this study, the results of schools utilizing the A/B block schedule were compared to the results of schools utilizing the seven-period traditional format. In the state of Virginia, there were 51 schools utilizing the A/B block and 104 schools utilizing the traditional format and the mean scale score data from 1996 were disaggregated by overall means, location, population, years in the block format, socioeconomic status, teacher-student ratio, and five-year trends (1991-1996) for all subject areas. Since this study focused specifically on mathematics achievement, only the results pertaining to mathematics will be reported in this summary of the study.

Overall, Arnold (1998) found that the mean scale scores were the same in mathematics between the traditional and block schedules suggesting that each scheduling format seems to produce relatively similar results in mathematics achievement with no significant differences. When disaggregated by location, urban and suburban schools on the block schedule outperformed urban and suburban schools on the traditional schedule by one and two mean scale points respectively, but rural schools on traditional schedule edged rural schools on the block schedule by one mean point. When disaggregated by size, the small and large schools on the block schedule outperformed those on the traditional schedule by one and three mean scale score points respectively, but the

medium size schools on traditional schedule were more successful on the TAP than those on the block schedule by three mean scale score points.

When disaggregated by years on the block schedule, schools in the first year of block scheduling outperformed those on traditional schedule by five mean scale score points, second year block schedule schools were equal with traditional schools, and traditional schools outperformed those on the block schedule for three or more years by two mean scale score points. With respect to socioeconomic status, schools on the block schedule performed better than those on the traditional schedule in the 0-10%, 21-30%, and 31-40% meal eligibility ranges by three, one, and four mean scale score points respectively. Schools on traditional schedule did better than schools on block schedule in the 11-20% meal eligibility range by two mean scale score points, and there were no meaningful differences in the 41-50% meal eligibility range. With respect to teacher student ratio, the schools on block schedule schools outdid the schools on traditional schedule in the 6-8.99 and 15-17.99 ratio categories by five and one mean scale score points respectively. The traditional schedule schools did better than the block schedule schools in the 9-11.99 ratio category by two mean scale score points. In the 12-14.99 ratio category, there were no differences in mean scale scores. Finally, there was a negative trend over the five years for mathematics mean scale scores in schools using the block schedule; however none of the results in this study showed significant differences between the mean scale scores of students on the block and traditional schedules.

In a similar doctoral dissertation by Alderman (2000), 11th grade students were studied as to their outcomes on the Virginia Standards of Learning tests based on schedule within which the courses were taken. In this study, the competing schedules

were the seven-period traditional schedule and the 4/4 semester block schedule. Student achievement was measured in language arts, mathematics, science, and social studies, however, for the purpose of this study only the results in mathematics will be reported. The data reported are the changes in mean scale score from the Spring, 1998 assessment until the Spring, 1999 assessment. In this statewide study, 93 high schools were identified as utilizing the 4/4 block and 70 schools were identified as utilizing the traditional format. In mathematics, comparison scores were given in Algebra 1, Geometry, and Algebra 2 and were reported as overall mean scale scores as well as disaggregated by size and location of the schools.

Overall, schools using the 7-period traditional schedule outperformed schools using the 4/4 block schedule on the Algebra 1, Geometry and Algebra 2 Standards of Learning Tests in 1998 by margins of 4.6, 11.10, and 14.79 mean scale score points respectively and by 2.09, 13.83, and 17.45 mean scale score points respectively in 1999. The traditional schedule schools showed increases of 10.76, 11.10, and 26.35 mean scale score points in Algebra 1, Geometry, and Algebra 2 respectively while the 4/4 block schedule schools showed increases of 17.99, 11.90, and 23.69 respectively over the same interval.

The location of schools was also considered as a variable as the schools in Alderman's study fell into one of three categories: rural, suburban, and urban. The statewide data showed that there were 57 rural schools, 17 suburban schools, and 19 urban schools using the 4/4 block schedule while there were 24 rural schools, 19 suburban schools, and 27 urban schools utilizing the traditional schedule. The data for rural schools showed that 4/4 block schools performed better on the Algebra 1 test than

traditional schools, but that traditional schools performed better on the Geometry and Algebra 2 Standards of Learning Tests for both years of the study. The data for suburban schools showed that 4/4 block schools performed better on the Algebra 1 and Geometry Standards of Learning Test than traditional schools, but that traditional schools performed better on the Algebra 2 tests for both years of the study. Finally, the data for urban schools showed that traditional schools performed better on all three mathematics Standards of Learning Tests for both years of the study and the margins were the widest for the urban population ranging from 21.88 to 39.99 mean scale score points.

The final variable used to disaggregate the data in Alderman's study was the size of the school. School size was defined as A (0-500 students), AA (501-999 students), and AAA (more than 999 students). For A schools, the 1998 data showed that the 4/4 block schedule schools outperformed the 7-period traditional schedule schools on all three area of mathematics. The 1999 data showed the 4/4 block schedule schools outperforming the 7-period traditional schools in the areas of Algebra I and Algebra II while the traditional schools outperformed the 4/4 block schedule schools in Geometry. For AA schools, the 1998 and 1999 data showed that the traditional schedule schools outperformed the 4/4 block schedule schools on the Geometry and Algebra 2 tests, but that the 4/4 block schools outperformed the traditional schools in Algebra 1. Finally for AAA schools, the 1998 and 1999 data showed that the traditional schedule schools outperformed the 4/4 block schedule schools on all three area of mathematics.

Are there underlying factors as to why the achievement of mathematics students in full-year formats seems to be higher than those students who take semester classes? The studies prior exhibited that in the area of mathematics the achievement of students

seemed to be better when the classes are taken on the traditional format which spreads out the information into smaller parts over the entire school year rather than the 4/4 format which seeks to cover the same information into larger chunks over half of the year. The theoretical framework which follows suggests that long-term memory of both rote recall as well as cognitive skills may be improved when the information presented and the skills practiced are broken into smaller parts and spaced over a longer period of time rather than when massed into shorter intervals.

Theoretical Framework

Dempster and Farris (1990) reported that one of the most remarkable phenomena to emerge from laboratory research, in terms of the improvement of classroom practice and the ability for students to retain information learned, is the spacing effect. The definition of the spacing effect is “the tendency, given an amount of study time, for spaced presentations to yield much better learning than massed presentations” (p.97). In fact, Dempster and Farris reported that two spaced presentations are twice as effective as two presentations given in mass quantity. This idea may relate to the study of the effectiveness of the 4/4 block schedule on student learning as opposed to the full-year learning format. One may even suppose that the 4/4 block schedule would be an example of mass presentations as the students are expected to obtain the same amount of information and skills in a time period that is half as long as the full year based on indications from prior studies outlined in this literature review. While classroom time remains similar, there is not sufficient time to practice the skills effectively enough for the long-term memory to take place.

While the article quoted above was written in 1990, the history of the spacing effect dates back as far as 1885, where Ebbinghaus published his results from an extensive study on memory (Dempster & Farris, 1990). Much of the work of Ebbinghaus (as cited by Dempster & Farris, 1990) focused on nonsense syllables, list-learning strategies, and unrelated words while more recent studies of the spacing effect actually show that there is a connection to more realistic learning strategies as well. Dempster and Farris (1990) give several examples that relate the spacing effect to instructional delivery, practice of learned skills and information, and other school-like activities. One example noted from earlier research was that of learning addition facts by drilling the items in one of two ways. Third grade students were either drilled twice a day for five days or they were drilled once a day for ten days. In each case, the students received ten repetitions of the material they were meant to remember, one strategy massed the practice over a shorter interval of time, while the other spaced the practice over a longer period of time. The results of the study showed that “their improvement in recall of addition facts was decidedly in favor of the latter instructional method (Dempster & Farris, 1990, p. 97).

Dempster and Farris (1990) also mention some other similar studies where spaced presentation/practice resulted in better achievement on tests of memory than did massed presentation/practice. The topics of these studies included text reading of four pieces with 3-hour intervals between readings versus unspaced readings, lecture with a 30 minute interval between presentations versus no interval, arithmetical rules reviewed one and seven days versus one and two days after the original learning took place, and English-Spanish vocabulary learned eight years prior based on those who had received

relearning trials separated by 30 days versus 24-hour intervals, in this last case the former were able to recall two to three times more material than the latter.

Hintzman (1974) stated that Jost noted a facilitative effect of the spacing of learning in the work of Ebbinghaus and set out to study it more closely. The results of this study gained formal recognition by the publication of Jost's Law in 1897 and ushered in a host of new studies on the spacing effect into the 1920's. (Dempster, 1988). The phenomenon of the spacing effect was again reviewed in the 50's and 60's by several works of Benton Underwood (1961). Underwood published an article in *Psychological Review* as a culmination to a ten-year study performed at Northwestern University. In this study, he identified two variables used to describe two different types of techniques for presenting material to subjects. These variables were called DP for "Distributed Practice" and MP for "Massed Practice." These variables are used as a means to explain the phenomena noticed in many of the studies outlined by Dempster and Farris as well as the work of Ebbinghaus, Jost, and Underwood. Recall that when larger intervals of time are given between presentations or practice that the results have showed time and again that the distributed practice seems to be more effective than the massed practice where shorter intervals of time exist or where lack of any interval of time between practice sessions exists. While these studies were not for the direct purpose of educational technique, the implications of the study have been used in educational circles to represent two different methods of presenting information to students and, in turn, methods by which they review the material in order to promote better long-term retention of both knowledge and skill.

Hintzman (1974) extended the studies of Underwood and began to make the theory practical. “The effect on retention of the spacing of repetitions is large, and the number of different conditions under which it occurs is truly remarkable” (p. 77). Hintzman describes two successive presentations of material as P_1 and P_2 and explains the effect that occurs if a long-term retention test is given following the two presentations. “When the $P_1 - P_2$ interval is short, retention is poorer than when the $P_1 - P_2$ interval is long” (p. 78). Notice here that the description of intervals has to do with the spacing between presentations as opposed to the distance between practice as itemized by Underwood (1961). The idea that the focus is now on presentations makes the phenomenon more applicable to instructional practice and more specifically the 4/4 block schedule format. Based on the research of Hintzman (1974), this spacing effect appears to exist in virtually all memory tasks, whether auditory or visual, as reported by several studies in his article. Further study has revealed that as the number of presentations increases beyond two, the magnitude of the effect of the spacing increases as well. In other words, the more distributed the presentation, and practice, the better the long-term retention level of the subjects being studied.

As the research on advantages and disadvantages to 4/4 block scheduling seems to suggest, students on the 4/4 block schedule often have better test scores and better academic achievement within the context of the class. However, when it comes to long-term assessments like final exams or standardized testing within the mathematics context, the research has also shown that students on the 4/4 plan are at a disadvantage to those on the full-year models. These observations from both proponents and antagonists of block scheduling are echoed by the studies of Hintzman (1974). He found in his experiments of

the spacing effect that there was a counter effect when subjects were tested immediately as opposed to after a longer interval of time. In other words, spaced presentations are more beneficial to long-term retention and massed presentations to short-term retention. Educators must now decide upon which type of retention they are more interested.

Dempster (1987) applied the spacing effect research to the classroom by studying its effect on vocabulary learning. He conducted five experiments on undergraduate educational psychology students at a state university to determine if variable encoding and spaced presentations have any effect on the ability to recall 38 uncommon English words. In some experiments he used 36 students and in others he used 48 students. In each case, the students received extra credit for their participation; they were randomly assigned to different conditions resulting in 12 students in each condition. The number of conditions in each experiment determined the total number of students that needed to participate.

The first experiment was a control experiment where they were able to gather baseline data on how well the typical student could recall the 38 words given three different sets of 38-page booklets, with one vocabulary word per page. One set that only included the word and its definition, one set that had the word, definition and a one-sentence context, and one set that had the word, definition, and three-sentence context. For this control experiment, the results were that students had a mean recall of 17.0 words with no context control, 15.33 for one-sentence context, and 16.5 for three-sentence context. There was very little variability in this data. The experiments that followed sought to change the variables slightly to determine whether spaced or massed presentation methods worked better in terms of the ability of the subject to recall what

they had learned. The later experiments used 114 pages per book rather than 38, which allowed for each word to be seen three times either in succession, representing massed presentation, or with 37 other words between each iteration of a word, representing distributed presentation. The results showed that the mean number of words recalled in each experiment was higher with spaced presentation than with massed presentation. With the single presentation words, word and definition, the mean spaced recall was 22.17 versus the mean massed recall of 13.42 for one experiment and 26.08 versus 19.25 in the other experiment for spaced and massed respectively. With the definition and three sentence structure words the spaced versus massed results were 17.42 to 12.92 respectively for one experiment and 26.58 to 13.25 respectively for the other experiment. His conclusions are that students learn much higher levels of vocabulary when taught by spaced presentations than they do when taught through massed presentations.

Dempster (1988) related this phenomenon to mathematics as well. According to his research, when written exercises in statistics are done in a single session or are spread over the course of several sessions the results are different depending on the way the information is presented. He found that students retained less with a single session of material than they did when the instruction was distributed over several sessions because the former type of instruction is “analogous to cramming for a test” (p. 169). Dempster (1988) later writes that:

The spacing effect is one of the most dependable and replicable phenomena in experimental psychology. Second, it is remarkably robust. In many cases, two spaced presentations are about twice as effective as two massed presentations and

the difference between them increases as the frequency of repetition increases. (p. 627)

In the recent past, several studies have been done to determine the optimal spacing interval necessary to facilitate retention over long periods of time, the kind of retention high school students need in order to succeed on achievement tests. Pashler, Rohrer, and Cepeda (2006) reveal that in today's educational practices, very little attention is paid to spacing learning episodes across time in an effort to boost memory. They say that many of the studies done in the past had not examined the effect that spacing had on memory intervals beyond one week. Most of the studies (Underwood, 1961; Hintzman, 1974; Dempster, 1988) actually dealt with the number of seconds between repetitions as to how long the brain would retain the data and shift the learning from short-term memory to long-term memory. More recent studies have looked at much longer term memory based on larger spacing intervals of review and practice. Most of the previous studies also dealt with vocabulary learning, pictures, or objects, while the newer studies actually looked critically at the effects on mathematics achievement.

Pashler, Rohrer, and Cepeda (2006) discussed how in a recent study 161 subjects were given two learning sessions. Various groups were given an "inter-study interval" (ISI), which is time between presentations, which was separated by as little as minutes and by as much as three months. The subjects were brought back to take a final test six months following their second session. The study found that the best results came when the ISI was 10 to 20 percent of the retention interval. Additionally, these studies have shown that for "larger retention intervals, such as one-year, the benefits of spacing grow larger as retention intervals are lengthened – one month of spacing can produce a three-

fold or greater increase in memory as compared to a day or even a week of spacing” (p. 225).

Pavlik and Anderson (2005) discussed several theories of spacing in existence which are tested by their Activation-Based Model. This study was done to demonstrate the effect that practice and spacing have on paired word associates between Japanese and English vocabulary. The participants were 40 college students from Western Pennsylvania who had responded to an online advertisement and who knew no Japanese prior to the experiment. The participants were split into two groups of 20 to which each group was assigned a 1-day or a 7-day retention interval to recall English and Japanese word pairs. During their first session, the participants either were presented with or tested on the word pairs according to varied spacing procedures. The participants were tested either 1, 2, 4 or 8 times with either 2, 14, or 98 intervening presentations to account for the varied spacing effects. The participants were then brought back either one or seven days later to test their ability to recall the word pairs.

The authors suggest that practice of items causes an encoding of both the stimulus and the context, but since encoding fluctuates over time, the more time that is placed between practices, the less redundancy occurs in the encoding of the data. Thus, the less redundancy, the more likely an event is to trigger the matching of items in memory to items in the present situation. The matching and accessibility of the stored data seems to be even greater when the successive repetitions continue to increase in difficulty. The outcome of the study reiterated that people forget more when the retention interval went from 1 to 7 days by a margin of 62% to 54% with a p-value of less than .05 reflecting that there is increasing benefit with more spacing as the repetitions increase.

The next theory Pavlik and Anderson (2005) sought to explain was the crossover effect between retention interval and spacing interval, the same idea that Pashler, Rohrer, and Cepeda (2006) saw in their studies. Again, this is the idea that when practice is spaced more closely, forgetting occurs more quickly. Conversely, when the time interval is increased between practice sessions, the final recall is significantly better, even though the performance during practice is significantly worse with the wider spacing. This may be a difficult concept to understand for the classroom teacher, parents, and even students. It is basically the idea of failure is allowable to produce future success. The results of the study confirmed that the standard spacing effect exists and showed that wide spacing of practice provides increasing benefit as practice accumulates and that people forget less when presentations are more widely spaced. Basically, the model that was produced demonstrated that the rate of decay of the memory is lower with more widely spaced repetitions in presentation and practice causing a greater probability of recall than those subjects who have received more massed presentations or practice.

A counterexample of the idea of spacing practice and presentation over time is the idea of overlearning. Overlearning, or post-criterion learning, is basically the study of the practice items beyond the point of one perfect trial (Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005, p 361). The overlearning technique seems to be used frequently in educational circles as review chapters and textbooks seem to focus on continued practice on the same idea over and over and over again, even if the subject has already achieved one perfect result. Its continued practice has been theorized as pushing the learning from short-term to long-term memory. The studies which make these claims, however, have not had a retention interval of more than 4 weeks and most were for less than one week.

Rohrer et al. (2005) performed a study on overlearning that was based on two experiments. In one experiment, subjects would memorize ten city-country pairs for 1 minute and then be asked to recall the country if given the city name and were given 50 seconds to do so. They were then allowed to look at the correct answers for ten seconds and repeat the trial either 5 times for the Lo Learners or 20 times for the Hi Learners thus splitting the participants into two groups. The participants were then asked to return in one, three, or nine weeks to see how many of the pairs they remembered over that retention interval. The overall results were that the Hi Learners remembered 70% after one week compared to the Lo Learners's 31%. After three weeks, the Hi-Lo ratio narrowed to 30%-17% respectively. After 9 weeks, the gap narrowed again to 24%-17% respectively. The results of this experiment showed that the Hi Learners recalled more than Lo Learners regardless of the length of the retention interval, however, the Hi Learners retention also declined at a greater rate than that of the Lo Learners. These results indicated that studying after reaching the intended criterion actually becomes counter-productive. Better to study a smaller amount of information stretched over a longer period of time than to study larger amounts in shorter periods of time. While the Hi Learners benefitted in the short term, their rate of decline was larger in the long-term suggesting less long-term retention when retention interval is increased even further.

In the second experiment, the learning material was varied and the time for each group remained constant. The Lo-Learners had to study 20 word-definition pairs in the same time frame that the Hi-Learners studied 10 word-definition pairs. The initial study period was 2 minutes followed by a 5 word, 30 second subtrial with feedback for a total of 20 subtrials. The participants were then asked to return in either one or four weeks for

the test of retention. The Hi-Lo ratio after one week was 64% - 38% and the Hi-Lo ratio after 4 weeks was 22% - 18% (Rohrer et al., 2005).

The findings of both of these studies seems to be that while overlearning may provide relatively great results immediately and moderately good results for one week, overlearning is not the method of choice for any type of long-term retention whether it be for three, four, or nine weeks. The point that Rohrer et al. (2005) have concluded is that overlearning may be plausible in some short-term retention instances, but that practice should be delayed until later. In other words, by distributing practice over a longer period of time rather than a large amount of practice all at one time, one is able to achieve much more long-term retention.

What implications does this have with block scheduling? One phenomenon of block scheduling is echoed in the perceptions of parents as reported by Knight and DeLeon (1999):

For example, one parent of a successful student noted that ‘...there is a steady, heavy load..., many nights there is a major overload ... the frustration of 100 pages to read and no time to do it’ Another related that several times she had ‘read to her daughter in the shower’ so she could complete her work. (p. 5)

Instructionally, the 4/4 block schedule automatically provides a situation where an entire subject area needs to taught over an interval half as long as the interval would be in a full-year schedule. Rather than taking a skill and spreading it over a two-three day period, teachers try to have students learn the same skill in one day, practice that skill over and over in class, then do homework that practices the same skill once more. The next day, new content is started and the previous one is reviewed weeks later at the end of the unit.

This is in direct line with the principles of overlearning and the spacing effect as discussed by Rohrer et al. (2005). When there is an expectation to learn too much information without the proper interval of time to digest, it becomes overwhelming for the student and counterproductive to being able to retain the information over long periods of time.

Rohrer and Taylor (2006) studied both overlearning and the spacing effect as they relate to mathematics specifically. In this study, two experiments were performed with 216 college students where the students solved one kind of mathematics problem before completing one of several types of practice schedules. The first experiment was a distributed practice experiment which required students to mass ten problems in a single session (Massers) or distribute the ten problems across two sessions separated by a week (Spacers). The second experiment focused on overlearning. In this experiment, students were asked to complete three or nine practice problems in a single session. The additional six problems constituted the overlearning strategy. Those students who had three practice problems were termed the “Lo-Massers” and those who had nine practice problems were termed the “Hi-Massers.” All students, regardless of which experiment, were then tested again either one or four weeks later to determine their retention. What makes this study particularly interesting is that previous studies of both overlearning and the spacing effect seemed to focus on vocabulary learning and rote memorization. None of the previous studies has focused on mathematics, especially in such a direct light as this study.

The results of Rohrer and Taylor’s (2006) first experiment showed that after one week, the Massers retained 75% of what they practiced in the initial session while the

spacers only were able to retain 70% of what they had practiced in the initial two sessions. However, after 4 weeks, the Spacers remained relatively stable with 64% retention versus the Massers retention level of 32%. Moreover, Tukey tests were utilized to determine both the reliability and significance of the results at both the one-week interval and the four-week interval. The Tukey test revealed that the results after one-week were not reliable, but those at four weeks were reliable. These tests also showed that there was a significant decline between the 1-week and 4-week test scores for Massers ($p < 0.05$) but not Spacers. This experiment demonstrates that the spacing effect not only applies to rote memorization and recall, but also to conceptual tasks in regards to the benefits of distributed practice. It also demonstrates that distributed practice produces better long-term retention rather than when practice is massed.

In Experiment 2, Rohrer and Taylor (2006) demonstrated the effects of overlearning on long-term retention of mathematics concepts. Their results show that after one-week, both the Hi-Massers and Lo-Massers had similar results with 69% and 67% retention levels respectively. After a 4-week retention interval, their results still remained relatively equal with 28% and 27% retention respectively. In their discussion, Rohrer and Taylor outlined the null effect that overlearning had on the results of the experiment. “In brief, the threefold increase in the number of same-session practice problems had no observable effect on subsequent test scores at either retention interval” (p. 1216). In general, the two experiments show that distributed practice is the only technique of the three to have a relatively high retention interval producing 64% retention after a four-week hiatus, while both massed practice and overlearning were only able to give retention rates of 32%, 28%, and 27% after just a four-week hiatus. Parents of

students who took part in a focus group were able to recognize the need for distributed practice as their feedback revealed they did share concerns about the pressure placed on students due to the acceleration of the content presentation (Knight and DeLeon, 1999).

As the results of the studies in this section have revealed, the spacing effect seems to be a phenomenon realized in many educational circles based on the response of students to learning tasks. The results have shown that for a greater retention interval it is essential that content and practice be spread over longer periods of time rather than massed into shorter intervals of time. If it is more important to recall information over a shorter interval, then presenting the content in massed quantities seems to bode well, however, if the intent is to be able to recall information and demonstrate skills over the long-term, then it becomes increasingly important to distribute the learning over time. Since standardized testing typically requires the latter, it would behoove schools and districts to take a deeper look at the spacing effect, especially as it relates to mathematics instruction as this phenomenon seems to speak directly to the impact of full-year traditional mathematics courses versus 4/4 block scheduled courses. The next section outlines the literature pertinent to the methodologies used in this study.

Review of Methodologies

In conducting a case study, evidence will be gathered through a variety of techniques in order to study elements in two high schools and their success in proficiency of mathematics students who have been placed on a full-year schedule compared with those who had been on the 4/4 block schedule. This study will utilize the methodologies inherent to case study in qualitative inquiry. The researcher will conduct an in-depth study of multiple cases using two high schools. This study will include a statistical

review of past achievement on both PSSA tests and MAP tests, current statistical data on test results, document review, interviews with administration, and two focus groups of mathematics teachers from each high school to gather information on teacher perceptions and methods of instruction regarding the effectiveness of 4/4 block scheduling and full-year scheduling as it relates to long-term mathematics retention. As described by Creswell (1998) in collecting information in a case study, interviews with ten participants, lasting up to two hours represent a reasonable sample.

Interviews are an effective way of gathering information that cannot be observed for ourselves through someone else's eyes. Case studies are designed to obtain multiple definitions and interpretations about the issue being studied. One of the best methods of "discovering and portraying multiple views of the case" is the interview, which is the "main road to multiple realities" (Stake, 1995, p. 64). While interviews may be conducted in a variety of ways be it by telephone, one-on-one and in-person, or by focus group, there are several facets that must be determined: identifying interviewees, method of interview, recording procedures, protocol, location, consent, and time frame (Creswell, 1998). Maxwell (2005) discusses planning the interview to be of particular importance as different perspectives will emerge, contextual information may be gathered, and a check on the other data will be uncovered. All of these aspects are important in the case study and in establishing triangulation. Focus groups provide an arena for researchers to tap the emotional and unconscious motivation not found within the structure of a conventional survey research (Garson, 2004). Focus groups are also used in situations where interaction between interviewees is necessary, where interviewees are similar and

cooperative, when time is limited, and when the interviewees may be hesitant to provide information one-on-one (Creswell, 1998).

Chapter Summary

Since the publication of *A Nation at Risk* (1983), the educational leaders of our country, our state systems, and our schools have been looking for ways to overcome the reality that “our once unchallenged preeminence in commerce, industry, science, and technological innovation has been overtaken by competitors throughout the world” (p. 1). We have looked for ways to improve on the time we use throughout the school day by incorporating the innovations of block scheduling and unleashing the power that is locked within. “Within the school schedule resides power, the power to address problems, the power to facilitate the successful implementation of programs, and the power to make possible the institutionalization of effective instructional practice” (Canady & Rettig, 1995, p. xi).

Many researchers described above have done studies as to the effectiveness of block scheduling and have found advantages and disadvantages to the process. Psychological research has been done that discusses how the mind works best and how to present and practice concepts in order for the mind to retain the information and skills most soundly. Federal and state legislative bodies have gotten involved and have decided to hold schools accountable for the proficiency of their students in mathematics, reading, writing and science. In the end, the overall outcome must be addressed and that is what facilitates student learning the best.

The researchers that advocated for block scheduling have shown many of the advantages of the scheduling format which are valid and have been realized by

administrators, faculty, and students. Block scheduling does allow both teachers and students to have a reduced workload which alleviates stress and allows for more focus and more personal attention. Block scheduling does allow teachers to cover material more in-depth due to extended time each day. Administrators have seen the decrease in discipline issues due to less time in hallways changing between classes and they have realized that students seem to do better in each of their classes by way of the grades that they receive. But the question remains, are they learning more and are they retaining what they have learned?

Some of the researchers did notice early on that there may be problems with long-term retention, especially in subjects like mathematics and foreign language where retention of previous skills is essential to new learning and comprehension (Marchant & Paulson, 2001). The studies done in the 1800's and mid-1900's by Ebbinghaus (1885), Jost (1897), and Underwood (1961) suggested that when information is practiced in mass and not distributed over longer periods of time some recall ability is lost. Hintzman (1974) went a step further and discussed that the spacing effect also has implications in the way that material is presented, case in point, block scheduling. Dempster (1987) also noted that distributed presentation and practice is about twice as effective as massed presentation and practice in affecting students' ability to recall.

Most of the block scheduling research that has been discussed in this document speaks of the positive impact that block scheduling has had on educational reform, school climate, depth of instruction, and teacher and student workloads. The area that does not seem to be addressed on a large scale is how students achieve over long-term period of

time. Few studies have been done to show that full-year scheduling is better for student long-term retention of concepts than semestering or 4/4 block or vice versa.

Some of the earliest proponents for block scheduling, Canady and Rettig, have conceded that the block may not be most effective for bolstering achievement levels of students in subjects such as mathematics. They suggest that schools, if possible, move toward a hybrid method of scheduling which allows for both block classes and full-year classes within the same school (Canady & Rettig, 2001). Is it possible that no one schedule is perfect for all types of instructional areas? Does the schedule have an impact on how students retain information and skills? Is retention more an effect of the instructional methods in the classroom regardless of schedule? Do both areas play significant roles? This study will seek to determine whether there is a correlation between the schedule and long-term student achievement. This study will also seek to uncover other underlying factors that may contribute to the long-term retention of student learning, especially as it pertains to mathematics knowledge and skills.

In the next chapter, the methodology will be detailed more fully. This study will be a case study that combines both quantitative and qualitative methods of inquiry to focus on one school district containing two high schools. These schools have exclusively utilized the 4/4 block schedule in recent history and have changed their fully 4/4 block schedule to a hybrid schedule which incorporates the full-year model for selected classes in mathematics. The goal is to determine if there are any changes in the results of PSSA and MAP testing in the area of mathematics. This study will seek to map out the process that was followed to implement the change and whether the resulting data have shown any significant changes.

CHAPTER 3

METHODOLOGY

Student achievement in mathematics is a topic of relatively high profile in the 21st century. Administrators are concerned with how their students fare in comparison with other students in the county, the state, the country, and the world. Federal and state legislation has been enacted that mandates performance levels for graduates of K-12 public schools and administrators are under enormous pressure to ensure that those outcomes are met. Due to reports of lacking performance and research that suggested new ways to structure the time in a school day (NCEE, 1983; NCTL, 1994), many school districts have made the decision to move to 4/4 block scheduling to enhance the learning that is taking place in their classrooms. The goal of this study is to investigate the results of such a move and the impact the schedule has on achievement in mathematics.

Overview of the Study

The theory of the “spacing effect” (Underwood, 1961; Hintzman, 1974) suggests that students learn better when material is presented to them over longer periods of time rather than shorter periods of time. The idea of massed practice versus distributed practice has implications that directly impact the choice of schools to use a full-year model to instruct students as opposed to 4/4 block scheduling. While 4/4 block scheduling does have significant advantages, the disadvantages in regards to student retention of skills and concepts in courses that require consistent practice and the construction of ideas upon one another are difficult to ignore.

The literature review focused on the history of block scheduling, the studies of American education during the 80’s and 90’s (NCEE, 1983; NCTL, 1994), the

innovations put forth by educational experts on school day and time management (Canady & Rettig, 1995; Jenkins, Queen, & Algozzine, 2002), and the results of both qualitative and quantitative studies utilizing the block schedule to instruct students (Marchant & Paulson, 2001; Alderman, 2000). Teachers and students have both reported how block scheduling eases the load of juggling so many courses, assignments, and assessments at one time. Teachers have discussed how much deeper they are able to go into subjects to explore the areas of the curriculum that are not able to be touched when time is wasted in opening, closing, and transitions throughout the day. Teachers and students have reported that teacher-student relationships are more easily developed due to a smaller volume of students to manage at one time. Students and teachers have also reported on improved performance on in-class assessments and overall course grading. There is one area, however, where the literature is inconclusive – the performance of students on standardized tests or on assessments of retention of content and skills. It is this area that is the focus of this study.

One school district was examined, in particular, which had implemented a hybrid schedule incorporating elements of both a 4/4 block and traditional format for selected courses in mathematics. The assessment data from students who took mathematics courses within each of these scheduling formats were analyzed. Administrators who created the schedules were interviewed and teachers who taught the courses participated in focus groups. Using this information, this study sought to determine the level of proficiency that students have achieved based on the scheduling format used to deliver their mathematics courses and specifically, how well they have retained that information

as well as making a determination as to which scheduling format more effectively facilitated that process.

Problem

The problem was high school students who took their mathematics courses on the 4/4 block scheduling model were experiencing low achievement in performance levels as evidenced by results in state and/or district standardized testing. The intent of this study was to delineate whether the inconsistencies were correlated to the scheduling format within which the mathematics courses were taken.

Purpose

The purpose of this case study was to report on the changes that occurred as a result of transforming the mathematics schedule from a block schedule format to a traditional format. It was to determine the effectiveness of the 4/4 block scheduling model and full-year models as they pertained to continuity in student achievement levels in moving from one mathematics class to the next and thereby affecting the ability to retain concepts and skills as demonstrated on achievement testing.

Research Questions

In order to determine to what degree the scheduling format plays a role in the achievement levels of students, the following research questions formed the basis for this study:

1. What conditions existed that lead this particular school district to investigate the need for a change in scheduling format?

2. What were the perceptions of teachers and administrators in regard to changes in instructional technique and student achievement as a result of the change in scheduling format?
3. Were there any changes on PSSA and NWEA student achievement data that correlated with the introduction of full-year classes for applied-level and college preparatory mathematics courses?

Context of the Study

The case study took place in two comprehensive high schools, including grades nine through 12, in Northeastern Pennsylvania. The school district, designated rural by the Pennsylvania Department of Education, is located in the center of a resort and recreation area. At the time of the study, the district encompassed approximately 217 square miles and served approximately 8,939 students in two high schools, two intermediate schools, and six elementary schools. The respective ethnic distributions of the student body for High School A and High School B included 44.9% and 63.8% White students, 27.3% and 17.6% Black students, 25.0% and 15.8% Hispanic students, and 2.8% and 2.7% Native American and Asian students respectively. The percentage of students identified as economically disadvantaged for those same high schools was 35.1% and 27.3% respectively (E. Forsyth, personal communication, December 2, 2008).

The “population in the attendance area of the school district had changed dramatically over the previous ten years. Much of the population moving into the area was from the middle to upper middle class with one or both parents/caregivers continuing to commute to New Jersey or New York for employment. In the county where the school is located, the population increased from 96,000 people in 1990 to 170,000 in 2000. The

county had grown 77.1% from 1990 to 2000, compared to the state's growth of only 3.36%" (Mulroy, 2008, p. 63). The school district had grown from just over 6,000 students in 1997 to just under 9,000 students in 2008 (E. Forsyth, personal communication, December 2, 2008). From the 11th grade PSSA data in the 2006-2007 and 2009-2010 school years, it was revealed the population was beginning to make some decline as evidenced by the numbers of eleventh grade students taking the PSSA exams. High School A had 334 students take the PSSA in 2006-2007 while High School B had 389 students take the PSSA exam. By 2009-2010, those numbers had shrunk to 271 and 319 respectively.

Research Design

The first step was to gather archival data from class-level MAP and PSSA testing for the case study schools using both traditional and block scheduling formats simultaneously. Secondly, each school's lower-achieving students were compared to archival data in an effort to uncover any correlation between schedule and performance. Third, the current one-year data of the college preparatory students were compared to one another for correlations in schedule and performance. Once the data were collected, they were tabulated using statistical analysis to find the correlations between the data and scheduling format used.

Focus group interviews were conducted with faculty members from the mathematics departments of each of the high schools. The content of the interviews were transcribed for accuracy in reporting. Three administrators were interviewed at the district and building levels to gain insights into conditions in existence at the time of the

schedule change as well as the process to make those changes. The content of these interviews were recorded and transcribed for accuracy in reporting as well.

Sample/Population

For this study, the first sample was archival testing data housed by mathematics class as well as current testing data from the case study schools. The data were gathered from the full population of students in applied-level Algebra 1, Geometry, and Algebra 2 classes over the span of 2003-2010. Depending upon the grade level and school year, students may have had any combination of mathematics classes on either the traditional or block formats. This sample was representative of the school population of applied students in grades 9-12 who took Algebra 1, Geometry, or Algebra 2 in the 2003-2010 school years.

A second sample was archival testing data housed by mathematics class as well as current testing data from the case study schools. The data were gathered from the full population of students in college preparatory Algebra 1, Geometry, and Algebra 2 classes over the span of 2003-2010. Depending upon the high school, students may have taken their mathematics classes on either the traditional or block formats. This sample was representative of the school population of college preparatory students in grades 9-12 who took Algebra 1, Geometry, or Algebra 2 in the 2003-2010 school years.

The conditions for selection of teachers to take part in the study were based on the characteristics and experiences of teachers as suggested by their building administrators (See Appendix F). The primary characteristics of teachers utilized in the study included teachers who have taught Algebra 1, Geometry, or Algebra 2 at the applied-level on both the block and traditional format. Additionally, the sample included teachers who have

taught Algebra 1, Geometry, or Algebra 2 at the college-preparatory level at High School A on both the block and traditional formats or at High School B on the block format. The teachers selected for the focus groups had experience on both types of scheduling formats.

Permission to conduct the study was obtained from the Superintendent (See Appendix A & Appendix B), the Assistant Superintendent for Curriculum and Instruction (See Appendix C) and both High School Principals (See Appendix D & Appendix E).

An invitation to participate in the study and a consent form were sent to the teachers who were suggested by administrators to participate in the focus groups (See Appendix G & Appendix H) to gather their perceptions as to the achievement levels that each type of scheduling format affords as well as teaching methods utilized, time spent on task by students, and amount of curriculum covered based on the scheduling format.

Additionally, school and district administrators were invited to be interviewed to provide background information regarding district graduation requirements, scheduling formats, reasons for changes, assessment specifics, system for remediation, and other pertinent district and school information. This sample was a sample of convenience as only teachers from the case study school district, due to their availability to the researcher and ease of data collection (Castillo, 2009), were used rather than a representative sample of all mathematics teachers in Pennsylvania. The 15 teachers who chose to respond represented the population of 36 combined mathematics teachers in both high schools, but their responses will not be generalized outside the scope of the school district.

Instrumentation and Data Collection

This case study was conducted by gathering evidence through several techniques in an effort to study the changes which occurred following a single school district that modified its method of scheduling to determine if there was a positive impact on student achievement. This study utilized mixed methodologies incorporating both quantitative and qualitative inquiry to fully study the case district. The researcher conducted this study by comparing the conditions of two high schools in the same school district prior to the schedule modification to the conditions in existence following that modification. This study included the use of focus groups, interviews, document review, and the gathering of assessment data to gather numerical data as well as perceptions regarding the impact that the schedule might have had on instructional technique and student achievement.

There were already two instruments in place at both the state level and the district level, the PSSA and MAP assessments. These instruments were designed to gather exactly the type of numerical data necessary to give some insight into student learning and achievement in mathematics.

PSSA Exams/Data

The state of Pennsylvania utilizes a testing system called the Pennsylvania System of School Assessment (PSSA). This system of assessment was designed to gather student proficiency data in the areas of mathematics and reading in grades 3-8 and 11 as well as writing in grades 5, 8, and 11, and science in grades 4, 8, and 11 (PDE, 2007). Since this study was one involving high school mathematics results, the instrumentation was limited to the 11th grade mathematics portion of the assessment.

The PSSA exam is a standards-based, criterion-referenced assessment measuring student attainment of the academic standards while simultaneously determining the extent to which school programs enabled students to achieve proficiency of the standards. The state-approved standards detail what students should know and be able to do. (DRC, 2007). The items used in the assessment go through a vigorous process to be considered eligible to be used. Item writers are selected by Data Recognition Corporation (DRC), the company responsible for development, scoring, and reporting results. To be qualified, item writers must be college graduates with teaching experience and have a demonstrated base of knowledge in the curriculum area. The writers are trained individually on how to write appropriate multiple-choice and open ended items. The concepts involved in the training include Pennsylvania academic standards, assessment anchors, and eligible content; Webb’s four levels of cognitive complexity: recall, basic application of skill/concept, strategic thinking, and extended thinking; general scoring guidelines for each content area; specific and general guidelines for item writing; bias, fairness, and sensitivity; principles of universal design; item quality technical style guidelines; reference information, and sample items (DRC, 2007).

The items are a collection of multiple-choice items and open-ended or constructed-response items. The items are constructed according to the five major reporting categories called “Assessment Anchors.” These anchors include numbers and operations, measurement, geometry, algebraic concepts, and data analysis and probability. These five categories are correlated to the categories used by the National Council of Teachers of Mathematics (NCTM) and the National Assessment of Educational Progress (NAEP) (DRC, 2007).

Each multiple-choice item has four response options, only one of which is correct. The student is awarded one point for choosing the correct response. PSSA items involving application emphasize the requirement to carry out some mathematics process to find an answer, rather than simply recalling information from memory. Each open-ended item requires students to read a problem description and to develop an appropriate solution. Most of the open-ended items are written in a scaffold format, which means that they have several components to the overall task that may enable students to enter or begin the problem at different places. Certain components ask students to explain their reasoning for engaging in particular mathematics operations or for arriving at certain conclusions. Students may also be asked to perform such tasks as constructing a graph, shading some portion of a figure, or listing object combinations that meet specified criteria. This provides insight into the students' mathematics knowledge, abilities, and reasoning processes. The open-ended items are scored on a published rubric with scores ranging from 0-4. The scores that students receive on the PSSA exam are reported by using one of four levels called advanced, proficient, basic, and below basic (DRC, 2007).

The validity of the assessment is demonstrated by the rigorous item-writing process indicated above as well as the connection to state content standards. In addition, the Pennsylvania State Board of Education commissioned an independent study of the PSSA by HumRRO. That study included an extensive evaluation of the items and the statistical relationships of the PSSA, including convergent and discriminant validity. The reliability of the assessment was calculated according to Cronbach's Alpha indices, these indices were calculated according to the traditional formula. The overall reliability for the 11th grade mathematics assessment is 0.94 and are also disaggregated according to

anchor by gender, race, LEP, IEP, and socioeconomic status, each of which is 0.92 or higher (DRC, 2007).

NWEA Exams/Data

The local school district being studied assesses students at both the beginning and end of the school year using an assessment developed by a company called Northwest Evaluations Association (NWEA). The NWEA is a non-profit organization that partners with more than 2300 school districts nationwide to provide products and services to measure and promote academic student growth and school improvement. These services include accurate assessments, timely reporting, practical classroom resources, and ongoing professional development (NWEA, 2004a).

The service utilized by the case study school district is the Measures of Academic Progress (MAP) testing feature allowing the district to gather data at the beginning and end of each school year to measure how much growth a student has achieved in both mathematics and language skills. Again, since this study was primarily interested in mathematics achievement, it will focus on the mathematics portion of the instrumentation.

The MAP tests are state-aligned computerized adaptive tests that accurately reflect the instructional level of each student and measure growth over time. The assessment itself is unique in that it adapts to the student's ability, accurately measuring what a child knows and needs to learn. In addition, MAP tests measure academic growth over time, independent of grade level or age. Most importantly, the results educators receive have practical application to teaching and learning. MAP tests measure a student's instructional level, providing useful information

about student achievement and therefore are useful for planning remediation and enrichment. Because the tests align to the content and structure of state standards, the information schools receive directly relates to the curriculum and classroom experiences. (NWEA, 2004b, p. 1)

The items used for the MAP testing are developed by mathematics teachers who go through extensive training in the NWEA item writing processes. With hundreds of new items being added each year, the MAP testing program is able to draw questions from a bank of more than 15,000. Each potential item must pass a rigorous bias and content review followed by field testing with a minimum of 300 students. The content of the items is aligned to the state standards and the results of the testing are reported to schools as an overall score as well as scores according to mathematics strands. The strands that are itemized include “number sense, estimation and computation, algebra, geometry, measurement, statistics and probability, and problem-solving, reasoning, and proofs” (NWEA, 2004b, p. 1). The NWEA website (2004d) reports:

NWEA assessments use a measurement scale that has proven to be exceptionally stable and valid over time. The scale is based on the same modern test theory that informs the SAT, Graduate Record Exam, and Law School Admission Test. The benefit of this test theory is that it aligns student achievement levels with item difficulties on the same scale. The scale used is divided into equal parts, like centimeters on a ruler. These parts are called RITs, which is short for Rasch Unit (after the test theory's founder, Danish statistician Georg Rasch). All of the test items are placed on the RIT scale according to their difficulty. Each increasing RIT is assigned a numeric value, or RIT score, that indicates a higher level of

difficulty. As a student takes a MAP test, he or she is presented with items of varying RITs, or levels of difficulty. Once the MAP system determines the difficulty level at which the student is able to perform and the system collects enough data to report a student's abilities, the test ends and the student is assigned an overall RIT score. In survey with goals tests, the student also receives RIT range scores for the goal strand components. (p. 1)

The validity and reliability of the MAP testing are published in a study done by NWEA (2004c) in relationship to test-retest standards as well as the test correlation to other established testing formats given concurrently to the same students. Validity for the MAP testing begins with the construct of the test and mapping existing state standards into the blueprint of the test. Test items are selected according to the connection to the standards and are of the appropriate difficulty level as to correlate to the grade level of the students being assessed. A uniform distribution of difficulties in questioning is also considered as the test is prepared. NWEA also uses concurrent validity to measure the validity of the MAP tests. Although not much data are given regarding the correlation of scores to tests of achievement in high school mathematics, the numbers that are available are given as a Pearson correlation coefficient. The results show that MAP testing validity is .81 in correlation with the Washington Assessment of Student Learning and a .84 correlation with the Colorado Student Assessment Program. In addition, a study was done by a graduate program at East Stroudsburg University that showed a strong correlation between the MAP test and the PSSA results of the same students, thus indicating the test measures what it is supposed to measure (NWEA, 2004c).

Reliability is measured in two ways, parallel forms reliability and internal consistency. With parallel forms reliability, the reliability is calculated by doing a test-retest format to determine if students taking similar tests will respond the same way to equivalent forms of the same test. According to the published results, for high school mathematics the test-retest reliability was measured between .82 and .90 on several different trials. Internal consistency is how consistently the same test question adequately measures the test's construct. NWEA uses a marginal reliability coefficient to take the majority of the information from the middle of the test where the measurement error seems to be at its minimum. According to the report, the marginal reliability coefficient stays consistent between .94 and .95 on multiple trials (NWEA, 2004c).

Quantitative Data Collection

The PSSA and MAP data were collected from archival records for the case study schools, maintained by an online program called Performance Tracker. MAP and PSSA results were gathered overall by assessment as well as by class and difficulty level to protect the identity of individual students and to make it possible to track trends in overall student data. The type of schedule format varied based on the class taken and in what year it was taken. The data were gathered from the Performance Tracker program for the 2003-2010 school years, however, class and difficulty level data were only available for the 2005-2010 school years.

The quantitative data utilized for this study were taken from a data warehouse used by the school district called Performance Tracker and the same data were collected for each high school independently. The data collected from Performance Tracker included NWEA MAP assessments given to students at the beginning and end of each of

their mathematics classes. These data were pulled for all students in Algebra 1, Geometry, and Algebra 2 mathematics classes at both the college preparatory (CP) and applied or basic levels from the 2005-2006 school year through the 2009-2010 school year. In addition, PSSA results were retrieved for all 11th grade students from the 2003-2004 school year through the 2009-2010 school year.

Interviews and Focus Groups

Interviews from administrators and focus groups from mathematics teachers were completed in each of the case study schools (See Appendix J) to gather their perceptions of student achievement and instructional methods afforded based on the schedule utilized. The teacher interviews were conducted in a focus group in order to gather the necessary data from teachers without burdening them beyond the scope of their regular daily activities (IRB, 2008). The focus groups were conducted during a regularly scheduled department meeting in each of the buildings according to the direction of the building principal and department chair. The focus group interviews did not exceed one hour in length. Garson (2004) suggests that focus groups and interviews are methods by which the researcher is able to uncover the motivations, emotional conditions, and unconscious drives behind the quantitative data found in the research. Focus groups are used in situations where interaction between interviewees is necessary, where interviewees are similar and cooperative, when time is limited, and when the interviewees may be hesitant to provide information one-on-one (Creswell, 1998).

The faculty participated in focus groups and the administration participated in interviews, both were held within the school setting. Teachers were interviewed in a focus group format as they are from the same department and work cohesively as a

group. A separate focus group was organized at each school consisting of seven teachers from High School A and 8 teachers from High School B. Interviews of three administrators involved in decision-making were performed in a one-on-one format. The following are a listing of the initial focus group questions of teachers (See Appendix J):

- How many years have you been teaching mathematics?
- How many years have you taught mathematics utilizing the 4/4 block schedule?
- How many years have you taught mathematics utilizing the full-year schedule?
- Which level of mathematics classes have you taught on the 4/4 block schedule?
- Which level of mathematics classes have you taught on the full-year schedule?
- In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the applied-level classes?
- In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the college-preparatory classes?
- Which model do you believe to be the best for mathematics instruction as it pertains to student achievement? Why?
- Are there levels of students for whom the traditional schedule is better suited? Are there levels of students for whom the block schedule is better suited?
- What might a typical day look like for a student in your class on the block schedule? What might a typical day look like for a student in your class on the traditional schedule?
- What type of instructional methods do you employ in your mathematics classes? Are they different based on the schedule on which you are teaching?
- Are there differences in the amount of curriculum that is covered in the courses you teach based on the schedule?
- What differences exist, if any, in the amount of time in which students are on task, based on the schedule?

The following are a listing of the initial interview questions of administrators (See Appendix K):

- What are the district/building policies/procedures governing the development/implementation of mathematics curriculum?
- What are the district/building policies/procedures governing graduation requirements for students?
- What are the district/building policies/procedures governing the scheduling of students in particular classes?
- What are the district/building policies/procedures governing the delivery of assessments for both PSSA and NWEA at the high school level?
- What are the district/building policies/procedures governing the professional development of teachers for instructional practices within the schedule being utilized?
- What circumstances led to the development of the master schedule as it exists today?
- What had been the history of the master schedule prior to these circumstances?
- Is the district/building showing any overall differences in student academic achievement since the implementation of the new method of scheduling?
- Have there been any other district/building changes as a result of the new scheduling method?
- Do teachers vary their instructional practices based on the schedule upon which they are instructing?
- What are the district/building policies/procedures governing the accountability of students with respect to results in testing?
- Are there any mechanisms in place for remediating students who do not demonstrate proficiency on the assessments?

The interview questions used for both the focus groups and interviews were developed based on themes found in the review of literature (See Appendix J). For this study, all teachers who had taught on each type of scheduling method for either college-

preparatory or basic level classes were given the opportunity to participate. The building principal and department chair selected the teachers based on these criteria (See Appendix F) and those that responded to the request to be interviewed were included in each of the focus groups.

Some advantages to focus groups include the ability to access substantive data while producing speedy results, large populations can be sampled at relatively low cost, and participants are placed on a more even footing with each other and the investigator (Berg, 2004). Grady (1998) also suggests that focus groups can allow the participants to react and reflect on answers given by coworkers in an effort to gather data unable to be tapped by a single interview format as the volley of conversation between the participants tends to stimulate further inquiry, new ideas and insight into the topic. The goal of developing the focus groups by using department chair recommendations was to ensure a formation that was intentional versus one that was composed by happenstance so that the focus group was a true representation or cross-section of the entire mathematics faculty (Patton, 2002). The objective of focus group research is to have the people involved consider their own views in the context of the views of others (Crowl, 1996).

Document Review

The student handbook, program of studies, criteria for scheduling students in mathematics classes, and policies related to curriculum development, assessment of student progress, and graduation requirements were reviewed as part of the document review to gain insight into the conditions in existence at the time of the study. The roles and responsibilities in implementing these policies were discussed with administrators as

well as their roles in ensuring that the policies were followed in connection with the particular needs of their buildings.

Protection of Human Subjects

Letters for permission to gather the data from the school's archival data were written to the superintendent of schools and the principal of each high school (See Appendices A & D). Because the study was conducted using the student achievement data of high school students as well as responses of school faculty, some of whom were under the direct supervision of the researcher, these participants were recognized as vulnerable and therefore approval from the Institutional Review Board (IRB) was necessary in order to show that the results gathered from the students test scores and teacher focus groups were not personally identifiable.

Data Analysis

In order to gain an accurate statistical analysis, the data were entered into an Excel spreadsheet and the data from the case study were analyzed for quantity, mean, standard deviation, percent of change and 95% confidence intervals for each school year, mathematics class, difficulty level (CP or Applied), and type of assessment (MAP or PSSA). The data gathered from MAP assessments were RIT scores from pre-assessments and post-assessments. The data gathered from PSSA assessments were scale scores and percentage of students demonstrating proficiency. These results were reported using time-series charts and tables.

In order to find statistical significance of the changes in data from year to year, a 95% confidence interval was used. "Users can choose the confidence level, usually 90% or higher because we want to be quite sure of our conclusions. The most common

confidence level is 95%” (Moore, 2010, p. 362). “When the 95% confidence intervals do not overlap, then the changes in data are considered to be statistically significant” (D. Rheinheimer, personal communication, May 22, 2013). For this reason, the 95% confidence interval was chosen as the means by which to prove statistically significant changes in data.

In addition, the normal approximation for binomial distributions was used to show the 95% confidence interval of data points involving the percentage of students who scored at or above the proficient level on PSSA mathematics exams. Since the n is relatively large, the researcher was able assume that the binomial distribution approached a normal distribution and therefore was able to use normal probability calculations to approximate the binomial probabilities (Moore, 2010).

Data from the interviews and focus group were synthesized by using categories of responses in correlation with scheduling models and the literature review.

Data analysis was ongoing and continued throughout the study through transcription of notes, tape recordings of interviews and focus groups, analysis of documents, videotapes, and photographs. The researcher reviewed the collected materials and the documented notes with the participants to gain feedback on the interpretation and accuracy of the data as needed. Key words and phrases were identified in categorizing the data to make meaning of the data derived from interviews and focus groups. The researcher worked in a manner that funneled the data from whole to part. Categories were identified to develop themes based on the participants’ responses and the themes in the related literature. (Mulroy, 1998, 68)

The themes were then cataloged in a table and tabulated based on the number of occurrences of each theme within the body of the interviews and focus group transcriptions including elements of the advantages and disadvantages of block scheduling as well as elements of the spacing effect. Validation of the data occurred by triangulating the responses of the participants, the themes emerging from the literature, the findings of the review of related documents, and the data collected from student achievement.

Assumptions and Delimitations

There were several variables which could be assumed in this study due to the study being restricted to two schools within the same school district. Each of the high schools utilized common curricula amongst each of the mathematics courses the students took. The common curricula incorporated courses which had been written in connection with state standards and assessment anchors for mathematics, utilize common final exams which guide the material to be instructed to provide consistency between different teachers, and employ spiral reviews which continued to give students practice periodically on already learned material.

Each of the schools had professional development plans coordinated by the district curriculum department. Professional development for teachers was held on the same days, with the same presenters and resources. The school district also utilized the same graduation requirements based on proficiency in mathematics and offered both tutoring and remedial classes to students who fall short of proficiency. In short, the assumption was that students from each high school were receiving the same curriculum from teachers who were trained in the same way. The students were assessed using

common assessments that were district-wide and they were expected to achieve the same requirements in order to graduate due to the consistency the school district had sought to achieve with their policies and procedures.

Students who took the PSSA exam were given a rating that fell into one of four categories based on how well the multiple-choice and open-ended questions were answered. While there was a numerical equivalency to produce the particular category into which a student fell called a scale score, the criteria changed annually based upon a comparison with the control group and thereby created a particular range of scores from year to year. The categories were itemized by DRC (2007) and their operational meanings are detailed below:

Advanced – Students who score advanced show superior academic performance indicating an in-depth understanding and exemplary display of the standards.

Proficient – Students who score proficient demonstrate satisfactory academic performance indicating a solid understanding and adequate display of the standards.

Basic – Students who score basic demonstrate marginal academic performance, and work approaching, but not yet reaching, satisfactory performance of the standards.

Below Basic – Students who score below basic show inadequate academic performance that indicates little understanding and minimal display of the standards (p. 81).

Students who took the MAP tests were given a RIT score as indicated above. The NWEA (2004b) indicated a breakdown for RIT scores in mathematics in correlation with

the assessment anchors from Pennsylvania mathematics standards and they were as follows:

Below 239 – Student is mathematically below high school level

240-243 – Student is mathematically on the 9th grade level

244-247 – Student is mathematically on the 10th grade level

248-251 – Student is mathematically on the 11th grade level

Above 251 – Student is mathematically on the 12th grade level or higher

Delimitations to this study were intentionally imposed to narrow the study and thereby limiting the generalizability of the results. First, was the small window of achievement data available to the researcher specific to the difficulty levels of the classes. There were boundaries with how many years were available with which to compare changes in order to draw conclusions. With applied-level data, there was only one year of student achievement results prior to the implementation of the modified schedule and with college preparatory data there were only two years of data beyond the point where the modified schedule was implemented for High School A. with which to compare the achievement scores following the implementation.

Secondly, the small-scale study only included one school district and a limited number of teachers and administrators. There were only 15 teacher participants in the focus groups from an available 35 high school mathematics teachers district-wide. These limited groups were due to the parameters placed on the department chairs to find teachers who had taught on the block and traditional schedules as well as availability of those teachers for the one day when the focus group was held for each school. The

number of administrators was also limited to the three who were the most instrumental in the process of making the change to the modified schedule and did not extend to include other administrators who may have been responsible for schedule creation and implementation.

A third delimitation specific to the case study was that the study chose to focus on students in applied-level classes over the span of four years of implementation as well as students in college preparatory classes in one school over the span of two years of implementation. These were the only difficulty levels on which the district or school administration chose to impose the traditional scheduling format for mathematics and therefore the study did not extend to the honors or advanced placement level. Finally, in the teacher interviews and focus groups, teachers were sampled on a strictly voluntary basis and may not necessarily represent the opinions of the entire mathematics faculty.

While these delimiters do hinder the ability to generalize outside of the areas chosen for the study, the study can certainly be replicated in other states based on state assessment program in place to satisfy federal regulations. The case study may also be replicated in another school, at any instructional level, where the district and administration are willing to make changes to the schedule in an effort to maximize student achievement.

Chapter Summary

This chapter specifically identified the methodology of the study, which included an overview of the study revisiting the problem, purpose and research questions. This chapter also included the context of the study, the research design, the participants, the instrumentation and data collection procedures, and the method of data analysis.

Additionally, this chapter identified the assumptions and delimitations of the study as well as the steps taken to protect human subjects. The data were collected and analyzed in an effort to answer the research questions for this study.

The methods used in this study were interviews of three district administrators involved in the implementation of the new scheduling format, two focus groups containing 15 teachers from both high schools who taught mathematics classes on both formats of the schedule, a review of policies and procedures governing assessments, graduation, curriculum, and student scheduling, and data collection of student assessment scores on both NWEA and PSSA mathematics exams. These exams have proven reliability and validity standards as detailed in the literature provided for them (DRC, 2007; NWEA, 2004c). The data included were the percentage of students proficient and mean scale scores for the PSSA and mean RIT scores for the NWEA. Results were tabulated and analyzed for statistical significance using a 95% confidence interval and reported in the following chapters.

The study has shown results in achievement levels of students who take their mathematics courses on either the 4/4 block schedule or full-year formats. Criteria were established to identify the levels of proficiency or grade level equivalency of the students to be studied. In chapter 4, the results and findings will be presented through the process of data collection and analysis. The achievement levels of students will be compared on the 4/4 block schedule with those on a full-year model of scheduling based on the school year, difficulty level of classes, and assessment type.

CHAPTER 4

RESULTS

The purpose of this study was to examine the effectiveness of the 4/4 block scheduling model as it pertained to student ability to retain mathematics concepts while moving from one mathematics class to the next. The study investigated what correlation, if any, existed between the type of schedule utilized and the achievement of students who have taken mathematics courses on such scheduling models. To achieve this purpose, a case study was done of a single school district containing two high schools, whose mathematics program, previously a 4/4 block schedule, was revamped to allow students to take mathematics courses for the entire school year in 45 minute classes as well as other students who continued to utilize the 4/4 block schedule for 90 minutes in selected

Table 1

Scheduling Format for Algebra 1, Geometry, and Algebra 2 Classes by School and Year

| School Year | High School A | | High School B | |
|-------------|---------------|--------------|---------------|--------------|
| | Applied | College-Prep | Applied | College Prep |
| 2003-2004 | Block | Block | Block | Block |
| 2004-2005 | Block | Block | Block | Block |
| 2005-2006 | Block | Block | Block | Block |
| 2006-2007 | Traditional | Block | Traditional | Block |
| 2007-2008 | Traditional | Block | Traditional | Block |
| 2008-2009 | Traditional | Traditional | Traditional | Block |
| 2009-2010 | Traditional | Traditional | Traditional | Block |

classes as a modified or hybrid scheduling format. Both high schools had utilized a full-year model for all of their applied-level mathematics classes of Algebra 1, Geometry, and

Algebra 2 since the 2006-2007 school year. High School A had also extended this model to all college preparatory Algebra 1, Geometry, and Algebra 2 classes since the 2008-2009 school year, while High School B remained in the 4/4 model in all college preparatory mathematics classes (See Table 1). The reason High School B did not make the change to a full-year schedule was due, in part, to the fact that this high school was entrenched a major building program at the time and it was thought by administration that space was at a premium, rooms were being changed due to the movement of the renovations, and the addition of more classes being rescheduled to a full-year format was going to take more time than was warranted. This high school was demonstrating 46% proficiency on PSSA mathematics exams compared to 28% at High School A and therefore was less in need of immediate changes given the additional stressors of renovations and room movement.

Both quantitative and qualitative data were collected from the case study school district in order to gain a clear picture of the outcomes of this newly-designed, hybrid model to determine what changes, if any, were seen in the achievement of students who had exited these classes. Comprehensive quantitative data were collected from each school by way of a data warehouse program called Performance Tracker. These quantitative data included overall PSSA proficiency percentages and mean scale scores from the 2003-2004 school year until the 2009-2010 school year taken as a whole as well as disaggregated by applied-level Algebra 1, Geometry, and Algebra 2 courses and college-preparatory Algebra 1, Geometry, and Algebra 2 courses. Secondly, the quantitative data included overall RIT scores from both pre-tests and post-tests taken at the beginning and end of each Algebra 1, Geometry, and Algebra 2 mathematics course.

These data are disaggregated by applied-level Algebra 1, Geometry, and Algebra 2 course and college-preparatory Algebra 1, Geometry, and Algebra 2. The ability to pinpoint data to a particular class was available from the 2005-2006 school year until the 2009-2010 school year. Qualitative data were also collected from each school based on interviews of administrators and focus groups with teachers and by the examination of school district documentation such as policies, student handbook, and program of studies.

Qualitative Data

Analysis of Teacher Interview/Focus Group Questions

This section summarizes the teacher responses to each of the 13 questions as they relate to teacher experience, instructional practice and their perception of student response to instruction delivered on each of the scheduling models for mathematics classes. These sessions were held as two separate focus groups, one held at each high school with a cross-section of mathematics teachers participating in each focus group. Since the main researcher in this study was an administrator in the school district at the time the study began, an adjunct professor from a local college, who was also another doctoral student, was asked to conduct the teacher focus groups in an effort to increase validity. The interviewer was given specific protocol as to method of asking questions within the realm of the focus group in accordance with the protocol outlined in chapter 3. From the two high schools, a total of 15 mathematics teachers participated in the two focus groups. Seven teachers represented High School A, which is the school that also employed the full year schedule for its CP classes; while eight teachers represented High School B, which is the school that only offered basic level courses on the full year format. Tables 1-6 give a clearer depiction of the levels of experience of each of the

mathematics teachers included in the two focus groups according to the responses each gave to questions 1-5. This information serves for an understanding of the knowledge base from which the teachers are drawing as they provide their professional analyses to the questions they have been asked regarding student achievement and engagement in classrooms based on the schedule.

Question 1: How many years have you been teaching mathematics?

To report on teacher responses to this question, Table 2 was created giving a synopsis of the responses given. The data were differentiated by school to give the reader a clear picture of the overall experience levels of the teachers involved in the focus groups. It is interesting to note that no teacher interviewed had less than three years of teaching experience. The highest was 24 years at high school B, which was an outlier as the measures of central tendency indicate. Half of the teachers have less than 7-11 years of experience and the other half were above 7-11 years of experience. The mean amount of experience was 9.6 years for High School A and 10.5 years for High School B.

Table 2

Years Focus Group Teachers have Taught Mathematics

| School | Range of years | Median Years | Mean Years |
|-----------------------------------|----------------|--------------|------------|
| High School A <i>Note: n=7</i> | 4-13 | 11 | 9.6 |
| High School B <i>Note: n=8</i> | 3-24 | 7 | 10.5 |

Question 2: How many years have you taught mathematics utilizing the 4/4 block schedule?

Table 3 was created to represent the number of years that teachers have taught on the 4/4 block schedule. The data were again differentiated by school to give the reader a clear picture of the experience levels of the teachers involved in the focus groups within the 4/4 block schedule. It is interesting to note that no teacher interviewed had less than three years of teaching experience and none had more than 14 years teaching on the block schedule. Half of the teachers have less than 7-9 years of experience and the other half were above 7-9 years of experience. As was expected, the mean number of years of experience teaching on the block schedule was 8 years.

Table 3

Years Focus Group Teachers have Taught Mathematics on the 4/4 Block Schedule

| School | Range of years | Median Years | Mean Years |
|-----------------------------------|----------------|--------------|------------|
| High School A <i>Note: n=7</i> | 4-12 | 9 | 7.9 |
| High School B <i>Note: n=8</i> | 3-14 | 6.5 | 8 |

Question 3: How many years have you taught mathematics utilizing the full-year schedule?

As can be seen by the data in Table 4, the teachers seem to have much less experience teaching mathematics courses on the traditional 45-minute, full-year schedule. This is due, in large part, to the fact that the mean experience of teachers is 10 years and the school district has been implementing the 4/4 block schedule exclusively for 14 years.

Unless a teacher taught in another school district, or as a part of this hybrid scheduling format, they would not have had much chance to teach mathematics classes on the full-year format. The data were again differentiated by school to give the reader a clear picture of the experience levels of the teachers involved in the focus groups within the full-year 45 minute period schedule. It is interesting to note that no teacher interviewed had more than ten years of teaching experience with this scheduling format and some had as little as one year. The measures of central tendency show that about half of the teachers have less than three years of experience on the traditional format and about half have more than four years, but none have more than ten years of experience teaching on the full-year, 45 minute schedule for mathematics classes.

Table 4

Years Focus Group Teachers have Taught Mathematics on the Full-Year Schedule

| School | Range of years | Median Years | Mean Years |
|-----------------------------------|----------------|--------------|------------|
| High School A <i>Note: n=7</i> | 1-5 | 3 | 2.7 |
| High School B <i>Note: n=8</i> | 1-10 | 3.5 | 4.6 |

Question 4: Which level of mathematics classes have you taught on the 4/4 block schedule?

Table 5 shows the responses of teachers in regard to which types of classes they have taught on the 4/4 scheduling format. Of the 15 total teachers included in the focus groups, all of them have taught at least one college preparatory class on the block

schedule. Twelve of the teachers have taught honors classes on the block schedule and twelve teachers have taught an applied-level class on the block schedule.

Table 5

Levels of Courses that Teachers Taught on 4/4 Block Schedule

| Levels of mathematics courses | Number of Teachers Referenced in the Responses |
|-------------------------------|--|
| Honors | 12 |
| College Prep | 15 |
| Applied | 12 |

Note n = 15

Question 5: Which level of mathematics classes have you taught on the full-year schedule?

Conversely, Table 6 shows the responses of teachers in regard to which types of classes they have taught on the traditional scheduling format. Of the 15 total teachers included in the focus groups, all of them have taught at least one applied-level class on the full-year, 45-minute schedule so they all have experience with the traditional schedule and can thereby give appropriate feedback about the response of students when being instructed on a 45-minute daily class period for an entire year. Only seven teachers have taught a college preparatory class on the traditional schedule, this is due in part to the fact that High School B did not change any of its college-preparatory classes to the traditional format and therefore few teachers from that school would have had this opportunity. Only one teacher has ever taught an honors course on a full year format. Once again, this

due to the fact that this school district uses the 4/4 block schedule for all honors mathematics classes in each high school.

Table 6

Levels of Courses that Teachers Taught on Full-Year Schedule

| Levels of mathematics courses | Number of Teachers Referenced in the Responses |
|-------------------------------|--|
| Honors | 1 |
| College Prep | 7 |
| Applied | 15 |

Note n = 15

Table 7

Teachers Who Taught the Same Course on Both the Block and Full-Year Schedules

| Levels of mathematics courses | Number of Teachers Referenced in the Responses |
|-------------------------------|--|
| Honors | 1 |
| College Prep | 6 |
| Applied | 7 |

Note n = 15

Table 7 was included with these data to give the reader a clear picture of which teachers have taught the same class on each type of schedule and therefore even more able to draw comparisons between the advantages and disadvantages of each type of

scheduling format and the resulting effects they have witnessed on student achievement as well as student response. A little less than half of the teachers have taught the same class on both the block and the traditional formats for both applied-level and college preparatory classes, in fact, the actual figures are seven teachers and six teachers respectively. Once again, only one teacher has even taught an honors course on the traditional schedule and therefore only one teacher has taught a course on each type of schedule.

Question 6: In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the applied-level classes?

Academic changes cited by the teachers in regard to changing the applied-level classes to 45 minutes all year versus the 90 minute semester block that had occurred in the past were overwhelmingly positive. In fact of the 15 teachers who participated in the focus groups, only one teacher noted that the change was negative. Two teachers noted that they did not teach on the 45-minute full year model once the district decided to make that change. The other 12 teachers gave a wide array of academic changes that they felt to be positive as a result of this change.

Seven of fifteen teachers noted that the 45-minute full year mathematics classes allowed the students to have better long-term retention of the material, that it afforded the teacher the ability to cover a broader range of material over the course of the school year, the ability to stretch a particular topic over several days, and promoted better classroom behavior which allowed for easier management of the classroom. Others noticed that lower level students were more actively engaged and that those who may have shorter attention spans were not lost as often during the class period. Furthermore, one teacher

commented that the test scores improved causing overall grades for the course to go up. Lastly, one teacher commented that the 45 minute full-year mathematics class “allows the students to have more chances to see the material and the ability to practice a topic over time.”

One individual teacher noted they saw no difference with the academics or the grades and they were able to cover the same amount of material on the block as they were on the full-year model. In addition, the curriculum was covered wide rather than deep. The same teacher felt the 90 minute block format gave more time to explain and that the 45 minute full year format did not afford enough time to teach after the homework was checked. “We need to have 45 minutes for remedial classes and 90 minutes in regular classes,” they concluded.

Question 7: In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the college-preparatory classes?

While the quantitative data will ultimately tell the story here, the teachers were asked this question as a means to find more interesting detail than simply a number on a graph. This allowed them the opportunity to verify advantages/disadvantages from the literature as well as verifying they see the same in their classrooms. Since High School A was the only school of the two to move to the 45-minute full-year model for college preparatory classes, this question was only asked of those seven teachers. The sentiments of the teachers with regard to college preparatory classes being moved to the 45 minute full-year model were much the same as they were with the applied-level classes. All seven teachers from High School A noted only positive results. Four teachers shared they were able to cover more material while three teachers said that the students retain

the information for a longer period of time, that they can cover more material and get further in the curriculum.

An additional change observed by five teachers was that absences or days off from class did not have as great an impact as it used to have when the course was taught 90 minutes for a semester. Teacher 1A (Teacher 1 from High School A) commented, “the students have more time to absorb or crystallize the concepts.” Finally, six of the seven teachers felt the students performed better on tests and that the academics showed better results when the college preparatory class was delivered on the 45 minute full-year schedule.

Question 8: Which model do you believe to be the best for mathematics instruction as it pertains to student achievement? Why?

Once again, this question was included in the protocol to give more robust information about the mathematics achievement results from students on different schedules. The responses here are to validate the information contained in the literature review as well as to paint a picture of the impact to student achievement as evidenced in the classroom. Of the 15 teachers interviewed in the focus groups, all of the teachers agreed that mathematics instruction yields the best results when the instruction is taking place for the full year. Whether it be a 45 minute period or a 90 minute period, each teacher believed that the continuity of the instruction over time was what was the most beneficial to student achievement. The teachers cited many reasons why the mathematics instruction should take place all year. Among those reasons, 13 out 15 teachers felt that a student should not go an entire year without taking a mathematics course. Teacher 7A

added, “By creating a schedule that enables mathematics to be taken for the entire school year, we are able to eliminate the gaps that seem to happen when using the block format.”

All the teachers have observed that students retain information better due to having “soak time”, 11 out of 15 said it enabled the teacher to cover more curriculum, and 11 out of 15 felt the traditional schedule allowed the instruction to take place in “small doses.” Teacher 4B commented, “The shorter class period all year allows students to focus better and avoids a teacher watering down the curriculum to accommodate for lack of engagement.” Eight of the 15 teachers included the phenomenon of the accentuated absence while on a block schedule which makes it too difficult for a student to make up the time missed, especially with multiple absences in a row. Teacher 6B also cited, “the block requires double lessons, students can’t handle the double lesson and typically shut down after the first topic is finished.” Six other teachers agreed with this statement. Teacher 1B added, “There is a need to change our teaching strategies to teach kids today using a 45 or a 90 minute period. Kids don’t even know times tables and basic skills are decreasing.” One final thought from Teacher 3B was this, “I have talked with college professors and they say there is a clear difference between students who have taken mathematics full year versus those who have taken it on the block.”

Thirteen out of 15 teachers were in favor of the block for honors students to enable them to be able to take multiple mathematics courses in the same year and since mathematics tends to be sequential with most courses, the block allows those students to be able to accelerate their mathematics instruction. In essence, this reason is still a matter of a full-year program, but doubling the topics for the students who are best equipped to handle the double-dose each day. Teacher 1B even suggested, “All kids need to have 180

days of mathematics in a school year. Can't we have 60 minute classes that take place for the full year?" It was also noted by Teacher 3B that while "it is more difficult to stay focused in a 90 minute period, it does prepare students for the longer classes they may have at the college level."

Question 9: Are there levels of students for whom the traditional schedule is better suited? Are there levels of students for whom the block schedule is better suited?

All fifteen teachers participating in the focus groups felt that the traditional full-year schedule is a better schedule for students who are taking college preparatory or applied-level classes based on their experiences. They felt that the block schedule is better for honors level or AP students who want to double up on their mathematics courses in the school year. Ultimately, all the teachers interviewed believed that all students need to have mathematics all year. Teacher 1B commented, "45 minutes per period is not long enough for the applied-level students, I would like to see these classes run for 90 minutes all year. PSSA and SAT tests are 3 hours long, we need to prepare students for these assessments." Teacher 2B noted, "The full year schedule is a benefit for the applied-level student as it allows them to focus more and to digest the learning over time to aid with better retention. We do, however, need more time to focus on bigger projects." Teacher 5B rebutted, "You can create more time for longer projects by not wasting time with checking homework on those days."

During the focus group, there was a commonality in the teachers' responses between a typical day in their classroom based on the type of schedule and types of instructional methods they employ based on the schedule on which they are teaching. Since the responses regarding a typical day were interrelated with the types of

instructional methods they employed, these questions and their responses were grouped together.

Question 10: What might a typical day look like for a student in your class on the block schedule? What might a typical day look like for a student in your class on the traditional schedule?

Question 11: What type of instructional methods do you employ in your mathematics classes? Are they different based on the schedule on which you are teaching?

Each teacher included in the focus groups, whether on the block schedule or on the traditional schedule, begins their lesson with a bellringer and a homework check. A bellringer is a district initiative to give student practice problems each day that connect to the state standards and assessments anchors they may see on the PSSA exams. The amount of time they spend on homework varies based on the schedule they are using. If they are on the 45 minute period, the teacher typically does not go into depth with discussion about the results the students found on the homework problems, while the 90 minute period allows teachers to take the time to answer questions about the homework.

The 45-minute full year schedule begins with a bellringer and time to check homework which takes five to ten minutes of the period for every teacher in the focus groups. Seven teachers report that homework checks are followed by direct instruction on one topic for 15-20 minutes and each reported that students have 15-20 minutes for related activities before ending class. Eight teachers reported that homework checks are followed by 30 minutes of direct instruction and the class period ends with five to ten minutes to further understand the topic with examples of how the topic can be applied or practice time to hone their skills.

Within the 45-minute period nine of 15 teachers reported they do not have time to go over homework with the class, four out of 15 said there is typically not enough time for further explanations, and all teachers shared that they are only able to cover one topic per day or stretch that topic over several days. According to four out of the 15 teachers, this schedule format does involve more direct instruction and less class time is afforded to work on long term projects. No teachers felt they have time to utilize one to one technology or to begin homework within the traditional format.

In terms of the 90 minute block schedule, the teachers reported the structure of the typical day in the classroom tends to be more diverse. Twelve teachers out of 15 utilize the first 30 minutes of class to complete the daily bellringer, check homework and review answers to homework. The other three teachers reported that they begin the block period with a five minute bellringer and homework check. Eleven out of 15 teachers spend 20-30 minutes on direct instruction involving two topics while the other four teachers use about 50 minutes for direct instruction also typically on two different topics. Eight out of 15 teachers utilize 15-20 minutes for guided practice and activities related to the new content, three teachers utilize 40 minutes for guided practice and related activities, and the other four teachers do not utilize class time for guided practice. Finally, 12 out of 15 teachers use the last five to ten minutes of the 90 minute period for assessment and closure while the other three teachers did not discuss closure or assessment as part of their daily process.

Within the 90-minute period, the teachers reported they deliver more content each day, more of the class time is devoted to either reviewing homework, checking the homework in depth or working on homework, and there is more time to give students

personal attention. In addition, many cover two topics per day, give more time for practice, and more time for class discussion. They tend to break up the time into several 15-20 minute intervals so they are not losing the attention of the students and allowing the students to be able to more fully focus on the topics being presented. The teachers are able to devote more time to projects, group work, technology, enrichment for honors students, more practice time for lower levels, and more discovery methods of instruction.

For Questions 12 and 13, the teachers felt there was not much more to say than was already shared so many simply summarized the thoughts that had been expressed with the previous questions. Once again these two questions will be reported together as the closing comments were brief in terms of differences in the amount of curriculum that is covered and the time that students are on task based on the scheduling format.

Question 12: Are there differences in the amount of curriculum that is covered in the courses you teach based on the schedule?

Question 13: What differences exist, if any, in the amount of time in which students are on task, based on the schedule?

All the teachers have observed that with the 45-minute full year schedule, they are able to cover more material over the course of the school year, they feel like they put less stress on the students to rush through the material, and that there is more time to allow the students to understand a topic before moving on to the next one. Teacher 5A added that with the traditional schedule “students are on task most of the time.” Teacher 3A extended that thought to share that “applied-level students are engaged better on the traditional schedule.” All teachers agreed that the best scenario would be 50-60 minutes every day all year long. With the 90-minute block schedule, all the teachers have

observed that they are able to cover the curriculum more deeply, but not as broadly, that the length of each daily period allows more time for discovery as well as more time to spend on homework. When discussing block schedule, Teacher 6A also added, “As a teacher, you are more relaxed, you talk about yourself more and get to know your students better.”

With respect to student engagement and time on task, the teachers have observed that with the 45-minute full year schedule, the students of all levels are on task most of the time, even at the applied-level as well as with special education students. Teacher 4B noted, “There is a huge difference with my CP students, they can’t stay on task for longer than 45 minutes, some can’t stay on task for longer than 10 minutes.” With the 90 minute block schedule, all teachers have observed that they need to keep the class moving by changing activities more often, they need to develop more rapport with students in order to keep their attention, but that they do get to know their students better. Teacher 1A commented, “You need to create more down time and mix it up more.”

Analysis of Administrator Interview Questions

This section summarizes the administrator responses to each of the 12 questions related to their perceptions regarding student achievement consistent with the schedule on which students took their mathematics classes. Three administrators were interviewed individually. The roles of the administrators included the Assistant Superintendent for Curriculum and Instruction and the building principal from each high school.

Administrator 1 was the assistant superintendent who had been in the current position for three years. Previously, administrator 1 had been an assistant principal and principal for one of the high schools as well as principal of an elementary school. Administrator 2 was

the building principal from High School B who had been in that position for three years having also served as an assistant principal at the same high school for six years following extensive out of state experience. Administrator 3 was the building principal from High School A who had been an assistant principal and principal at the middle school level for six years prior to moving to the current position as building principal having served two years at the time of the interview.

The two principals were interviewed in their offices and the assistant superintendent was interviewed in the library of High School A. Each of the interviews lasted approximately 45 minutes. All three administrators were asked each of the 12 questions included in the protocol and all responses were recorded and transcribed. The responses of all three administrators are included together in the following section, question by question.

Question 1: What are the district/building policies/procedures governing the development/implementation of mathematics curriculum?

The collective response of all administrators was that the school district has a six-year curriculum development cycle. The process of curriculum development or revision begins with curriculum mapping for the mathematics program K-12 which is based on assessment data that have been collected. These data detail the saturation and the gaps in the curriculum based on areas of strength and weakness in the assessment data.

Administrator 1 indicated:

Since we have two high schools, we pair them up. Initially, all the grade levels meet together to do a scope and sequence K-12. We have people from all levels together so that they understand the essential content. As they write they have to

make sure that they have the standards, the essential content, the assessments they will be using, the activities, the curriculum exemplars, the resources including any technology resources. They do write it in committee. The essential content – what all students need to know – they develop together with the essential questions at all levels. You then have the different levels, the Honors, the AP, and so forth where they will ensure that their assessments are formative and summative, that they also use higher-level thinking skills and Bloom’s taxonomy. After the curriculum is written, it is reviewed by the department chairs, they put it all together and give it to me, I review it, revisions are made and it is then approved by the board. Professional development is provided for teachers as they are introduced to the new textbook while we develop at the bell activities and additional assessments. They do common mid-terms and common finals and, in some courses they do monthly assessments.

High school curriculum development then involves the mathematics department chair from each high school as well as teachers who teach the actual courses being written or revised. It is a three year process consisting of a year of research prior to the implementation to evaluate possible textbooks where the team determines the essential content that needs to be covered in the curriculum in accordance with the state standards and assessment anchors for mathematics instruction. Administrator 2 added:

My department chair will select some teachers depending on their expertise in a subject area. So if one of my teachers teaches mostly algebra and that is really her bailiwick then we would request she be on the committee. Someone else that might have expertise in statistics or trig then we would request that teacher be

placed on the committee because each of my teachers has different strengths and different expertise. All of them could probably teach any of the subjects, but I know my best algebra teachers, I know my best trigonometry teachers, I know my best pre-calculus teachers and they are the ones I would want to be part of the curriculum committee and the ones that would make the decision as to the progressive nature as to whatever the subject matter.

After a text is selected, the curriculum is written over the course of the next year then differentiated to be taught at three different levels of instruction including Basic, College Preparatory, and Honors levels. Finally, the process ends with a year of piloting prior to actual adoption.

All three administrators noted that items that are included with the written curriculum include technology integration, engaging activities to make the curriculum come to life, resources to be utilized, and the assessments that will be employed to determine whether students learned what was intended. Administrator 3 noted:

Our procedure for the implementation of the mathematics curriculum is an ongoing process. Working in collaboration with the department chair and the staff members that service that department, they are constantly looking at and reviewing the curriculum to ensure things are in alignment. At the same time, as a result of the various assessments, whether it's the MAP assessments or PSSA assessments, based upon the interpretation of that data, there are things that are constantly being reviewed and tweaked to ensure that things are in alignment and meeting the necessary standards.

Both formative and summative assessments are utilized as well as varying levels of questioning in accordance with Bloom's taxonomy. Summative assessments are common to both high schools to maintain consistency and to ensure that all students are receiving the same instruction.

In their responses the administrators included that teachers receive professional development to ensure that instruction is consistent at each school and at each level. Teachers are expected to include all components of the curriculum in their daily lesson plans including objectives, standards, content, resources, assessment, and differentiation. Administrators also ensure curricular connections with their supervision activities and lesson plan reviews including both formal and informal evaluations of instructional practice.

Question 2: What are the district/building policies/procedures governing graduation requirements for students?

The collective response of all administrators was that all students must earn 28 total credits to graduate which includes four credits in mathematics. Students are required to earn a credit in Algebra 1, Algebra 2, and Geometry, which are mandated, and then in the fourth year they may take another mathematics course. In addition, they must demonstrate proficiency on the PSSA assessment in eleventh grade. If they are unsuccessful, then they must complete one of the following to demonstrate proficiency: a rating of proficient or advanced on the PSSA Senior retake exam, full completion of the Study Island program with at least 70% mastery, or pass the district created assessment of proficiency. Administrator 1 also added:

IEP students may have an IEP team make that decision; if they are a vo-tech student they may demonstrate proficiency on their NOCTI exam. We try to hold very strongly to their completing Study Island program and demonstrating proficiency, but we do have another assessment if we feel that the student has tried we have another assessment we can give them, so yes there are some alternatives, but we try to keep it pretty rigorous. They can demonstrate proficiency through our MAP assessment which is Measures of Academic Progress.

As indicated by Administrator 1, when each of the other possibilities are exhausted a student may demonstrate proficiency through testing out of each of the five assessment anchors of the MAP assessment. These expectations are district-wide and therefore consistent for each high school as the responses of Administrators 2 and 3 echoed that of Administrator 1.

Question 3: What are the district/building policies/procedures governing the scheduling of students in particular classes?

The collective response of all administrators was that the process for scheduling students into classes involves several factors to ensure that students are properly placed according to their abilities and to provide the appropriate support and challenge to allow them to be engaged in a manner so that they can progress to the attainable expectations for the class. Administrator 1 revealed:

Again through the scheduling process, teachers do make recommendations for students. We use our MAP assessments to try to recommend which students should be taking the higher level courses. But we are a public school, so there is a

free and appropriate education, so if a parent disagrees with our recommendation, then we have a waiver process where they can choose to put their student in a class that we do not recommend and then sign a waiver indicating that they take full responsibility if the student is not successful.

Administrator 3 further clarified the process by sharing:

The first element that is looked at in assigning students to a level of course offering is the MAP assessments which are administered in both the beginning and the end of an academic semester. We utilize those scores to assess the performance levels of those students. Based on their achievement, we are able to closely identify the best academic level for those students as they continue through their courses. Outside of the MAP testing scores, teachers are also involved in the selection process as to what level and they may even meet and counsel with a student as to what they feel may be the most challenging and opportunistic level for their performance. If necessary, there may also be collaboration with parents or a guidance counselor to assist with that process as well.

Administrator 2 added the following:

We basically give the NWEA and we look at their scores, we also have their current teacher recommend a level. Sometimes a student may only be a few points away from being proficient in the NWEA, but they really shine in their algebra class so we may recommend them for a more difficult level especially if they have above a 75 or above an 80 and their NWEA scores are really good. However, if a student's NWEA scores are not good and they have achieved like a

70 or 75, I am not going to be as quick to recommend they go to the next level. I am all for challenging students to do better, but I think if they don't have the basic skills then they are only going to get frustrated.

All administrators detailed that the process starts with teachers from the previous year make recommendations for students which are taken in conjunction with the MAP assessments results and other classroom achievement to recommend the appropriate placement in a mathematics class. Students entering grades 9 and 12 also have PSSA scores that are considered in course and level placement. However, if a parent disagrees with the recommendation, there is a provision to have the parents sign a waiver allowing the student to select any level of instruction that they and their parents find appropriate. The waiver process involves a meeting between the parents and guidance counselor and, if requested, an administrator. The school district personnel have the opportunity to present their findings to the parents as well as reiterating their reasoning for the recommendation. The parents then have the option to accept the recommendation of the school district personnel or they must agree to take full responsibility should the student not meet with success.

All the administrators noted that when a student transfers to the school district, they are also given a MAP assessment to determine the appropriate placement in a mathematics class in conjunction with the courses listed on their transcript and the grades achieved within those classes. If teacher data are available with the transfer paperwork, that information is also considered to make the placement in the appropriate mathematics class and level.

Question 4: What are the district/building policies/procedures governing the delivery of assessments for both PSSA and NWEA at the high school level?

The collective response of all administrators was that with PSSA the school district follows the PSSA windows that are given by the state. A testing coordinator from each building is trained based on the newest information regarding the PSSA testing that is given by the state. Administrator 1 detailed the process by saying:

With PSSA, obviously, we follow the PSSA windows that the state gives us. Prior to that, we develop a presentation on the assessment as well as the proctoring of the assessment and we train the building coordinators. They, in turn, need to train anyone at their building who is administering the PSSA test. There is also a schedule that is given from PDE for implementing the PSSAs, but the district actually has the ability to alter that schedule. We tried doing it, initially, with two tests a day. When we weren't doing well, we went back and tried it for one test a day. This year one building did one test a day and another did one, one, two, and two. So there is some flexibility to administer the test the way the buildings feel it will best meet their needs. Of course, we have to start it and end it in compliance with the state window.

For the NWEA, that is done primarily through the mathematics and reading departments. The teachers have been trained on how to implement the test and they do it on a regular basis. MAP is given two times a year for all students whether it is block or year long classes. If students are participating in tutoring, they must take the test three times a year, because through the grant the state requires that we have benchmark data at three data points.

This school district feels that the fewer sections taken in one day, the better the students will be able to perform by lessening the fatigue factor. The school schedule also somewhat dictates how the sections are delivered so it may not always be one section per day. Some schools tried initially with two tests a day, but found they were not meeting with much success. Consequently, they went back and tried one test a day. Administrator 3 did one test a day and Administrator 2 did one, one, two, and two. The only absolute is that the assessments must be taken within the published state window for the assessments.

Administrator 3 reported their procedure as follows:

There are a few things that we have setup for our building and specifically for this past year as far as PSSAs were concerned. First, for the testing windows for the 11th grade PSSAs we established a test mode schedule so that our entire school population was in a testing mode setting. Thus we were able to provide and afford for our 11th graders the best possible testing environment and utilization of necessary staff and resources to provide the best testing setting. One of our assistant principals has training sessions with all staff who will be administering the PSSAs. There is also information that is discussed during our faculty meetings prior to these testing windows to ensure that everyone is aware of the expectations for testing. When it comes to the actual testing days and the schedules that we follow, we feel that we have some things in place to assist in how well the students achieve -- we only administer one testing section per day. The window of time is two hours and extended time is available if necessary for particular students. We feel as though by affording the students just one section a

day, that they are able to use their energy and efforts towards that one section and not get drained as a result of trying to complete multiple sections.

In comparison, Administrator 2 also reported these strategies to assist with student performance:

In terms of PSSA, we have the students placed on a separate floor for homerooms. We design the assessment so they are in their homeroom classes where there is a comfort level with the setting. We will assign a teacher into those classes from the corresponding subject area to be the proctor.

Administrators 2 and 3 agreed with Administrator 1 in that the MAP assessment is done primarily through the mathematics and English departments. Those assessments are then given electronically allowing the information and feedback to be immediate. The data are then compiled and delivered to the schools in a timely fashion for the district/school to utilize for instructional planning. The teachers have been trained on how to implement that test and they do it on a regular basis. The MAP assessments are delivered at the beginning and the end of each of the semesters of that academic year. If students are participating in tutoring or taking yearlong classes, they must take the test three times a year.

Administrator 2 reported:

The assessments...the NWEA we give three times a year. Beginning, ending and middle so we have a beginning and ending score. Because some students will not have mathematics again until the following year which is a problem so we want to make sure we get an assessment in the beginning and again in January before they end the course. And then we will have an ending assessment when we will rotate

them through. For instance, if they didn't have a mathematics class at the moment but they did have one for us to get another score we will pull them from another class. We will do that for the English and the Mathematics classes to make sure we get everybody.

This statement seems to be consistent with Marchant and Paulson (2001) who stated:

The developers of this new style scheduling, called 4/4 block scheduling, failed to see that the reduction in workload per semester would cause gaps in the continuity of instruction in all subject areas. These gaps, while unrecognizable in subjects where material does not build on previous knowledge, are accentuated in subjects where repetition and continuous practice are necessary to maximize retention, namely foreign language and mathematics.

Question 5: What are the district/building policies/procedures governing the professional development of teachers for instructional practices within the schedule being utilized?

Administrator 1 noted:

The school district has provided professional development for teaching in the block, however, it has not been something that has been continuous. We are currently putting a plan into place to address more continuity in professional development. There is a commitment to teach the teachers how to differentiate the instruction, but this detail has been reported as a big weakness in our district – teachers have not had continual training. It would seem to be prudent to have continual professional development especially in light of some circumstances particular to our school district, namely that here has been a lot of teacher

transiency and there has not been a system in place to make sure that the new staff are trained on a continual basis.

Administrator 3 reported:

As far as additional professional development opportunities, a big push has been with technology to ensure how the instruction is being delivered in a manner consistent with the growth of society. The district is looking for ways to tap into the various modalities in which the students may learn. We have increased and bolstered the skills and strategies of teachers to be able to utilize the number of different ways to deliver such.

Administrator 2 commented on other initiatives the district has instituted to address instructional practice:

We did something different this year with the staff development. We actually started an initiative on co-teaching - regular education and special education partnerships between teachers to provide both within the same classroom. We took teachers that we knew were going to form co-teaching teams and they completed a full-day training specific to co-teaching. In addition, permission was granted to have an additional half day session during the school day with teachers covering their classes on preparation periods. Rather than having substitutes from the outside, we were able to provide actual mathematics instruction to the students during these training sessions to ensure the students did not fall behind. We are continuing to look for creative ways to provide professional development to teachers in a way that does not become financially taxing on the school district.

For Questions 6 and 7, the responses were reported collectively since the content in each of these responses was similar and administrators seemed to give much of the same feedback for each question.

Question 6: What circumstances led to the development of the master schedule as it exists today?

Question 7: What had been the history of the master schedule prior to these circumstances?

The collective response of all administrators was that many related factors played a role in the development of the master schedule. Testing results were low, feedback from teachers suggested that full year mathematics classes needed to be implemented at the lower levels, administrative observations were showing the inability of teachers to really keep the attention of the students for 90 minutes, and feedback from parents and students indicated that the long-term retention lacked because there was such a lapse between mathematics classes. Especially for IEP students and low-achievers, they needed continual exposure to the mathematics on a year-long basis.

Administrator 1 recalled:

The district initially tried just having the basic level mathematics classes as well as self-contained special education classes meet all year rather than on the block. The results from the students in terms of the year-long classes seemed to go well in the first year of implementation, at least they seemed to be more focused and performed better. Since the results from students in the college prep (CP) classes seemed to be stagnant or even moving backwards, the district entertained the notion of the classes at those levels trying the same schedule.

It was offered to each high school to extend the trial from the previous year and try full year mathematics classes at the CP level. One high school decided to go ahead and make this move while the other did not feel they could make it work at the time since they were going through building construction at the time. Therefore, the superintendent did not want to see additional stress on that high school by making the scheduling process more complicated.

Administration thought, “Hey, its two high schools, it’s a perfect opportunity to do some action research, so we will see if it works, and we will be better able to make informed decisions for the future.”

Hence, this case study arose out of the need for the school district to see improvements in their student achievement at both the applied and CP levels, while one school chose to change the schedule at both the applied and CP levels, the other school only chose to change the schedule at the applied-level.

The collective response of all administrators was that the honors and Advanced Placement (AP) classes remained untouched at each high school due to the students continuing to meet success at these levels within the classroom as well as being able to accelerate the number of courses they can take in mathematics prior to graduation.

Administrator 1 added:

When speaking with parents of honors students, they get very upset when you even think about going back to traditional because for them it’s giving them an opportunity to double up on their courses to take all their mathematics courses and get into AP Calc 1, AP Calc 2, and we’ve even implemented an AP Calc 3.

Our honors students have been doing well under the block so we did not see a need to change that.

Administrator 3, who also implemented CP classes as year-long courses indicated the following:

We were able to create in our building for the two lowest performing levels of students - the basic and CP level classes – a structure which allowed for 45-minute year-long classes. For those classes which are honors level or above, those students continue for a block for the semester. The driving force was the data from PSSA's, MAP scores, and collaborating with necessary stakeholders to look at something different which was within our control. We found the change would be of no cost to the school or district for us to deliver this instruction to see if it may make a difference among a certain population of students. These same data, according to the Pennsylvania Department of Education, are what placed the school in corrective action and thereby resulted in the need for a change. Within the parameters of a school improvement plan developed by our school leadership team, this “hybrid schedule” was something that our team determined may be beneficial to promote a difference in the data we were seeing.

Prior to this change every class in every subject area was conducted for a 90 minutes per day for half of the school year – the classic 4/4 block scheduling model.

Administrator 2 reported:

We decided that with the applied classes, in addition to larger numbers of special education students, the students seem to have an inability to concentrate for 90 minutes at a time. Even if you break the class up into 15 or 20 minute snippets

and you change the activity, which the mathematics teachers tried to do, their attention span was limited and as a result I felt we were losing 45 minutes a day of instructional time in mathematics. We could not afford to do that so we decided to try the year-long, 45-minute model with those classes alone. It is very difficult doing a decent schedule because we are now doing a hybrid, but we were committed to the cause. Since mathematics is the area we did not make AYP last year, mathematics was our focus. So for us we felt especially for the applied kids, if we do not give them that class year-long by the time they're eleventh grade year came along they are going to forget tremendous amounts of material and we are not going to be able to effectively do any kind of review. We tried a number of different strategies in the past such as after-school tutoring, pull-out classes, and the "Edge" program to give additional remediation to students who were not demonstrating proficiency. These programs, while helping, did not seem to be enough. So our philosophy is that perhaps having the kids in Edge classes all year and in 45 minute mathematics classes all year will effect a better change."

Question 8: Is the district/building showing any overall differences in student academic achievement since the implementation of the new method of scheduling?

While this information was also ascertained in the quantitative data, it was the intent of this question to discover if the administrators were noticing the same results that the data were indicating and to perhaps offer their opinions about the causes as well as observations of change not able to be uncovered by the numerical data. Administrator 1 reported:

As we look at their PSSA data and MAP data, we have seen good growth, especially at the high school implementing the full year mathematics program at both the applied and CP levels. Last year (07-08) they made about 10% improvement overall, and the results for this year (08-09) show they went up another 6% which is phenomenal. They went from 38% proficiency two years ago (06-07) to about 50.6% proficient which shows phenomenal growth. The 08-09 school year was the first year implementing the hybrid among the applied and the CP level classes. Preliminary data also indicate that the increased growth for this year should ultimately move the school into safe harbor.

In terms of the other high school, they have also done better. The applied students have done better, not necessarily as well as Administrator 2 feels they should but it takes more than one year to get something done. So we're going to continue to do it, we also did different strategies for all the juniors with study island implementing that to try and get them a review. And for the students we try to back it up against a 45 minute Edge classes so in effect they are getting a block of mathematics a day, but it was different. I think we are going to make progress again this year. I don't think as a district or as a school we could have tried harder. I mean we changed many things around this year, I mean major overhaul.

The responses of Administrators 2 and 3 corresponded with this response from Administrator 1.

Question 9: Have there been any other district/building changes as a result of the new scheduling method?

Administrators 2 and 3 collectively reported both advantages and disadvantages that came about as a result of the change in the master schedule to allow for applied mathematics classes, and CP classes for one school, to meet full year in the midst of a primarily 4/4 block master schedule. Administrator 2 experienced the following:

We had to change things that made other things more difficult to schedule. If you add another 45 minute English class, which we did, and you add another 45 minute CP, now there are three things that you can't move. It's almost like we are creating a new fruit. I mean you can do a little bit, but the difficulty comes when students are at the applied-level for mathematics, but at the CP level for English. Unless the CP classes are also on the 45 minute schedule, it is very difficult to get the schedule to work out for that individual student.

As a result, additional remedial mathematics and English classes were added that met for 45 minutes every day for a semester as well as PE/Health classes that were able to balance the 45 minute mathematics/English classes. They noted it was very difficult to do, but with the rise in technology being utilized to build a master schedule, it is certainly possible if all student choices/recommendations and all building parameters are loaded into the system in advance, it should be able to develop a good base schedule from which to make alterations to allow the most students to be scheduled fully without conflicts and then the individual conflicts must be resolved with the students individually in terms of electives.

Administrator 3 noted:

The advantages were that reports coming from students, parents, and staff showed a decrease in frustration that maybe was being experienced by some students as a result of the 90 minute block mathematics class. Their ability to maintain attention, to stay focused and to work well with that teacher certainly was much higher in addition to diminishment in the frustration of the students. While frustration and performance are difficult to measure, one could look at feedback and assume a correlation in academic performance, in that, the better the students feel about the class, the better they can perform as a result.

Additionally, Administrator 1 discussed the feedback received from talking with teachers as follows:

At the district office, we have had informal conversations with teachers who are implementing the “hybrid” schedule. The comments which are being reported by those teachers are very positive and complimentary such as the following. “We not only got through the curriculum, but we were able to go on to the next level, for example, we got through all of the CP curriculum and are getting into some of the honors material.”

All three administrators have also found that the teachers, indeed, have gotten through more of the curriculum than they had on the semester schedule. They felt this feedback has certainly indicated that the changes have made a profound difference. Administrator 2 added, “Also, because it is 45 minutes, teachers have stated that they are able to keep the attention of the students and there are not as many disruptions within the classroom.”

Question 10: Do teachers vary their instructional practices based on the schedule upon which they are instructing?

Based on formal observation and “learning walks”, the administrators each reported that some teachers are differentiating their classroom instruction based on the needs of the students, but the practices need to improve and they need to be more widespread. The district is planning professional development to assist the teachers with grouping students based on needs and providing multiple modalities of activities to encourage the students to be instructed in a manner that fits their particular learning style.

Instructional delivery seems to be better than before in that there is less lecture and more cooperative learning, chunking, student discussion, small groups, guided practice and scaffolding of instruction that allows for gradual release of responsibility. There is also opportunity to integrate technology into the classroom with the use of SMART Boards, CPS Clickers, Graphing Calculators and instructional websites like Study Island and Compass Learning. This is especially necessary in those classes where students are not as apt to be motivated to learn mathematics. It becomes incumbent on the teacher to create enthusiasm and generate interest by connecting the instruction to real world application and student learning style.

Administrator 2 added:

It is imperative that the teachers make adjustments in how they are delivering their instruction since some of the classes meet for 90 minutes and others meet for 45 minutes. The length of the class determines how many different types of activities take place. Those teachers who are meeting with success have classroom environments which are extremely structured and are designed to move

the students from one activity to another. Their planning for the class is based on state standards and is connected to district curriculum which is also standards-aligned.

Question 11: What are the district/building policies/procedures governing the accountability of students with respect to results in testing?

All administrators responded that for the students that are not meeting proficiency on PSSA or as reflected through the MAP assessments, the district offers a math Edge class which is based on the standards and assessment anchors where the student has not met with success. The MAP assessment data are used to isolate those standards or strands in which a student may have deficiencies. The student would be enrolled in that course and receive the direct instruction in the areas where they were not proficient using Study Island along with explicit instruction in the areas of deficiency. The student is then expected by state regulation to take a senior retake in the subject areas that were not proficient in 11th grade.

In addition, Administrators 2 and 3 reported that each of the schools offer various incentives for students to prepare for the 11th grade PSSA exams as well as for those students who do meet proficiency expectations on the exam results. Students may be eligible to be entered into a drawing for an iPod for completing the Study Island preparation activities prior to the exam. For students who actually demonstrate proficiency on the PSSA, they have the ability to have senior release, privileged parking in their senior year, or the ability to choose more electives rather than having the Edge class. (Edge classes were designed to provide another level of remediation for students

whose MAP scores showed them to be below grade level as well as for 12th grade students who did not score proficient or higher on the PSSA.)

Question 12: Are there any mechanisms in place for remediating students who do not demonstrate proficiency on the assessments?

All administrators said that the school enroll students in a math Edge class in their senior year should they not be proficient on the 11th grade PSSA mathematics exam. They explained that the Edge course is designed to give explicit instruction in the strands where the student was not proficient and thereby prepares them for the senior retake exam which is proctored in October. Administrator 1 noted:

We do have tutoring services that I did not mention previously, after school and before school tutoring in some buildings and we do have the study island that we are having students work through; again that is a technology based program. Since tutoring occurs after school, we can't mandate it. We do mandate that students who don't do well do take the Edge classes so it's not always the same students, it can be, but it's not necessarily.

The Edge class continues until the end of the first semester and then continued remediation is dependent upon the results of the senior retest results. If the student is proficient on the retake, then they have met their graduation requirement for proficiency and not in need of any further remediation. Administrator 3 added:

The 11th grade students who are not proficient on the PSSA exam have the opportunity to demonstrate proficiency through the retest when they are in 12th grade. If they were not to find proficiency there, they would then be enrolled in the study island course with which to do so, and if at that point, they were still

not able to meet proficiency, there is also a district assessment that could be administered to demonstrate proficiency.

For students who are not proficient on the senior retake, they may demonstrate proficiency by completing all Study Island modules with a 70% rate of correctness. If the student is unable to complete this work by several weeks before the end of the school year, they may go through a series of school assessments to demonstrate proficiency either by taking the Study Island posttest, testing by individual assessment anchors through MAP, or by taking the district created proficiency exam. Administrator 2 further explained:

If they didn't pass the NWEA, before they took the PSSA, we did boot camps this year. We had two mathematics teachers do pullouts with 180 kids. These kids were pretty close, but they may have been 5-10 points below. We offer after school tutoring, we put them in Edge classes, we have given them access to study island, strictly in grades 11-12. We will try to do some kind of tutoring during the day with pullouts to try to get them more proficient and we will try to get them into smaller classes. We try to have those students who need more support to be included with regular education students to create a co-teaching class so that there are two adults in there trying to help them.

Administrators' responses to all of the questions indicated they saw a need in terms of scheduling of mathematics classes based on student proficiency data. Based on their observations, they felt the schedule needed to be changed to facilitate better instructional practice and the ability for students to maintain continuity of mathematics instruction throughout the school year while minimizing the lag time between

mathematics courses. They specified that district policy and procedure had been consistently being followed in both high schools providing a level of consistency for instruction, assessment, and remediation.

Discussion of the Interviews and Focus Groups

The responses detailed in this chapter were evidence taken from the interviews of three administrators and the focus groups of 15 teachers from two high schools in one school district. The themes of the spacing effect, advantages of block scheduling, and disadvantages of block scheduling were evident in the responses of both the teachers and the administrators. Themes identified in the focus groups and interviews were presented as an analysis in correlation with the literature to provide examples of the teacher and administrator perspectives on student achievement that both preceded and followed the implementation of a traditional format for applied-level and college preparatory math courses.

Themes Identified in the Interviews

Teacher-Identified Themes

Persistent themes related to the research on block scheduling (Marchant & Paulson, 2001; Canady & Rettig, 1995) emerged during the analysis of the interviews with teachers as well as connections to spacing effect studies (Hintzman, 1974; Dempster, 1988; Dempster & Farris, 1990; Rohrer & Taylor, 2006). The themes regarding spacing effect are described in Table 8 as reported in the theory of Underwood (1961). The teachers identified classroom phenomena associated with the ideas of massed presentation/practice, distributed presentation/practice, and retention interval

repeatedly as their response discussed how students reacted to both the block and traditional scheduling formats.

The ideas contained within the theory of the spacing effect seemed to be reiterated again and again in the responses of the teachers. During the focus group, many of the responses seemed to focus on the distribution of material over a period of time to allow the students to have, as one teacher stated, “soak time.” The teachers felt strongly that when the material is presented over the full year rather than a semester allowing students to have ample time for practice, it allows them to better comprehend the concept and retain both the knowledge and the skill for a longer period of time. As Teacher 2B commented, “I like to stretch the material out over more days.” Whether it was described as absorption, digestion, crystallization, or soaking, it was evident that the teachers overwhelmingly felt most students needed to have the time to ponder the material before being presented with new material. Teacher 5B remarked, “mathematics has to be learned in small doses.”

Additionally, the teachers were clear in their feeling on massed presentation as well. They felt that instructing mathematics on the block for one semester forced the teacher to amass the presentation of the mathematics in such a way that the students were able to have short bursts of practice in class, but had to quickly move on to the next topic in order to cover all the curriculum by the end of the semester. They felt that the massed presentation and practice also did not give ample time to address problems with student practice as they needed to move on to the next topic too quickly. In fact, the teachers stated that the only way that the massed presentation was successful was with those students who were more avid mathematics students and therefore took honors courses.

The block did allow those students to take mathematics all year by taking two different courses. As one teacher put it, “Kids need 180 days of mathematics, can we have 60-90 minute periods all year?”

Table 8

Themes that Demonstrate the Spacing Effect During Focus Groups Using Underwood’s Theory

| Persistent Themes (teacher-identified) | Number of Times Referenced in the Responses |
|--|---|
| Distributed presentation/practice | 24 |
| Retention Interval | 22 |
| Massed presentation/practice | 20 |

Note n = 15

Coupled with each of these presentation and practice ideas comes the issue of retention interval as well. In accordance with the theories of Underwood (1961), the teachers concur that the retention interval is longer when the presentation, and subsequent practice, of the material is stretched over a longer period of time. One teacher stated, “there is a benefit for students to digest the learning over time to aid in better retention.” If the retention interval is longer, then the achievement of students tends to be better (Rohrer et al., 2005).

The focus groups with teachers also reflected themes identified by Canady and Rettig (1995) regarding the concept of block scheduling and the advantages that come with utilizing this scheduling format as the basis for the development of a master schedule. These themes are identified in Table 9. Additional studies done by researchers have further demonstrated these same advantages seen in action within schools that have

adopted a block schedule (Knight & DeLeon, 1999; Veal & Flinders, 2001; Zepeda & Mayers, 2001; Hurley, 1997; Staunton, 1997; Marchant & Paulson, 2001).

Although the teachers were in agreement that the retention level was better when the presentations and practice were distributed over time, they did note some positive aspects to the 4/4 block schedule which also played a large role in the decision of the school district to only modify the applied-level and college-preparatory mathematics classes. The most prominent advantage noted was that the 90 minute period did afford the teachers the time within a single class period to both deliver direct instruction and to implement a variety of additional instructional strategies including projects, more discovery and technology infusion. This ability to provide more varied strategies also lent itself to facilitating teachers in going more deeply into the instruction at times when they were not moving through two topics at once.

While not mentioned quite as often as varied techniques and depth of instruction, a prominent reason for maintaining block scheduling among honors and advanced placement leveled courses was the ability for students to “double-up” on mathematics courses as the block did afford them the opportunity to take two mathematics courses in the same year. This was especially necessary when successive courses have prerequisite knowledge that is expected such as Algebra 1 and Algebra 2. The teachers felt that the block did allow students to have better course grades as they were able to earn more grades for completing projects, the ability to incorporate activities and grades appealing to multiple intelligences, and shorter term goals as they completed units much more quickly. Finally, they felt that there was a better rapport between teachers and students since they spend more time with one another, the teachers are juggling less students, and

it allows the teacher “to be more relaxed, to talk about yourself more, and to get to know your students better,” as Teacher 6A revealed.

Table 9

Themes that Demonstrate the Advantages of Block Scheduling During Focus Groups Using the Theory of Canady and Rettig

| Persistent Themes (teacher-identified) | Number of Times Referenced in the Responses |
|--|---|
| Varied instructional strategies | 22 |
| More depth of instruction | 15 |
| Acceleration of upper-level students | 12 |
| Better course grades | 7 |
| Better teacher/student rapport | 7 |

Note. n = 15

The teachers were also quick to share the disadvantages that came as a result of the block schedule which is in direct correlation to other researchers who have discovered the same dichotomy (Marchant & Paulson, 2001; Knight & DeLeon, 1999; Trenta & Newman, 2002; Evans, Rice, & McCray, 2002; Lawrence & McPherson, 2000; Thomas, 2001; Hurley, 1997; Gruber & Onwuegbuzie, 2001). The most notable study within this group is the one by Marchant and Paulson (2001) which describes a host of problems associated with the implementation of the block schedule purported by Canady and Rettig in 1995. Based on their research, many schools adopted this scheduling format and while several researchers had proposed some disadvantages, empirical data were not really available until the study done by Marchant and Paulson (2001). These themes are categorized in Table 10.

As discussed by each of the participants, there are many disadvantages to taking mathematics courses on the block schedule for 90 minutes per day for half of the school year. The teachers in their focus group frequently spoke about the attention and engagement of students when taking a course for 90 minutes per day. The teachers described not only the fact that the attention spans of students may not last the length of the period, but also the fact that this much material in a single period seems to be information overload causing the students to shut down after the first topic. The teachers also discussed the ability of students to have long-term retention when so much is thrown at them in one setting without sufficient “soak time” to practice before more is given the next day.

Additionally, the teachers described utilization of class time as a factor in student success in mathematics and feel that the traditional schedule allows them to utilize the class time more appropriately than does the 90 minute schedule. They cite that much time is devoted to students completing homework in class and that time tends to be wasted because it is difficult to motivate non-honors students to continue to persevere a full 90 minute period. The lack of variation in instructional technique is also noted by teachers as they discuss what disadvantages there may be to the 90 minutes period. Once again, the teachers feel the stress of having to complete twice as much material each day and therefore find themselves simply using the same methods as a 45 minute class for twice the amount of time in order to ensure they have covered a sufficient amount of material each day to have students ready to move on at the end of the school year.

As reflected in Table 10, the teachers’ responses echoed the importance of taking mathematics classes continuously rather than having large gaps of time between courses

which many times happens within the semestering format of the 4/4 block schedule. A student may have a mathematics course in the fall of one school year and then not again

Table 10

Themes that Demonstrate the Disadvantages of Block Scheduling During Focus Groups Using the Theory of Marchant and Paulson

| Persistent Themes (teacher-identified) | Number of Times Referenced in the Responses |
|---|---|
| Attention/engagement of students | 26 |
| Less long-term retention | 22 |
| Utilization of class time | 15 |
| Lack of varied instructional strategies | 14 |
| Too much time between courses | 13 |
| Magnification of absences | 8 |

Note. n = 15

until the spring semester of the following school year. This hiatus could be as much as one full year without any mathematics instruction and teachers overwhelmingly agree that mathematics skills need to continue to be sharpened on a regular basis, like playing a sport. Finally, the teachers have observed that when a student misses a day of mathematics class due to illness, due to changes in school schedule, playing a sport or being involved in other activities, that they have a hard time catching up with the material lost on the block schedule as it tends to be twice as much material and typically two topics that build on one another. Since much of this is out of the control of the teacher, they feel the magnification of absences from class unduly hinders a student from being able to achieve well.

Administrator-Identified Themes

The responses of administrators during their interviews showed similarities to the responses of the teachers. The interviews with the administrators also revealed themes connected with the spacing effect consistent with Underwood's (1961) theory. Table 11 represents the themes indicated by the administrators categorized and tallied.

Table 11

Themes that Demonstrate the Spacing Effect During Interviews Using Underwood's Theory

| Persistent Themes (administrator-identified) | Number of Times Referenced in the Responses |
|--|---|
| Retention interval | 5 |
| Distributed presentation/practice | 3 |
| Massed presentation/practice | 1 |

Note. n = 3

In this school district, the administrators did not have a large quantity of data which corresponded to the theory of the spacing effect directly in their responses, but much more was implied as they discussed the lengths to which they went to change the schedule in connection with school improvement plans. These plans were designed to assist with the long-term retention necessary to achieve well on summative assessments taken in 11th grade meant to assess all mathematics that had been learned in high school to that point. The administrators did make seven overt references to the spacing effect when the assistant superintendent for curriculum mentioned "the fact that retention was not there because there was such a lapse of time between classes." She also recalled that the administrative team felt that students "needed continual exposure to mathematics on a

yearlong basis.” One principal also noted that “unless you keep practicing something, you are going to lose it.....by the time they get to 11th grade, they are going to forget tremendous amounts of material.” In all cases the spacing effect is clearly one topic on the minds of the administrators when making the change to the hybrid schedule. One last note comparing massed presentation to distributed presentation from the experience of Administrator 2 is “you can’t just sit there and teach, teach, teach, teach. Unless you do like 10-15 minute lessons and then practice, you’re going to lose them.”

There are advantages that come from block scheduling as indicated in the research. In Table 12, the themes identified by Canady and Rettig (1995) are summarized from the interviews with the administrators. The administrators described the varied use of instructional strategies as a key element for block scheduling to really be done effectively. There was some conversation that the teachers were not using varied instructional strategies enough in spite of having had a great amount of professional development devoted to teaching in the block. The administrators did mention that there had been some time since this professional development had happened along with the continued need to cover more material that may have led to less variance in instructional strategy taking place.

During the interviews, the administrators also described the importance of the honors level students being able to accelerate through the curriculum and double up on courses each year so they could be adequately prepared for entering college degree programs in a mathematics-related field. Additionally, the administrators mentioned some of the other positive aspects of block scheduling such as being able to go deeper in

a course, better grades on the short-term assessments and course results, and better relationships being formed between teachers and students.

Table 12

Themes that Demonstrate the Advantages of Block Scheduling During Interviews Using the Theory of Canady and Rettig

| Persistent Themes (administrator-identified) | Number of Times Referenced in the Responses |
|--|---|
| Varied instructional strategies | 5 |
| Acceleration of upper-level students | 2 |
| More depth of instruction | 1 |
| Better course grades | 1 |
| Better teacher/student rapport | 1 |

Note. n = 3

While the administrators discussed advantages of block scheduling in their interviews, the focus of conversation was overwhelmingly on the disadvantages of block scheduling as evidenced in the data contained in Table 13. This focus on the disadvantages of block scheduling is consistent to the theories of Marchant and Paulson (2001) in regard to data from schools that had moved to block scheduling.

Attention and engagement of students seemed to be the most prevalent theme in the responses of administrators as it was in the responses of the teachers. The administrators feel that especially among “applied students, it is difficult for them to attend.” “Their attention span was limited and as a result we were losing 45 minutes a day on instructional time in mathematics.” All three administrators felt it was really difficult for teachers to “keep their attention for 90 minutes. Much of the lack of

attention among students may be due to the observations of administrators that teachers were not varying their methods of instruction enough to hold the attention of the students

Table 13

Themes that Demonstrate the Disadvantages of Block Scheduling During Interviews Using the Theory of Marchant and Paulson

| Persistent Themes (administrator-identified) | Number of Times Referenced in the Responses |
|--|---|
| Attention/engagement of students | 8 |
| Lack of varied instructional strategies | 6 |
| Less long-term retention | 5 |
| Utilization of class time | 3 |
| Too much time between courses | 3 |
| Magnification of absences | 0 |

Note. n = 3

which was the second most prevalent theme among the administrators, in addition they are not using class time well. A teacher needs to prepare “hands-on or small, like 10-15 minute lessons, whether its in think-pair-share, small groups, or having them up and putting stuff on the board and then explain it like they are the teacher.”

As described in the themes associated with the spacing effect from the administrator interviews, there was a great deal of concern regarding how much information the students were able to retain over a long term interval. Concerns were also raised about too much time between courses as indicated by some of the following statements. Administrator 2 stated:

Students may not have mathematics again until the following yearif you put a kid in and he has it in September, in 10th grade, if you are lucky he will have it again, or better still, will have it the second half of his 11th grade year and then he will take the PSSA's and have the class for maybe four weeks before taking the assessment.

One of the reasons Administrator 1 felt the students were not retaining the material for the assessments was “because of the lapse of time between mathematics courses.”

As identified in Table 11, Table 12 and Table 13, the administrators' responses reflected the effect that the spacing of presentation and practice has on the long-term retention of students. The administrators shared that these ideas were essential to the ability of students to retain information for long periods of time in order to achieve well on summative assessments. Additionally, the administrators connected these themes to both the advantages and disadvantages of block scheduling and their perception of the need to make a change to the schedule, but not to “throw out the baby with the bath water” so to speak. They felt they could keep the portions of the block schedule that seemed useful for the honors students in mathematics, but make changes as they saw the need for the applied-level students, and at one school, the college preparatory students as well. This hybrid schedule became the hallmark of helping those levels of students to have increases in their achievement scores as observed by the administrators in their responses. The next section is a review of the policies which govern the actions of administrators and school personnel in terms of curriculum, instruction, scheduling of classes, assessment, and graduation requirements.

Review of Policies and Documents Related to Curriculum and Scheduling

A review of policies and documents related to curriculum development and student scheduling was conducted as a part of this study. These documents were surveyed to ascertain if there was a connection between the actions of administrators and school personnel and the school board approved policies and procedures which guide them.

Listed below are the policies and documents which were reviewed:

- Policy 105, Curriculum Development,
- Policy 213, Assessment of Student Progress,
- Policy 217, Graduation Requirements,
- Board Approved Program of Studies,
- Student Handbook, and
- Assessment Criteria for Scheduling Students in Mathematics Classes.

In the district curriculum policy, Policy 105 - Curriculum Development as required by PA school code 1512 and Title 22, the important elements related to this study are that the board policy requires curriculum to be written in accordance with state standards, that courses are developed and adapted according to the age, development and needs of the student, and that remediation is provided for students who do not meet proficiency guidelines. These elements connect directly with the interview responses of administrators in terms of curriculum. It is also important to note that the curriculum is developed district wide so although there are two separate high schools, they each use the same curriculum developed by teachers from each high school in a joint initiative. The fact that curriculum is written in accordance with state standards ensures that the planned

curriculum is consistent with the assessed curriculum on both the PSSA exam and the MAP assessment which is also aligned to Pennsylvania academic standards.

Policy 213, Assessment of Student Progress, reflects the PA School Code 1531 and 1532. The policy states that both the PSSA and NWEA assessments are approved by the school board as a means to ascertain student achievement according to the state standards. In addition, school personnel have been given the authority to develop common assessments, which are used consistently district-wide, as a means of ascertaining student acquisition of curricular goals within individual courses. These assessments are meant to measure student academic progress, to measure achievement of academic standards, and to provide insight into assisting students, who are having difficulty, to meet those standards.

The PA School Code 1611 and 1613 governs policy 217, Graduation Requirements. The district policy, as it pertains to mathematics, requires a student to complete four credits in approved mathematics courses out of the total of 28 overall credits needed to graduate as well as the completion of a culminating graduation project. Students must also score proficient or better on the 11th grade PSSA mathematics exam or they may score proficient or better on the 12th grade senior make up PSSA mathematics exam or they must complete the district created mathematics assessment to meet proficiency requirements. Additionally, students may utilize a proficient score on the NOCTI exam, which is used for students attending a vocational or technical school, or demonstrate sufficient growth toward and achieving their IEP goals for graduation. Finally, a student may take individual modules of Study Island assessments which pertain specifically to

their area(s) of weakness to demonstrate proficiency for meeting the graduation requirement.

The Program of Studies, which is board-approved, provides the specific procedures that students and staff must complete in order to follow the mandates set forth in the policies described above. Three of the four mathematics credits necessary for graduation must be Algebra 1, Geometry, and Algebra 2 on either the applied, college preparatory, or honors levels. It gives the specifications for how classes are scheduled based on student choice, parent input, teacher recommendation, and utilization of MAP/PSSA scores. The Program of Studies provides course descriptions to aid students in choosing a class that best suits their needs and a further clarification of what students need to do to demonstrate proficiency for graduation.

The Board Policy and Program of Studies provide consistent guidelines for curriculum development, student assessment, graduation requirements, and scheduling of mathematics courses all of which play a role in the achievement of students. As in the responses of administrators, the curriculum is developed using a specific set of guidelines and according to state standards which ensure consistency in goals between schools with students who take courses at the same difficulty level. As the curriculum is written according to state standards, the assessments with which students are measured are aligned to state standards as well and therefore directly connected to the mathematics material learned by students. Graduation requirements are in concert with the guidelines for demonstrating proficiency on state assessments and student scheduling of courses is determined by the outcomes of those assessments, teacher recommendations based on success in previous mathematics courses, and parent/student choice. There is a

commitment by the district, reflected in both the policies and school philosophy, to provide an educational program that is consistently implemented in both high schools, in accordance with Pennsylvania Academic Standards and the State System of Assessment, to ensure that students are receiving the instruction according to their needs to meet the requirements put forth by the state and school district to graduate from high school.

Quantitative Data

Analysis of Student Assessment Data

This section summarizes the data collected from Performance Tracker, a data warehouse utilized by the school district to house and analyze student assessment data for the purpose making decisions on curriculum and instruction. The data collected were from MAP and PSSA assessments taken by students during the school years 2003-2010. The data were taken as an overall proficiency, proficiency broken down by course/level of study, and as a cohort over the course of three years of instruction/assessment. The goal of the data review was to determine if any statistically significant changes occurred in the assessment data as a result of the changes that occurred in master scheduling at the time.

Important to note as these data are reviewed is that each school in the district first implemented the full-year mathematics classes during the 2006-2007 school year. In addition, High School A implemented a full-year mathematics schedule for the college preparatory classes in the 2008-2009 school year, while High School B's master schedule for college preparatory classes remained as the 4/4 block schedule. Additionally, while PSSA data were available in Performance Tracker as early as the 2003-2004 school year, the data warehouse did not begin to break down scores by class and teacher until the

2005-2006 school year. MAP data were also not available in Performance Tracker until the 2005-2006 school year as disseminated by class and teacher so therefore the data prior to 2005 would not be sufficient in answering the questions posed by this study in regard to changes in student achievement based on the level of the class and the schedule on which the course is scheduled.

All scores were downloaded as a sterile list of proficiency percentages, scale scores and RIT scores free from any identifiable student data as Performance Tracker provides the ability to do so within the framework of its data gathering tools. The data were downloaded from the Performance Tracker database into an Excel Spreadsheet for data manipulation, calculation, and graph generation. Time-series graphs and descriptive data tables were constructed from the results received.

To answer the research question regarding student achievement data, this study looked at an array of figures containing time-series graphs based on the individual results of students on the Pennsylvania System of School Assessment (PSSA) and the Northwest Education Association (NWEA) RIT scores. These student results were contained in the Performance Tracker warehouse purchased for use by the school district to analyze student assessment data. PSSA proficiency and mean scale scores were reviewed for the entire 11th grade student population as a whole from each high school for each year scores were available. Next, the PSSA proficiency, mean scale scores, and mean RIT scores were reviewed for students disaggregated by applied-level and college preparatory mathematics courses. Finally, the mean RIT scores were reviewed for cohorts of students over a three-year span of mathematics classes which were taken on both the block and

full-year model of scheduling. For each data comparison, a 95% confidence interval was utilized to demonstrate statistical significance.

Overall School Data for Each High School

Figure 1 and Figure 2 show the percentage of students scoring proficient or higher on the PSSA exam for each school year from 2003-2004 until 2009-2010. Each school demonstrated an overall increase in proficiency percentage over the course of interval. Furthermore, in the years prior to 2006-2007 each school was utilizing the block schedule for all classes, but after 2006-2007 each school had altered the schedule to utilize the full-year format for all applied-level courses. In addition, High School A implemented the full-year format for college-preparatory courses beginning with the 2008-2009 school year. The number of students who demonstrated proficiency was compared to the total number of students who took the exam to arrive at a percentage of students who demonstrated proficiency on the PSSA exam for each school year in each high school. In order to demonstrate proficiency, a student's mean scale score must fall in the range of scores assigned to the proficient or advanced ratings.

The percentage of proficiency for High School A increased overall by 24.81% over the total span of time while High School B increased overall by 26.38%. It is also important to note that in the years prior to 2006-2007, the overall increase of High School A was 9.15% for an average annual increase of 3.05%. This was followed by an overall increase of 14.51% in the years following 2006-2007 for an average annual increase of 4.84%. Additionally, in the years prior to 2006-2007, the overall increase of High School B was 11.87% for an average annual increase of 3.96%. This was followed by an overall

increase of 15.66% in the years following 2006-2007 for an average annual increase of 5.22%.

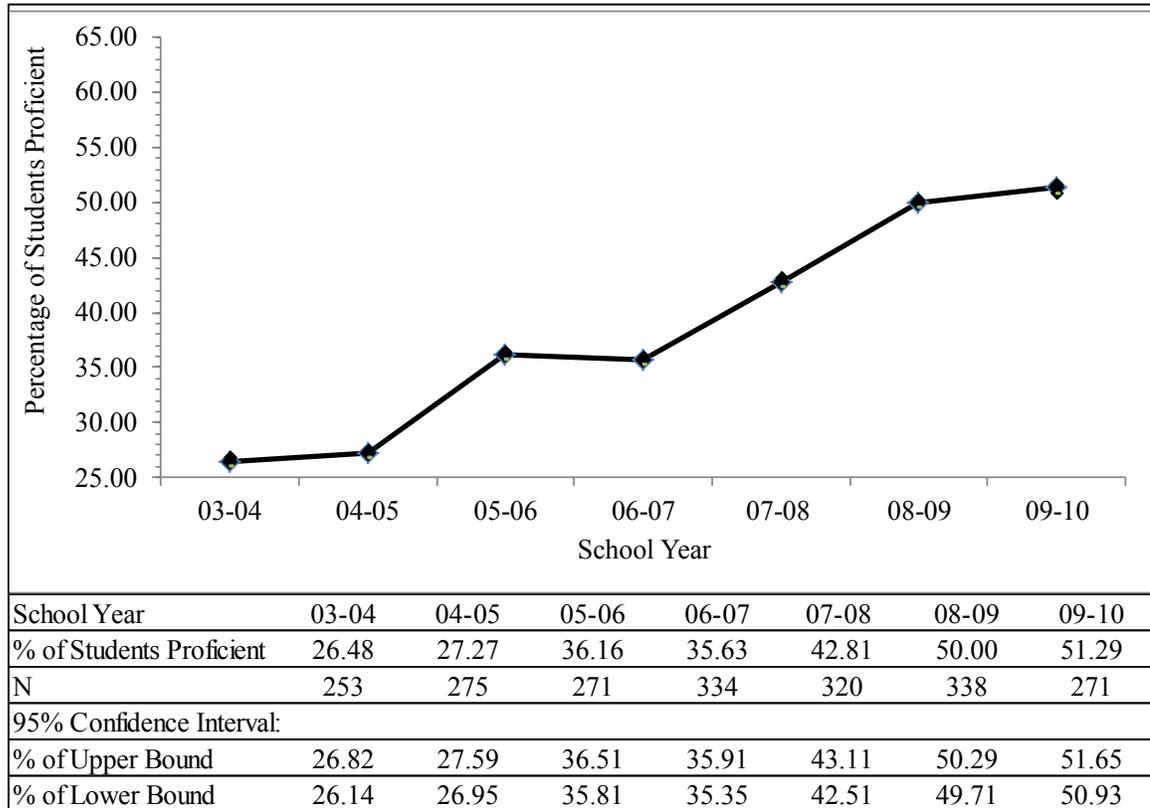


Figure 1. Time-series chart displaying overall percentage of 11th grade students who scored proficient or advanced on the PSSA mathematics exams from High School A. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses. The 2008-2009 school year was the first year that the full-year program was implemented for the college preparatory Algebra 1, Geometry, and Algebra 2 courses.

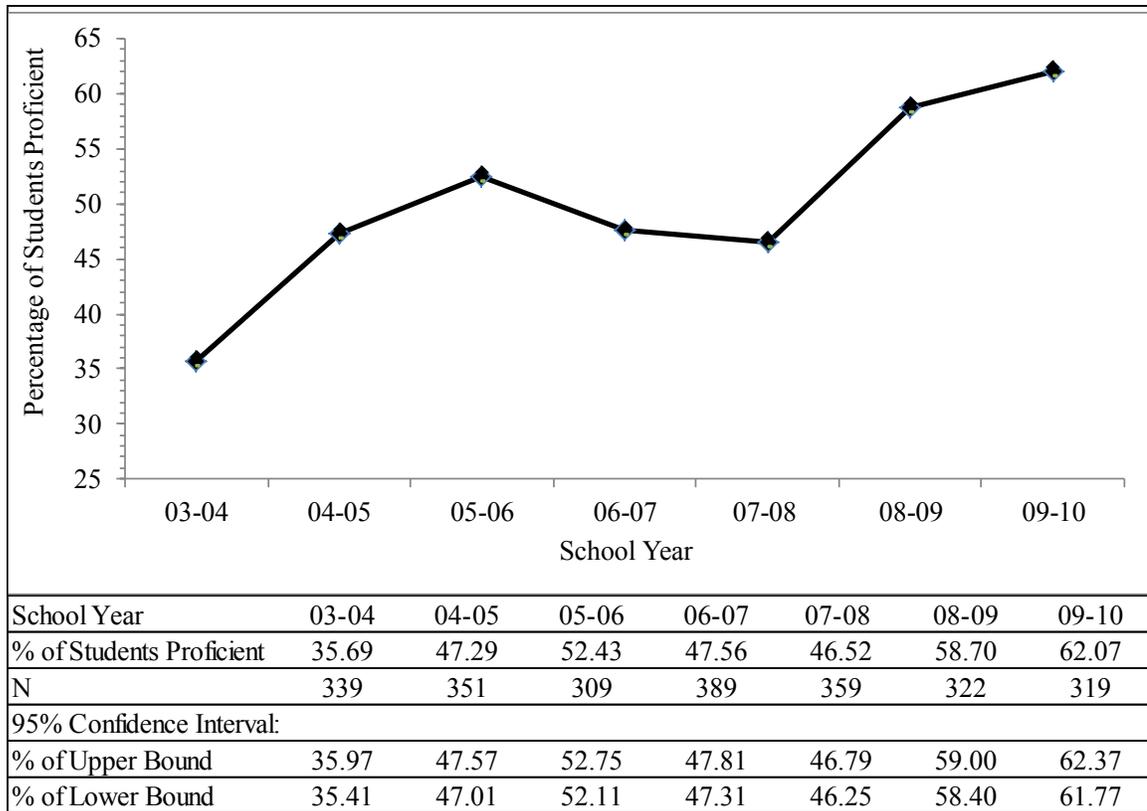


Figure 2. Time-series chart displaying overall percentage of 11th grade students who scored proficient or advanced on the PSSA mathematics exams from High School B. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses. High School B did not implement a full-year program for the college-preparatory courses during the time frame studied.

To determine if these changes in proficiency percentage were significant, the 95% confidence interval was applied to the data to determine if the error bars formed by the upper or lower bounds from one data point overlap with the error bars of a comparison data point. When looking at proficiency percentage for High School A, it is noted that all intervals in Figure 1 show significant changes save the change that occurred between the 05-06 school year and the 06-07 school year. In this interval, it was observed that the lower bound of 35.81% in 05-06 fell within the 95% confidence interval of 35.35%-

35.91% in 06-07 and therefore demonstrated the change that occurred between those two school years was not a significant event. All other comparisons in this figure did represent significant growth as indicated in Table 14.

Table 14

Statistical Significance of Changes to PSSA Overall Proficiency Percentage by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | + Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | + Sig | + Sig | + Sig |
| 2004-2005 | + Sig | + Sig | + Sig | + Sig |
| 2003-2004 | + Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | - Sig | + Sig | + Sig |
| 2005-2006 | - Sig | - Sig | + Sig | + Sig |
| 2004-2005 | + Non-Sig | - Sig | + Sig | + Sig |
| 2003-2004 | + Sig | + Sig | + Sig | + Sig |

Note. This table compares the percentage of students demonstrating proficiency on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident due to proximity to the mean the observer must use upper and lower bounds to draw comparisons.

+ = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

Similarly, when looking at the proficiency percentage in Figure 2 pertaining to High School B, it is noted that all intervals showed significant changes from year to year and therefore across the interval as well. Based on Table 14, the only data that were not

significant were the three year growth/decline data over the interval from the 04-05 school year to the 07-08 school year. In this case, the upper bound in 04-05 of 47.57% fell within the 95% confidence interval of 47.31%-47.81% in 07-08 and therefore showed the change that occurred over this three year span was not significant. However, for the purpose of this study, there was significant growth from 03-04 to 09-10 including large increases in the interval from 03-04 to 05-06 and in the interval from 07-08 to 09-10 when the applied-level students were being instructed in full year classes (See Table 14).

When examining the mean scale scores from the PSSA Mathematics exam of students from each high school, there was an overall higher increase in the years following the implementation of the full-year schedule for applied-level courses than in the in the years preceding that change in scheduling format. Figure 3 and Figure 4 show the mean scale scores of 11th grade students on the PSSA mathematics exams for each school year from 2003-2004 until 2009-2010. Each school demonstrated an increase in overall mean scale score over the course of interval. Furthermore, in the years prior to 2006-2007 each school was utilizing the block schedule for all classes, but after 2006-2007 each school had altered the schedule to utilize the full-year format for all applied-level courses. In addition, High School A implemented full-year format for college-preparatory courses beginning with the 2008-2009 school year.

The data from overall mean scale scores for High School B paints a slightly different picture as indicated by the chart in Figure 4. According to these data, the overall mean scale scores rose for the interval from 03-04 to 05-06 school years, fell between the 05-06 and 07-08 school years, and then rose again between the 07-08 and 09-10 school years. In the years prior to 2006-2007, the overall increase of mean scale scores was

3.33% for an average annual increase of 1.11%. This was followed by an overall increase of 4.52% in the years following 2006-2007 for an average annual increase of 1.51%. When comparing the data from successive years to find statistically significant changes based on the 95% confidence interval (See Table 15), it was noted that there

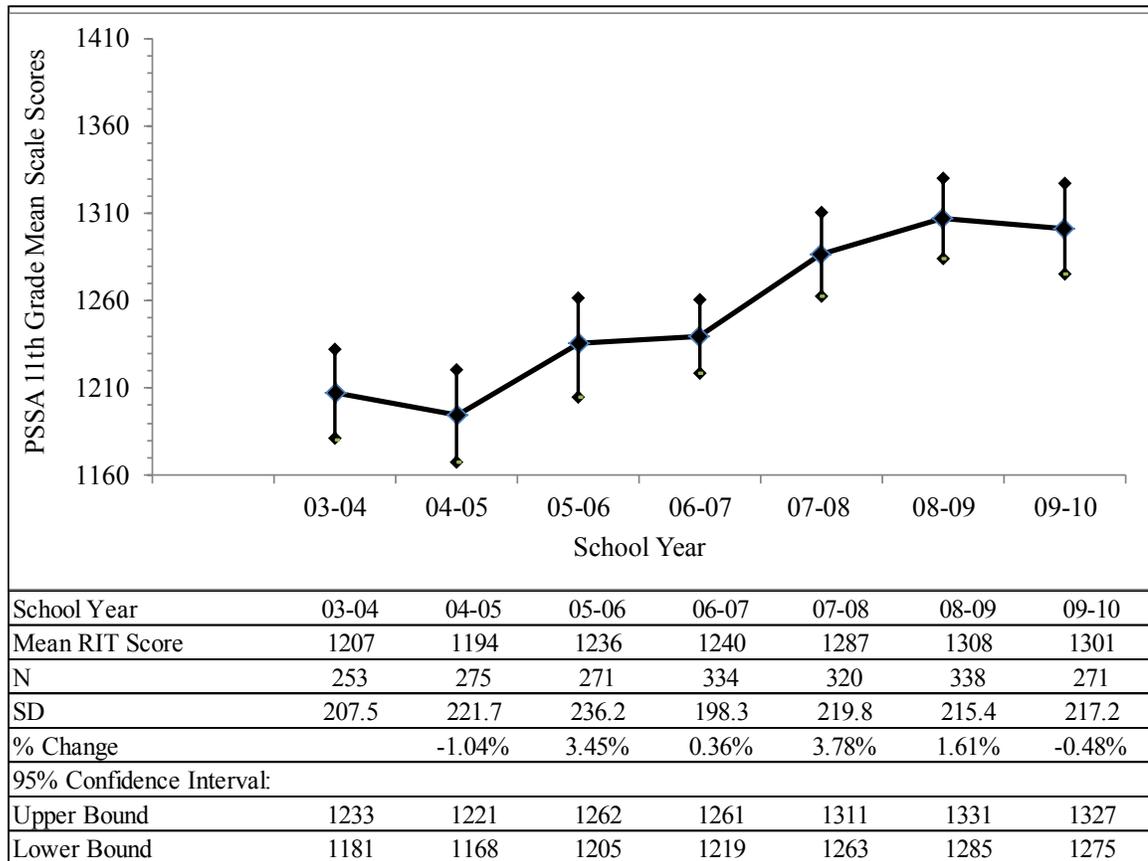


Figure 3. Time-series chart displaying overall mean scale scores on the PSSA mathematics exams of 11th grade students from High School A. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses. The 2008-2009 school year was the first year that the full-year program was implemented for the college preparatory Algebra 1, Geometry, and Algebra 2 courses.

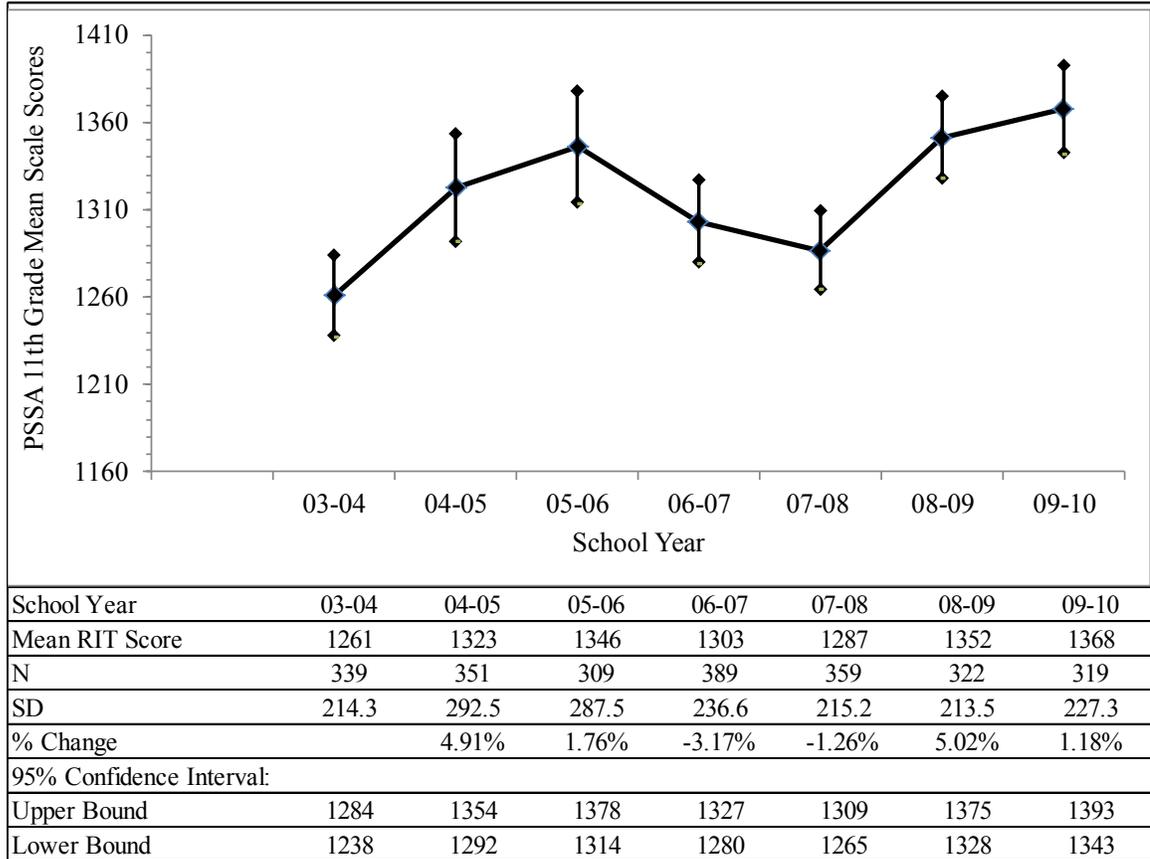


Figure 4. Time-series chart displaying overall mean scale scores on the PSSA mathematics exams of 11th grade students from High School B. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses. High School B did not implement a full-year program for the college-preparatory courses during the time frame studied.

were no overlaps in the intervals when comparing both the 03-04 and 07-08 school years to the final two years of data in 08-09 and 09-10. However, no other data between the 03-04 and 09-10 school years yielded significantly significant changes based on the confidence intervals (See Table 15).

Table 15

Statistical Significance of Changes to PSSA Overall Mean Scale Scores by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | - Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | + Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | + Sig | + Sig | + Sig |
| 2004-2005 | + Sig | + Sig | + Sig | + Sig |
| 2003-2004 | + Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | - Non-Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | - Sig | + Non-Sig | + Non-Sig |
| 2004-2005 | - Non-Sig | - Non-Sig | + Non-Sig | + Non-Sig |
| 2003-2004 | + Non-Sig | + Non-Sig | + Sig | + Sig |

Note . This table compares the overall mean scale scores on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons.
 + = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

In short, each school reported a positive trend with a steeper slope and higher average gains in the percentage of students scoring proficient or advanced on the PSSA exam in the years following the 2006-2007 school year than they did in the years preceding the 2006-2007 school year. Additionally, each school reported higher gains in the overall mean scale scores of 11th grade students on the PSSA mathematics exam in

the years following the 2006-2007 school year, than they did in the years preceding the 2006-2007 school year. The 95% confidence interval also confirmed statistically significant changes in data when comparing the 08-09 and 09-10 school years to previous years for both high schools, with High School A also showing statistically significant changes when comparing 07-08 to prior school years (See Table 15).

Applied-Level Data for Each High School

To determine the effect of the change in schedule on student achievement data for students in applied-level classes, overall PSSA proficiency, mean PSSA scale scores, and mean RIT scores of 11th grade students who took mathematics classes in applied-level classes were examined. These data were also obtained through the Performance Tracker system as there is a feature in its data mining tools that allows the user to separate student data based on class list. The student data were downloaded and analyzed based on students being in a class that has been determined to be at the applied-level. Time-series graphs were constructed for the test area of Mathematics based on the individual results of students on the PSSA and NWEA assessments as contained in the Performance Tracker program for the school district.

Figures 5 and 6 give proficiency percentages of applied-level students from each school. The number of students from applied-level classes who demonstrated proficiency on the 11th grade PSSA mathematics exams was compared to the total number of students from applied-level classes who took the exam to arrive at a percentage of students who demonstrated proficiency on the PSSA exam for each school year in each high school. The earliest data contained in Performance Tracker based on class lists for results on the PSSA exams were from the school year 2005-2006 and continued up to and including the

school year 2009-2010 for each high school. Each of these figures shows the percentage of applied-level students scoring proficient or higher on the PSSA exam for each school year from 2005-2006 until 2009-2010. Each school demonstrated an overall increase in proficiency percentage for applied-level students over the length of interval.

Furthermore, in the one year prior to 2006-2007 each school was utilizing the block schedule for all classes, however beginning in 2006-2007 each school had altered the schedule to utilize the full-year format for all applied-level courses.

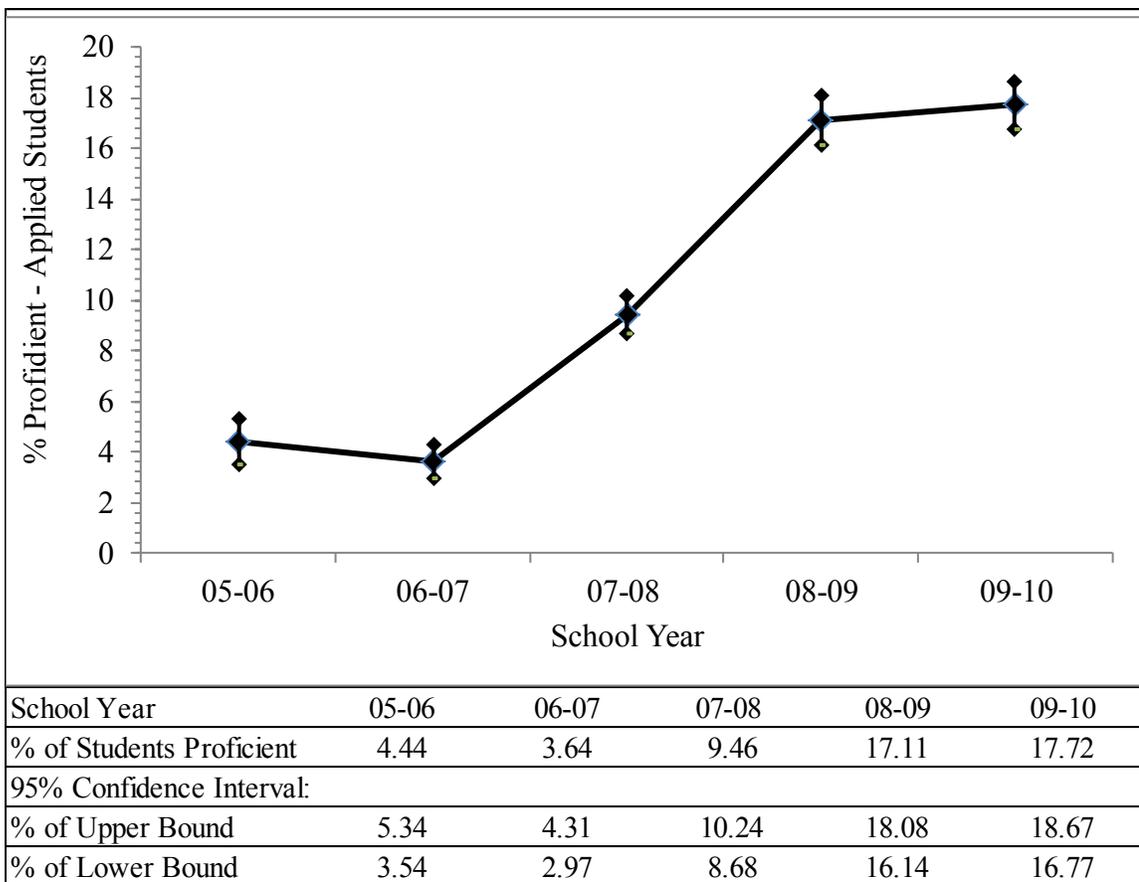


Figure 5. Time-series chart displaying percentage of 11th grade applied-level students who scored proficient or advanced on the PSSA mathematics exams from High School A. No specific class data exist for the school years prior to 2005-2006. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

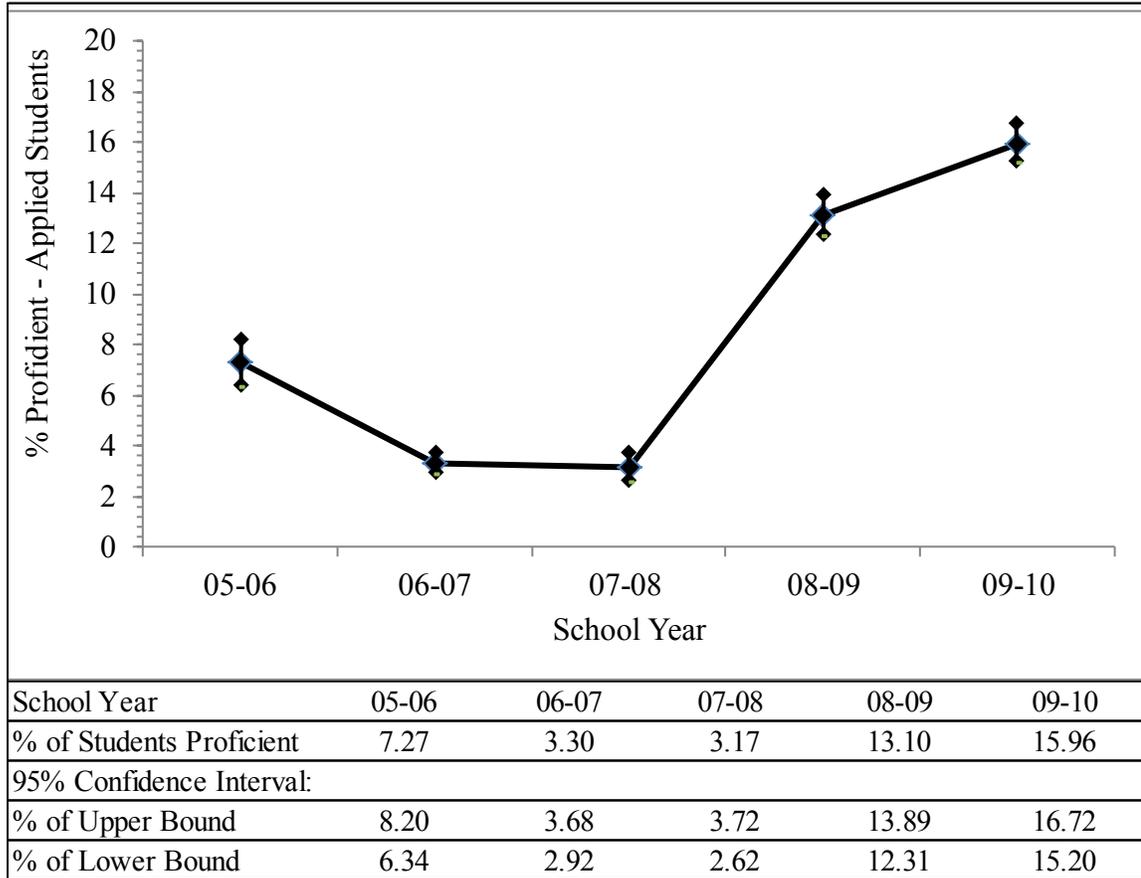


Figure 6. Time-series chart displaying percentage of 11th grade applied-level students who scored proficient or advanced on the PSSA mathematics exams from High School B. No specific class data exist for the school years prior to 2005-2006. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

The percentage of proficiency for applied-level students at High School A increased overall by 13.28% over the total span of time while High School B increased overall by 8.69%. It is also important to note that in the one year prior to 2006-2007, there was a slight .8 % decrease at High School A. This was not statistically significant

based on the 95% confidence interval (See Table 16). This was followed by an overall increase of 14.08% in the three years following 2006-2007 for an average annual increase of 4.69%. Since the upper and lower bounds do not overlap when applying the 95% confidence interval, these changes in data are considered statistically significant (See Table 16) in the three years following the implementation of the new schedule.

Table 16

Statistical Significance of Changes to PSSA Applied-Level Proficiency Percentage by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | + Sig | + Sig | + Sig |
| 2005-2006 | + Non-Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | - Non-Sig | + Sig | + Sig |
| 2005-2006 | - Sig | - Sig | + Sig | + Sig |

Note . This table compares the percentage of applied level student demonstrating proficiency on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons.

+ = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

Additionally, in the one year prior to 2006-2007, there was a decrease of 3.97% at High School B. This was followed by an overall increase of 12.66% in the three years following 2006-2007 for an average annual increase of 4.22%. When applying the 95%

confidence interval to High School B, it was evident that in the first year following the new schedule implementation there was significant decline which was then followed by one year that did not have significant growth (2007-2008). There was, however, significant growth in the next two years (2008-2009, 2009-2010) as the upper and lower bounds of the 95% confidence interval do not overlap those of either the 2005-2006 or 2006-2007 school years (See Table 16).

Another measure of student achievement which was recorded and analyzed was the individual mean scale score from the PSSA Mathematics exam of applied-level students from each high school. These scale scores were also downloaded from the Performance Tracker database. When the mean scale scores were examined from the PSSA Mathematics exam of 11th grade applied-level students from each high school, consistent increase was able to be seen in the years following the implementation of the full-year schedule for applied-level courses.

Since mean scale scores represent an average of all students in the applied-level courses, the percentage of growth each year will not be as dramatic as is realized in the percentage of proficiency. When determining percentage of proficiency, each individual student counts as one unit and therefore each student who is not proficient, whether by 2 points or 200 points, impacts the overall percentage in a consistent manner. Conversely, when scale scores are averaged to find the mean, an extremely low non-proficient score has a larger impact on the overall mean than does a non-proficient score that is slightly below the proficiency threshold. For this reason, the percentages while increasing for mean scale scores did not show as dramatic a level of growth as will the proficiency percentage.

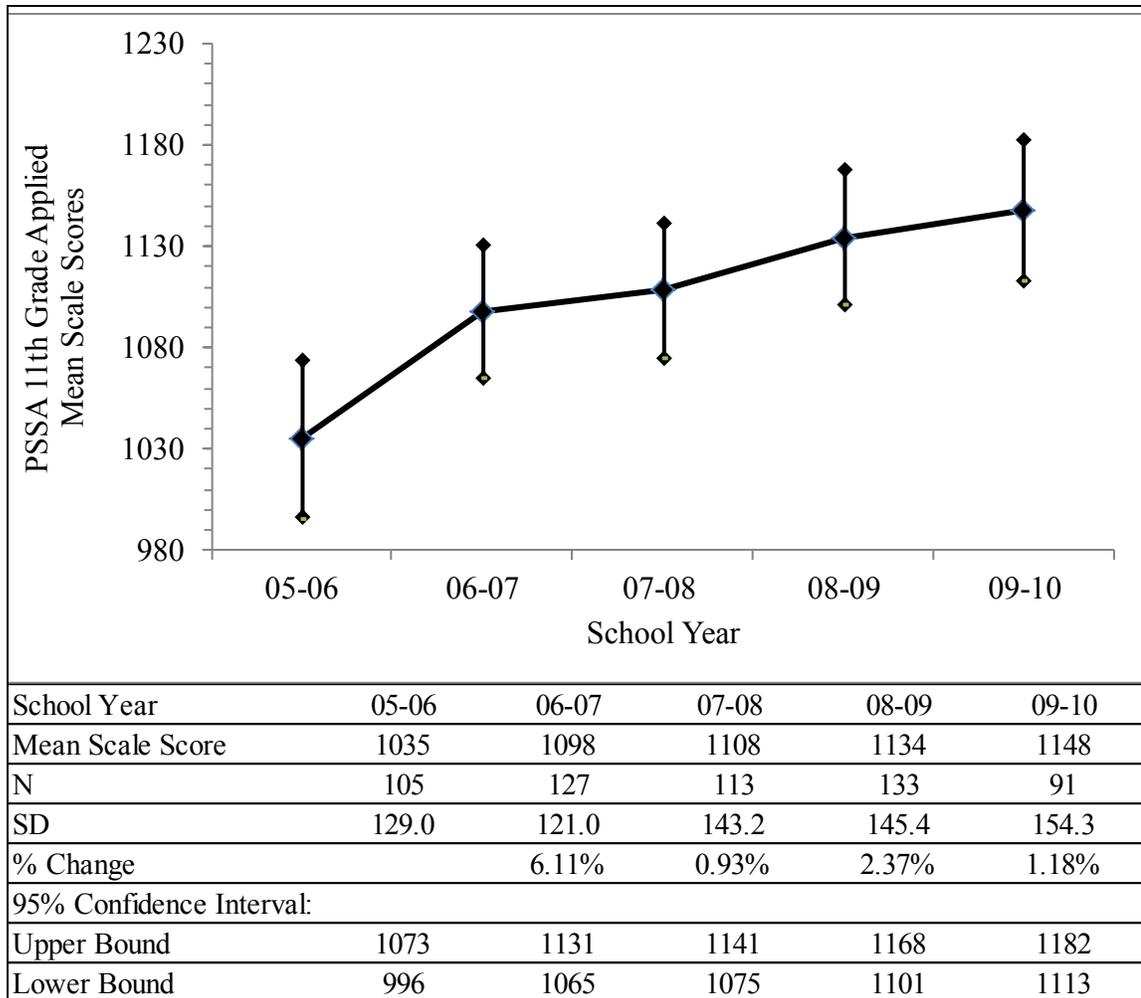


Figure 7. Time-series chart displaying the mean scale scores of applied-level students on the PSSA mathematics exams of 11th grade students from High School A. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

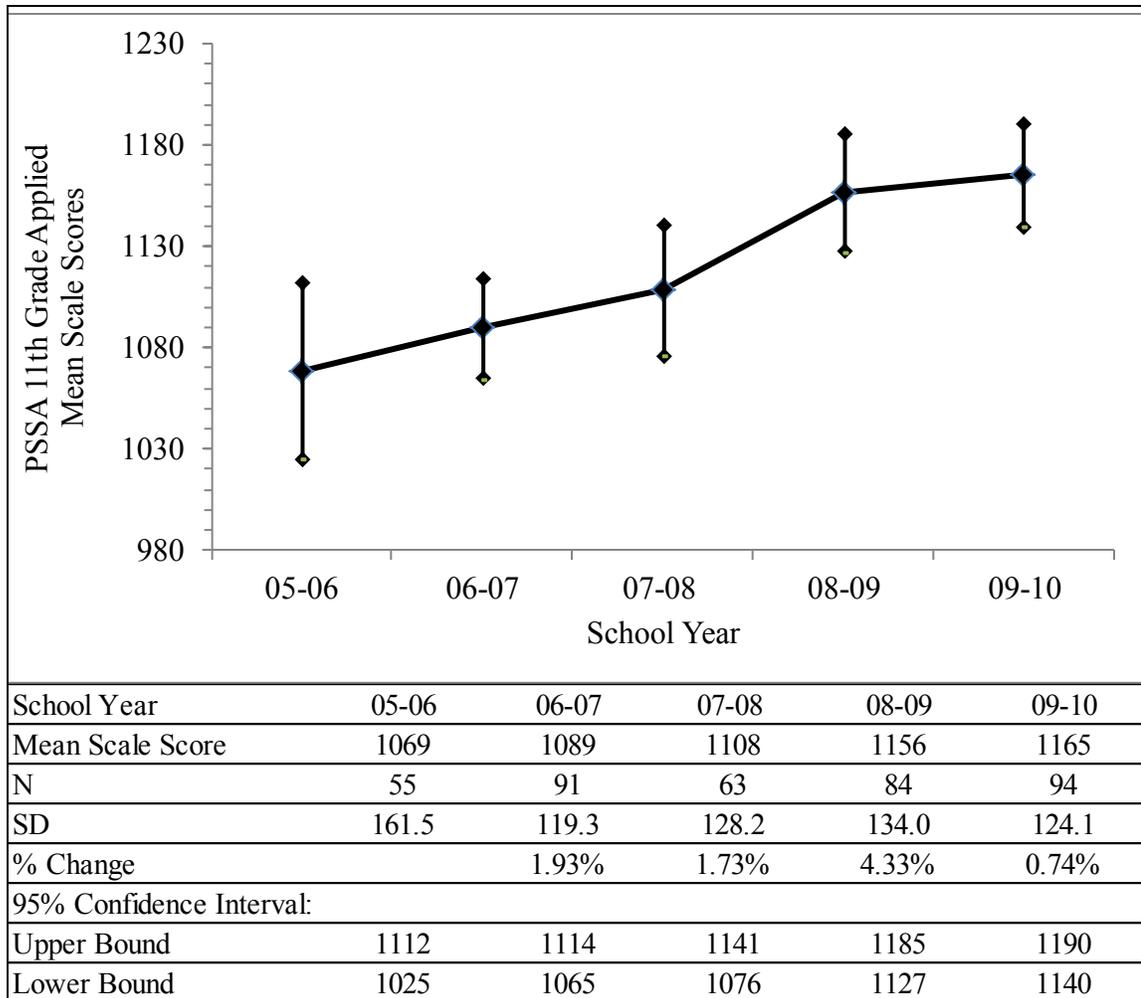


Figure 8. Time-series chart displaying the mean scale scores of applied-level students on the PSSA mathematics exams of 11th grade students from High School B. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

Figure 7 and Figure 8 are time-series graphs of PSSA mean scale scores as housed in Performance Tracker for each high school. Each of these figures shows the mean scale scores of applied-level students on the PSSA mathematics exam for each school year from 2005-2006 until 2009-2010. Both schools demonstrated an overall increase in mean scale score for applied-level students over the course of interval. Furthermore, in the one

Table 17

Statistical Significance of Changes to PSSA Applied-Level Mean Scale Scores by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | + Sig | + Non-Sig | + Non-Sig |
| 2005-2006 | + Non-Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | + Non-Sig | + Sig | + Sig |
| 2005-2006 | + Non-Sig | + Non-Sig | + Sig | + Sig |

Note . This table compares the applied-level mean scale scores on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons. + = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

year prior to 2006-2007 each school was utilizing the block schedule for all classes, but after 2006-2007 each school had altered the schedule to utilize the full-year format for all applied-level courses.

The mean scale scores for applied-level students at High School A increased overall by 113 points over the total span of time while High School B increased overall by 86 points. For High School A, the 113 point increase over the four year interval represents an overall growth of 10.91% for an average annual growth of 2.73% per year.

For High School B, the 86 point increase over the four year interval represents an overall growth of 7.90% for an average annual growth of 1.97% per year.

When the 95% confidence interval was applied to the data, it was clear that for High School A each successive year shows no statistically significant changes, however, when comparing the 2007-2008, 2008-2009, or 2009-2010 school years to the 2005-2006 school year there was significant growth as the bounds of the interval do not overlap. The confidence interval for High School B showed a similar trend, however, it is not until the 2008-2009 and 2009-2010 school years that significant growth is achieved when compared with the data from 2005-2006 (See Table 17).

The final measure for 11th grade applied-level students which was reviewed and analyzed in this study was the mean RIT score from the Northwest Evaluation Association (NWEA) Measure of Academic Progress (MAP) assessment. This assessment is given at the beginning and end of a mathematics course to show student growth as they complete a mathematics course. To maintain consistency with the PSSA exam, the contents in Figure 9 and Figure 10 are taken from posttest of students exiting the applied-level Algebra 2 exam, which for the vast majority of students is the end of the 11th grade year.

In order to show change in achievement, the end of year mean RIT scores from the MAP assessment of 11th grade applied-level students were put into time series graphs for each school as another measure of change. Note that since this exam is a post test, the retention interval for the MAP assessment is much shorter than the PSSA exam which is a summative assessment of three years of high school mathematics. With the retention interval being shorter there is less of an impact from the spacing effect, but still an impact

nonetheless. (Underwood, 1961). RIT scores from MAP assessments are also housed in the Performance Tracker data warehouse and are available for download by course and level. In this case the scores were located in Tracker based on whether they were an applied-level Algebra 2 course for each year the data were available. As indicated earlier, class data are only available beginning with the 2005-2006 school year. Each of these figures shows the mean RIT scores of applied-level students on the 11th grade NWEA MAP assessment each school year from 2005-2006 until 2009-2010.

High School A demonstrated an overall increase in mean RIT score for applied-level students over the course of interval beginning with a mean RIT score of 219 in 2005-2006 and ending with a mean RIT score of 237 in 2009-2010. This move from 219 to 237 is an 18 point increase in mean RIT score over the 4 year interval with an average annual increase of 4.5 points per year. At the time of these assessments, the RIT score range for a student on grade level was expected to be 248-251 for 11th grade. Note that for a student to be on grade level in 9th grade, the RIT score must be in the 240-243 range and to be on grade level for 10th grade, the RIT score must be in the 244-247 range.

This group of students who had, on average, been traditionally well below grade level by several years mathematically in the years leading up to and including 2005-2006, were now demonstrating near grade level performance on average by the time they have reached the 2009-2010 school year. Furthermore, since the range of scores needed to demonstrate proficiency rises by about four points per school year, each successive class from 2005-2010 made more than one year of growth with an average gain of 4.5 points of growth on the RIT scale.

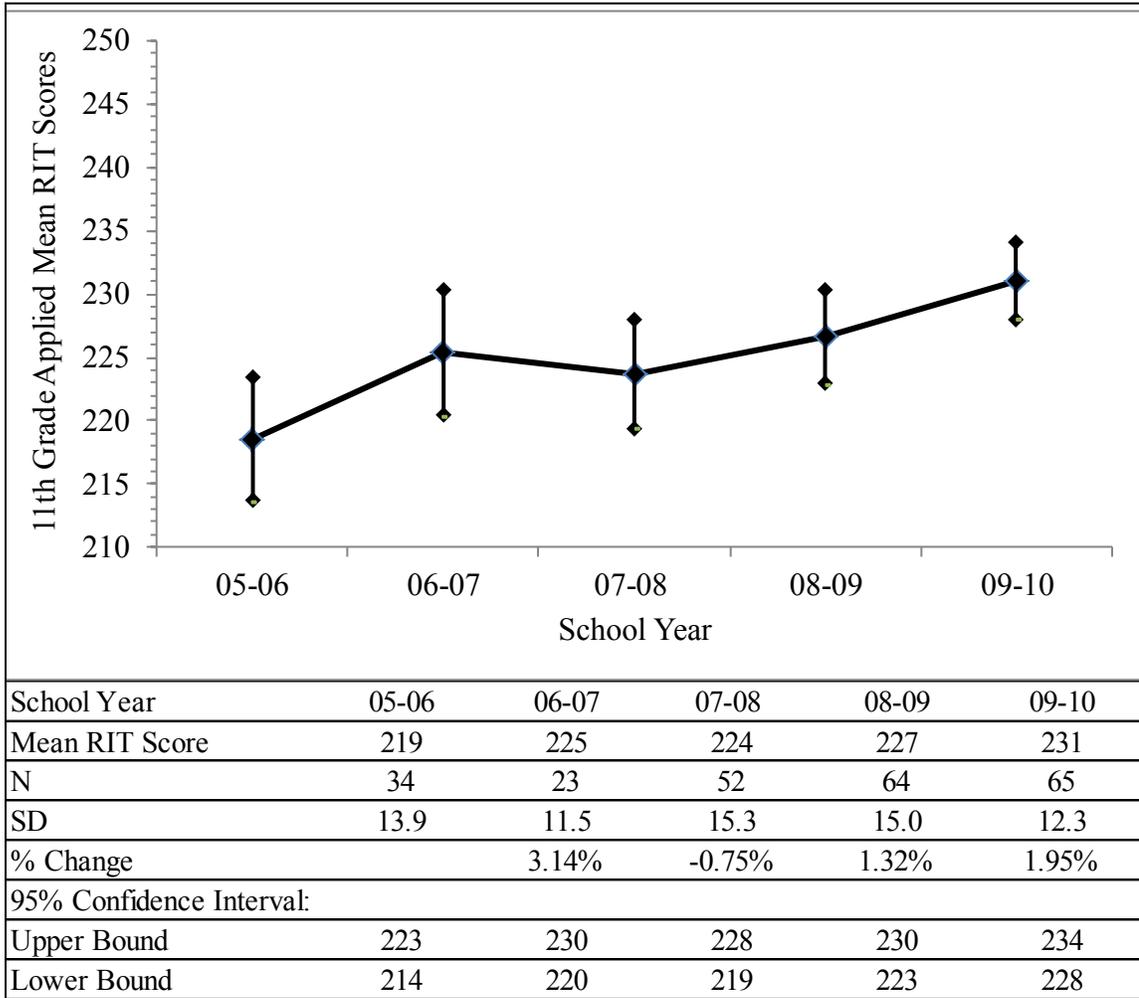


Figure 9. Time-series chart displaying the mean RIT scores of applied-level students on the NWEA mathematics exams of 11th grade students from High School A. No specific class data exist for the school years prior to 2005-2006. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

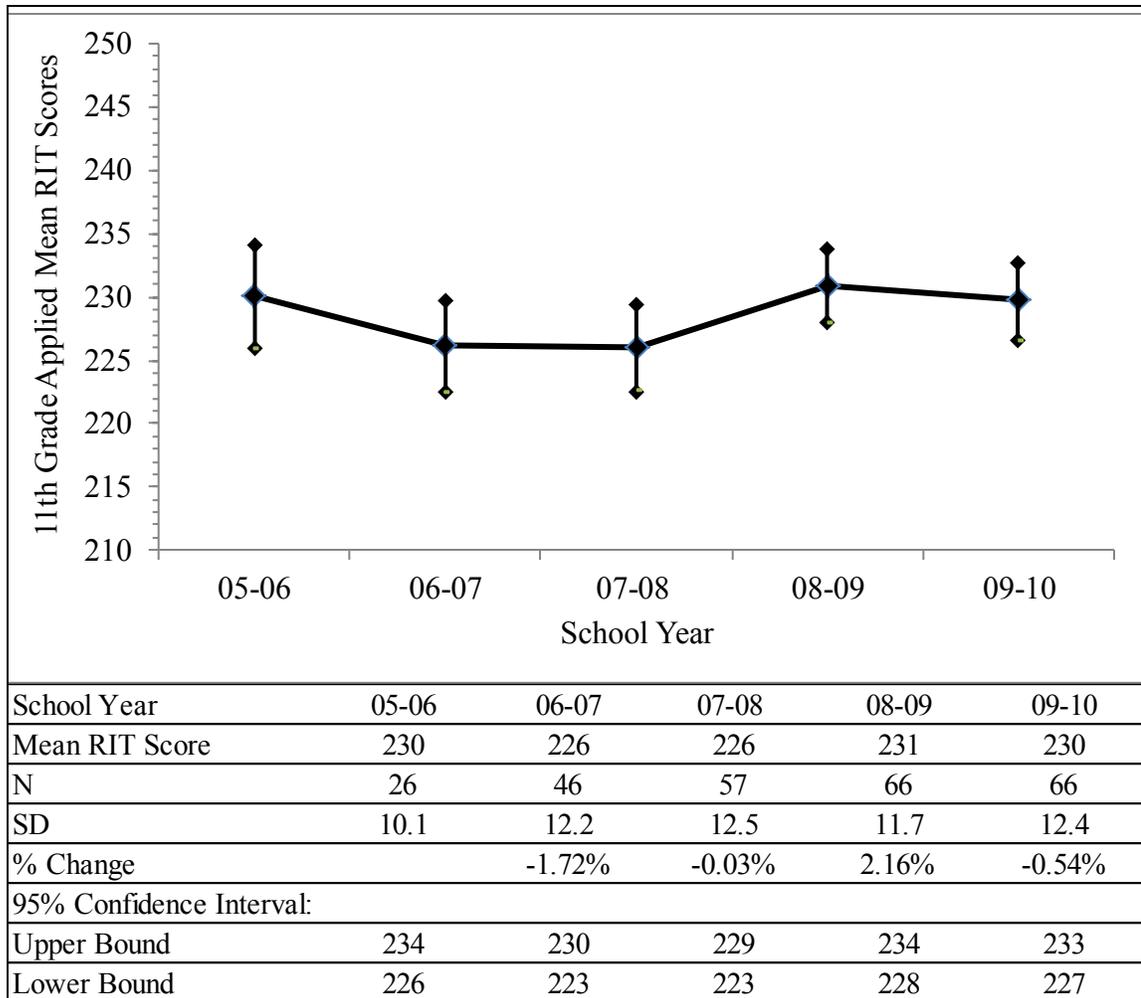


Figure 10. Time-series chart displaying the mean RIT scores of applied-level students on the NWEA mathematics exams of 11th grade students from High School B. No specific class data exist for the school years prior to 2005-2006. The 2006-2007 school year is the first year where the full-year program was implemented for the applied-level Algebra 1, Geometry, and Algebra 2 courses.

Additionally, the 18 point increase over the four year interval for High School A represents an overall growth of 8.2% across the interval for an average annual growth of 2.05% per year. Recall that the typical student when entering 11th grade begins with a RIT score of about 247 is expected to make a growth of about 4 points on the RIT scale over the course of one year. This growth of 4 points in the 11th grade year is about a

1.62% increase. The students in High School A demonstrated a greater than expected growth each year when moving from cohort to cohort. When the 95% confidence interval was applied, it showed no significant growth or decline with each successive year, however, when the 2008-2009 and 2009-2010 school years are compared with the 2005-2006 school year there was once again significant growth.

High School B demonstrated no gain in mean RIT score for applied-level students over the term of the four-year interval beginning with a mean RIT score of 230 in 2005-2006 and ending with a mean RIT score of 230 in 2009-2010. In fact, this high school showed a decline on three out of the four years in comparison to the class from the year prior. Once again, the RIT score range for a student on grade level was expected to be 248-251 for 11th grade, the RIT score must be in the 244-247 range to be on grade level for 10th grade, and the RIT score must be in the 240-243 range to be on grade level in 9th grade.

In summary, each school reported a decline in the percentage of applied-level students scoring proficient or advanced on the PSSA exam in the one year preceding the 2006-2007 school year, and positive gains in the three years following the 2006-2007 school year. As was determined by the 95% confidence interval, the loss was not significant but the gains were significant when comparing the 2007-2008, 2008-2009 and 2009-2010 school years to the baseline scores from the 2005-2006 school year for High School A. The loss was significant when comparing 2005-2006 to the 2006-2007 school year, no significant change from 2006-2007 to 2007-2008, and the gains were significant when comparing the 2008-2009 and 2009-2010 school years to the baseline scores from the 2005-2006 or 2007-2008 school years for High School B.

Further, each school reported gains in the mean scale scores of applied-level 11th grade students on the PSSA exam in the one year preceding the 2006-2007 school year, as well as positive gains in the three years following the 2006-2007 school year. The 95% confidence interval determined that these gains were not significant from year to year, but were significant when comparing the 2005-2006 school year to the 2007-2008, 2008-2009, and 2009-2010 school years for High School A (See Table 18). It was also

Table 18

Statistical Significance of Changes to NWEA Applied-Level Mean RIT Scores by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|---------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Non-Sig | + Sig |
| 2006-2007 | | - Non-Sig | + Non-Sig | + Non-Sig |
| 2005-2006 | + Non-Sig | - Non-Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | - Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | - Non-Sig | + Non-Sig | + Non-Sig |
| 2005-2006 | - Non-Sig | - Non-Sig | + Non-Sig | - Non-Sig |

Note . This table compares the applied-level mean RIT scores on the NWEA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons. + = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

determined that these gains were not significant from year to year, nor were the changes significant when comparing any school years within the interval for High School B leaving the RIT scores at this school relatively unchanged based on Table 18.

Finally, neither school showed significant changes on the mean RIT scores of applied-level 11th grade students when the means were compared from year to year. High School A did show significant gains when the mean RIT scores from the 2005-2006 school year were compared with the 2008-2009 and 2009-2010 school year as was indicated by the 95% confidence interval. For High School B, there were no significant changes in mean RIT score from year to year nor for any comparisons obtained from any point in the interval when compared to any other school year (See Table 18).

College Preparatory Data for Each High School

To determine the effect of the change in schedule on student achievement data for students in college preparatory classes, the overall PSSA proficiency, the mean PSSA scale scores, and the mean RIT scores of 11th grade students who took mathematics classes in college preparatory classes were examined. These data were also obtained through the Performance Tracker system as there is a feature in its data mining tools that allows the user to separate student data based on class lists. The student data were downloaded and analyzed based on students being in a class that has been determined to be at the college preparatory level. Time-series graphs were constructed for the test area of mathematics based on the individual results of students on the PSSA and NWEA assessments as contained in the Performance Tracker program for the school district.

Figures 11 and 12 give proficiency percentages of college preparatory students from each school. The number of students from college preparatory classes who demonstrated proficiency on the 11th grade PSSA mathematics exams was compared to the total number of students from college preparatory classes who took the exam to arrive

at a percentage of students who demonstrated proficiency on the PSSA exam for each school year in each high school.

The earliest data available from Performance Tracker based on class lists for results on the PSSA exams was from the school year 2005-2006 and continued up to and

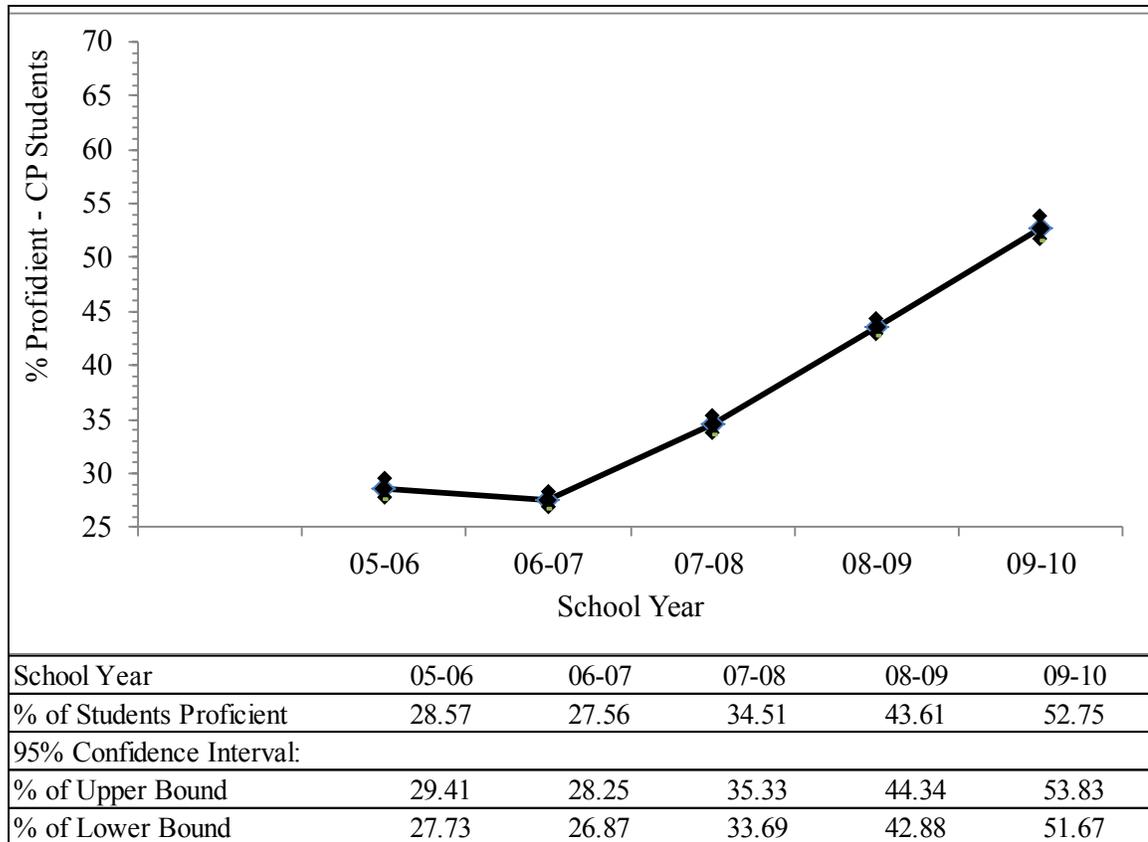


Figure 11. Time-series chart displaying percentage of 11th grade college preparatory students who scored proficient or advanced on the PSSA mathematics exams from High School A. No specific class data exist for the school years prior to 2005-2006. The 2008-2009 school year is the first year where the full-year program was implemented for the college preparatory Algebra 1, Geometry, and Algebra 2 courses.

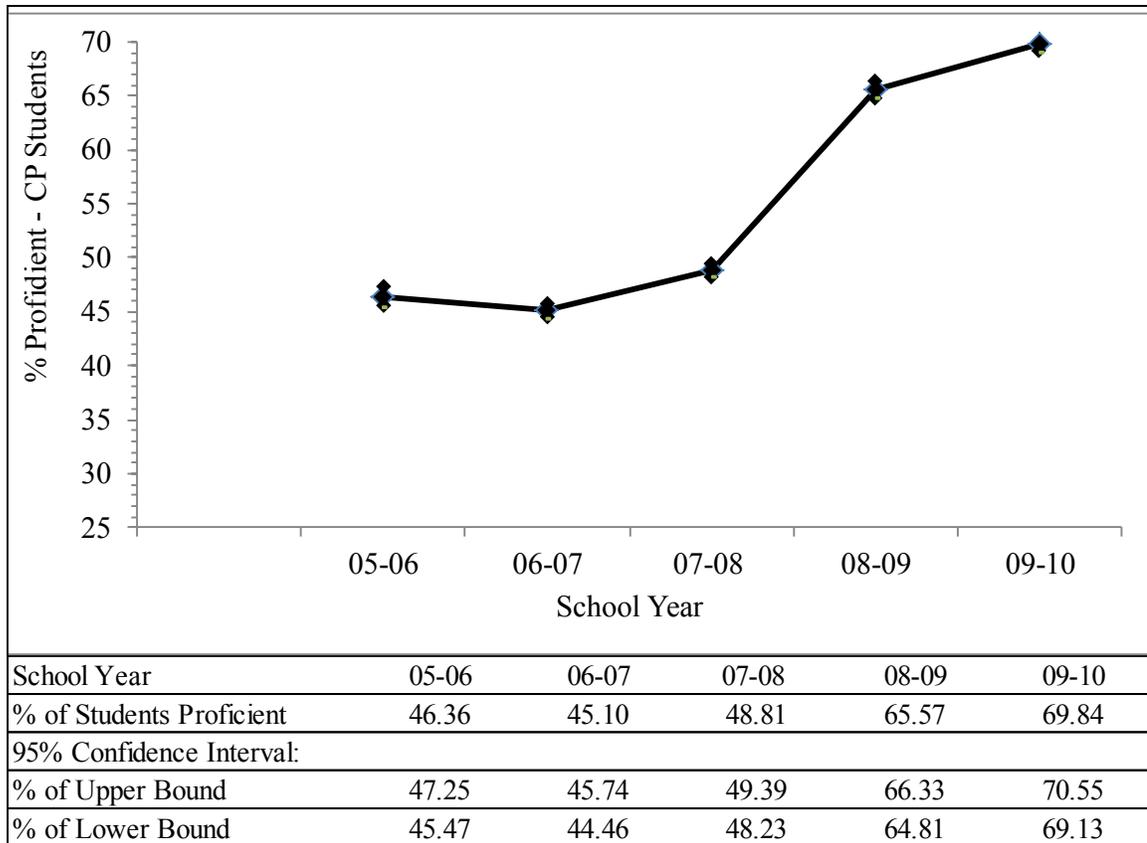


Figure 12. Time-series chart displaying percentage of 11th grade college preparatory students who scored proficient or advanced on the PSSA mathematics exams from High School B. No specific class data exist for the school years prior to 2005-2006. High School B did not implement the full-year program for the college preparatory Algebra 1, Geometry, and Algebra 2 courses, these courses remained on a 4/4 block schedule.

including the school year 2009-2010 for each high school. Each of these figures shows the percentage of college preparatory students scoring proficient or higher on the PSSA exam for each school year from 2005-2006 until 2009-2010. Each school demonstrated an overall increase in proficiency percentage for college preparatory students over the length of the interval. Furthermore, in the one year prior to 2006-2007 each school was utilizing the block schedule for all classes, but after 2006-2007 only High School A had altered the schedule to utilize the full-year format for all college preparatory courses

while High School B left the college preparatory classes untouched and on the semester format.

The percentage of proficiency for college preparatory students at High School A increased overall by 24.18% over the four-year span. This overall increase can be broken down to an average annual increase of 6.045% per year. Although there was one year where the percentage of proficiency dropped slightly by 0.99%, it was followed by a three year period where the overall gain was 25.19% over the three year span. This growth can be broken down to an average annual gain of 8.39% per year. Note that the college preparatory classes at High School A moved to a full year schedule during the 2008-2009 school year which impacts the last two years of PSSA proficiency. So while in the previous two years the gains were -0.99% and 6.95% respectively, the gains in the last two years were 7.10% and 9.14% respectively.

The percentage of proficiency for college preparatory students at High School B increased overall by 23.48% over the four-year span. This overall increase can be broken down to an average annual increase of 5.87% per year. Although there was one year where the percentage of proficiency dropped slightly by 1.26%, it was followed by a three year period where the overall gain was 24.74% over the three year span. This growth can be broken down to an average annual gain of 8.25% per year. Note that the college preparatory classes at High School B did not move to a full year schedule during the 2008-2009 school year as did High School A which means the schedule change had no impact on the PSSA proficiency data from the last two years as it did with High School A. So while in the previous two years the gains were -1.26% and 3.71% respectively, the gains in the last two years were 16.76% and 4.24% respectively.

When the 95% confidence interval was applied to each set of data, the interval showed that the changes in proficiency from year to year were not significant for either school when comparing the 2005-2006 school year to the 2006-2007 school year, however, each school made significant gains in each of the years following the 2006-2007 school year (See Table 19).

Table 19

Statistical Significance of Changes to PSSA College Prep Proficiency Percentage by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | + Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | + Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | + Sig | + Sig | + Sig |

Note . This table compares the percentage of college prep students demonstrating proficiency on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons.

+ = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

Another measure of student achievement which was recorded and analyzed was the individual mean scale score from the PSSA Mathematics exam of college preparatory students from each high school. These scale scores were also downloaded from the

Performance Tracker database. When the mean scale scores from the PSSA Mathematics exam of 11th grade college preparatory students from each high school were examined, a consistent increase in the years following the implementation of the full-year schedule for college preparatory courses in High School A was noted, but there was also a consistent increase in those same years at High School B where there was no implementation of full-year college preparatory mathematics classes.

Since mean scale scores represent an average of all students in the college preparatory courses, the percentage of growth each year would not be as dramatic as was realized in the percentage of proficiency. Recall that when determining percentage of proficiency, each individual student counted as one unit and therefore each student who was not proficient, whether by 2 points or 200 points, impacted the overall percentage in a consistent manner. Conversely, when scale scores were averaged to find the mean, an extremely low non-proficient score had a larger impact on the overall mean than did a non-proficient score that was slightly below the proficiency threshold. For this reason, the percentages while increasing for mean scale scores would not show as dramatic a level of growth as would the proficiency percentage. Figures 13 and Figure 14 are time-series graphs of those mean scale scores as housed in Performance Tracker for each high school.

Each of these figures shows the mean scale scores of college preparatory students on the PSSA mathematics exam for each school year from 2005-2006 until 2009-2010. Both schools demonstrated an overall increase in mean scale score for college preparatory students over the course of interval. The mean scale scores for college preparatory

students at High School A increased overall by 97 points over the total span of time while High School B increased overall by 42 points.

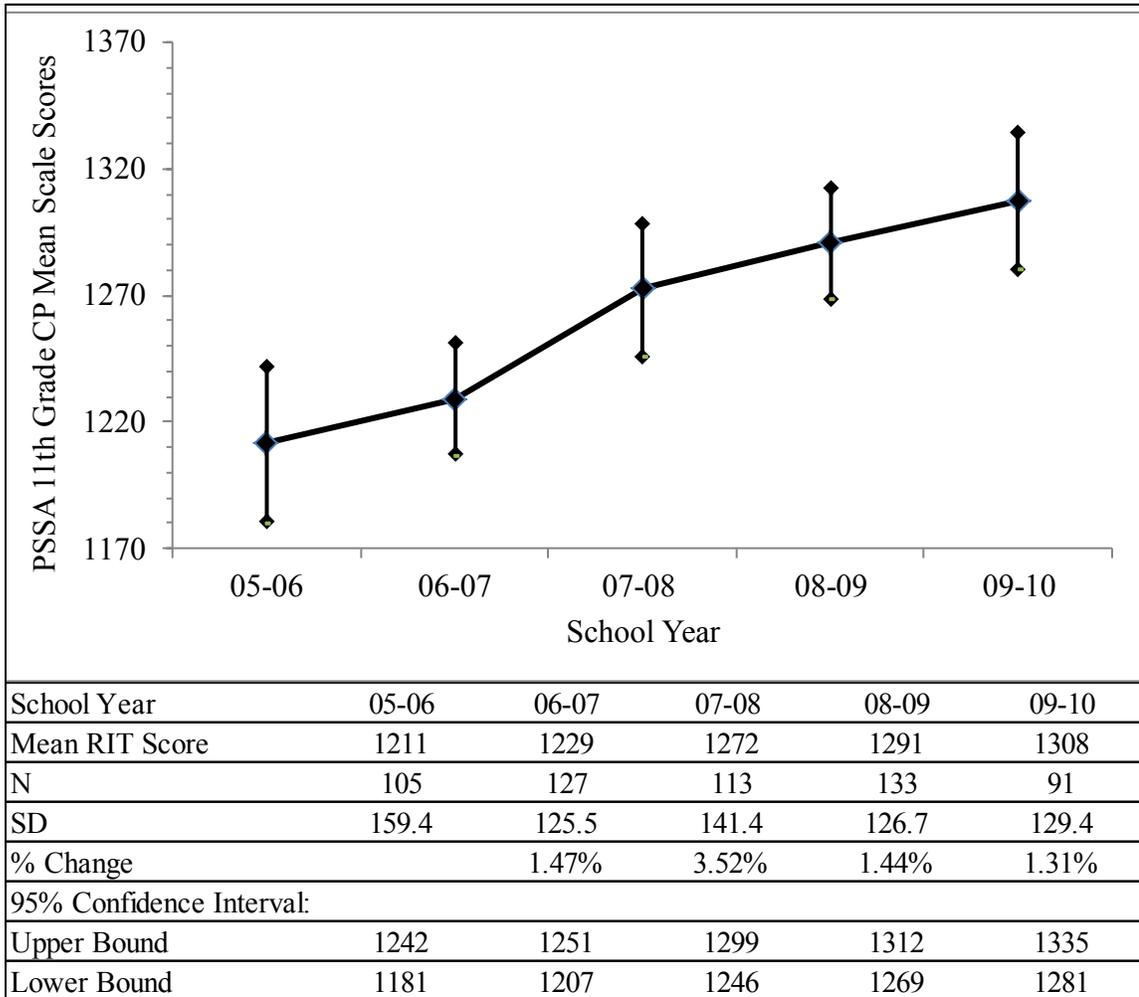


Figure 13. Time-series chart displaying the mean scale scores of college preparatory students on the PSSA mathematics exams of 11th grade students from High School A. No specific class data exist for the school years prior to 2005-2006. The 2006-2007 school year is the first year where the full-year program was implemented for the college preparatory Algebra 1, Geometry, and Algebra 2 courses.

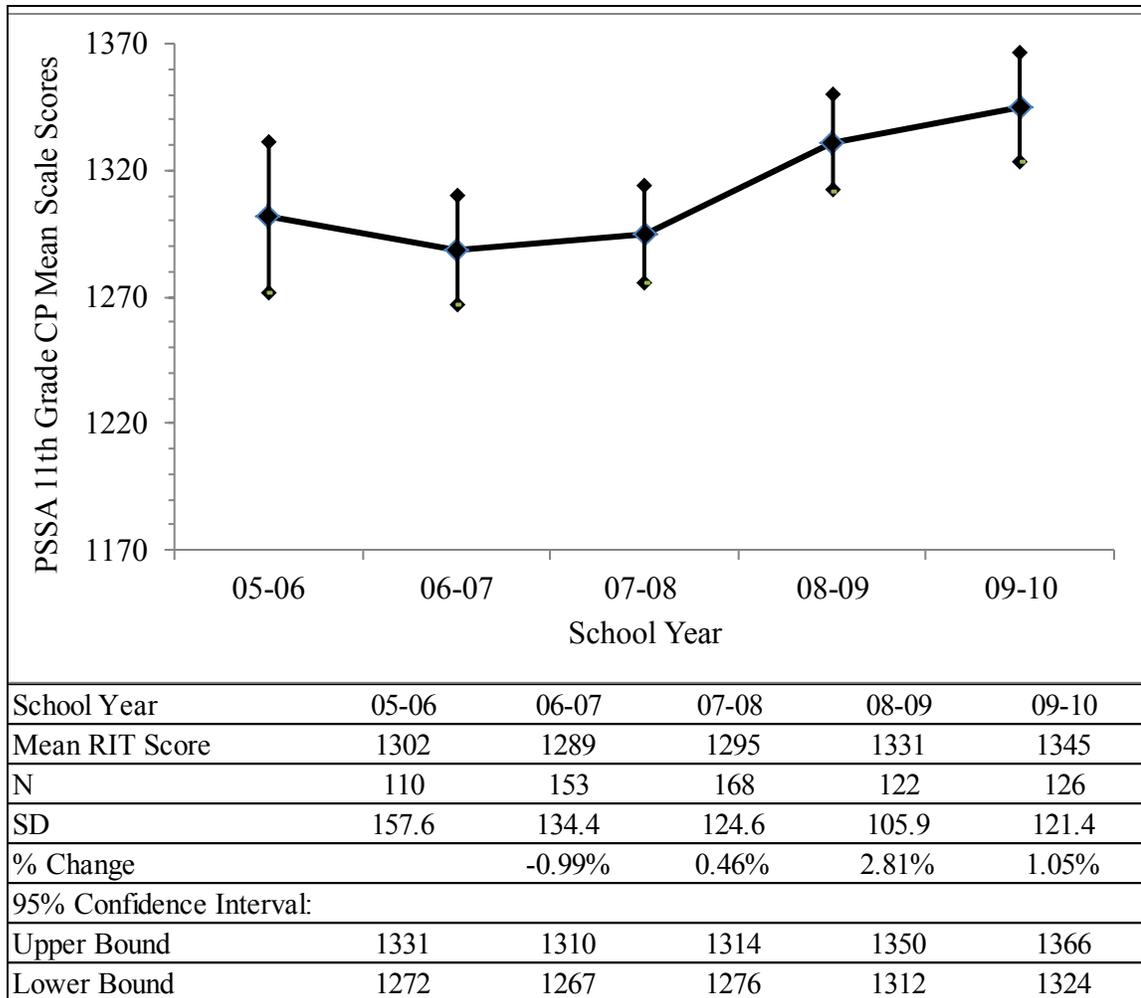


Figure 14. Time-series chart displaying the mean scale scores of college preparatory students on the PSSA mathematics exams of 11th grade students from High School B. No specific class data exist for the school years prior to 2005-2006. High School B did not implement the full-year program for the college preparatory Algebra 1, Geometry, and Algebra 2 courses, these courses remained on a 4/4 block schedule.

For High School A, the 97 point increase over the four year interval represents an overall growth of 8.01% for an average annual growth of 2.00% per year. High School A demonstrated positive growth for each of the four years recorded in the data. In the two years prior to the implementation of the full-year schedule, the growth was 4.99% for an average annual growth of 2.50%. In the two years following the implementation of the

full-year schedule, the growth was 3.02%, for an average annual growth of 1.51% per year. Looking at all four years of growth, it is notable that the highest year of growth was from 06-07 to 07-08, the year before the implementation of the full-year schedule, where the gain was 3.52% and was more than double any of the other three years which all hang at about 1.5%. When the 95% interval was applied, there was no significant increase in mean scale scores when comparing successive years. However, when comparing the 2008-2009 and 2009-2010 school years with either the 2005-2006 or 2006-2007 school years, there was significant growth as the intervals did not overlap for those comparisons (See Table 20).

For High School B, the 46 point increase over the four year interval represents an overall growth of 3.53% for an average annual growth of 0.88% per year. In the two years prior to the implementation of the full-year schedule, the growth was 4.99% for an average annual growth of 2.50%. In the two years following the implementation of the full-year schedule, the growth was 3.02%, for an average annual growth of 1.51% per year. When the 95% confidence interval was applied to these data, there were no significant changes in mean scale score when comparing any year to any successive year. However, there was significant growth when comparing either the 2008-2009 or 2009-2010 school years to the 2006-2007 school year, but no significant growth when the either the 2008-2009 or 2009-2010 school years were compared to the 2005-2006 school year (See Table 20).

Table 20

Statistical Significance of Changes to PSSA College Prep Mean Scale Scores by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|----------------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | + Non-Sig | + Sig | + Sig |
| 2005-2006 | + Non-Sig | + Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Non-Sig | + Sig |
| 2006-2007 | | + Non-Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | - Non-Sig | + Non-Sig | + Non-Sig |

Note . This table compares the college prep mean scale scores on the PSSA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons. + = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

Since High School B did not implement the full-year schedule for college preparatory mathematics classes, there are not comparison data to link pre and post implementation data. Looking at all four years of growth, it is notable that the highest year of growth was from 07-08 to 08-09, the same year that the full-year classes were implemented at High School A, yet they were not implemented at High School B. In the four-year span of date, High School B actually had one year of a slight negative trend followed by three straight years of positive growth.

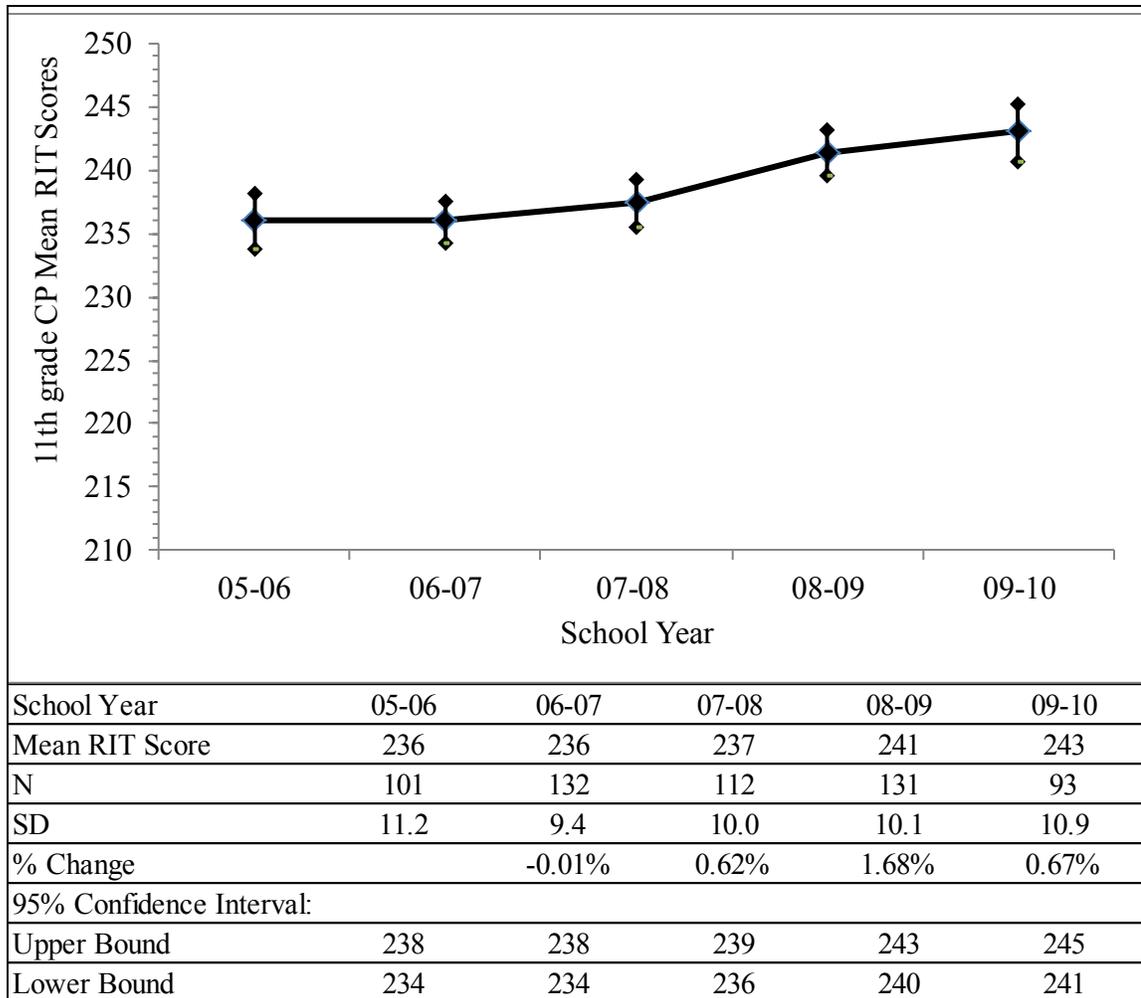


Figure 15. Time-series chart displaying the mean RIT scores of college preparatory students on the NWEA mathematics exams of 11th grade students from High School A. No specific class data exist for the school years prior to 2005-2006. The 2008-2009 school year is the first year where the full-year program was implemented for the college preparatory Algebra 1, Geometry, and Algebra 2 courses.

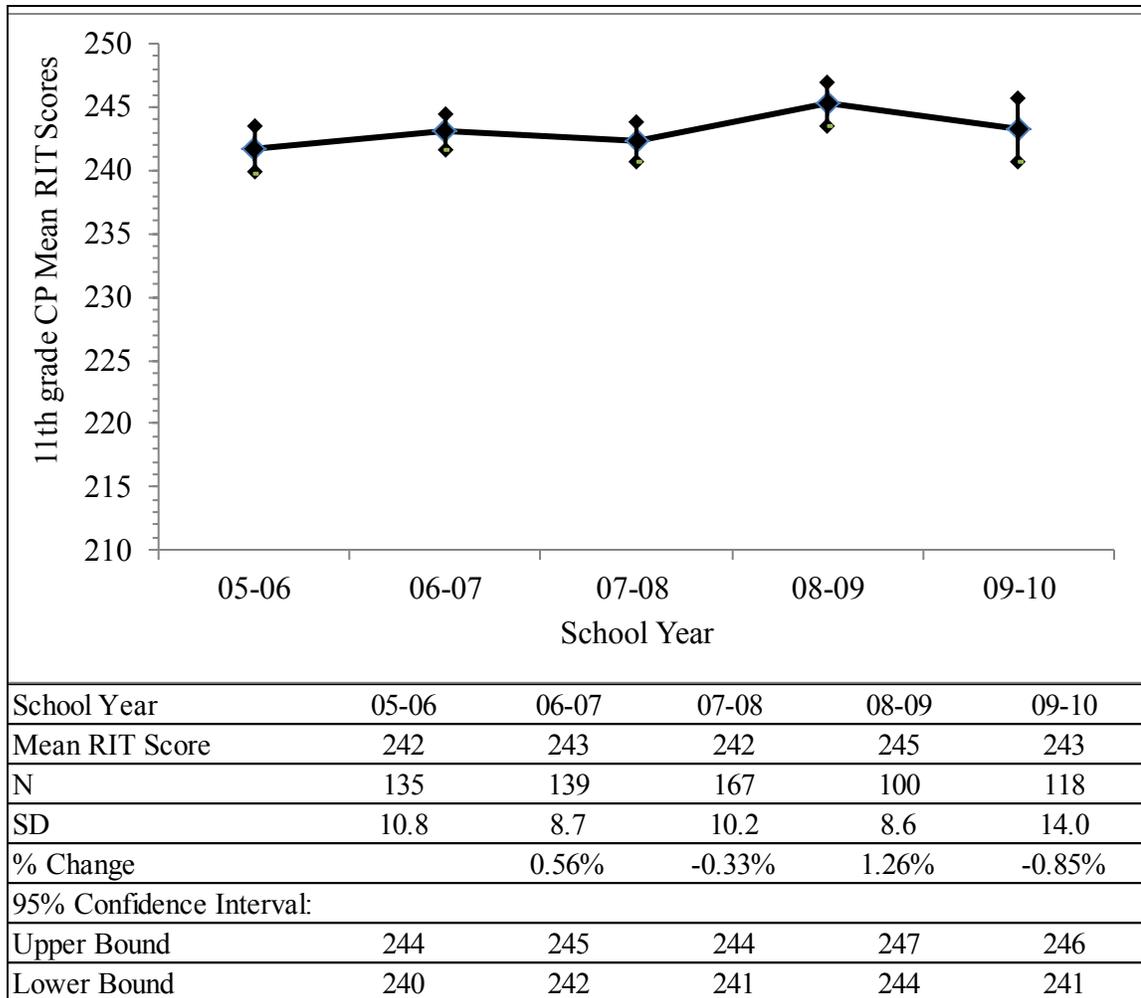


Figure 16. Time-series chart displaying the mean RIT scores of college preparatory students on the NWEA mathematics exams of 11th grade students from High School B. No specific class data exist for the school years prior to 2005-2006. High School B did not implement the full-year program for the college preparatory Algebra 1, Geometry, and Algebra 2 courses, these courses remained on a 4/4 block schedule.

The final measure for 11th grade college preparatory students which was reviewed and analyzed in this study was the mean RIT score from the NWEA MAP assessment.

This pre and post assessment shows student growth as they complete a mathematics course. To maintain consistency with the PSSA exam, the contents in Figure 15 and

Figure 16 are taken from posttests of students exiting the college preparatory Algebra 2 exam, which for the vast majority of students is the end of the 11th grade year.

In order to show change in achievement, the end of year mean RIT scores from the MAP assessment of 11th grade college preparatory students were put into time series graphs for each school as another measure of change. Recall that since this exam is a post test, the retention interval for the MAP assessment is much shorter than the PSSA exam which is a summative assessment of three years of high school mathematics. With the retention interval being shorter there is less of an impact from the spacing effect, but still an impact nonetheless (Underwood, 1961). The RIT scores were located in Performance Tracker based on whether they were a college preparatory Algebra 2 course for each year the data were available. As indicated earlier, class data were only available beginning with the 2005-2006 school year. Each of these figures shows the mean RIT scores of college preparatory students on the 11th grade NWEA MAP assessment each school year from 2005-2006 until 2009-2010.

High School A demonstrated an overall increase in mean RIT score for college preparatory students over the course of the interval beginning with a mean RIT score of 236 in 2005-2006 and ending with a mean RIT score of 243 in 2009-2010. This move from 236 to 243 is a 7 point increase in mean RIT score over the 4 year interval with an average annual increase of 1.75 points per year. At the time of these assessments, the RIT score range for a student on grade level was expected to be 248-251 for 11th grade. Note that for a student to be on grade level in 9th grade, the RIT score must be in the 240-243 range and to be on grade level for 10th grade, the RIT score must be in the 244-247 range.

This group of students who had, on average, been traditionally at or near grade level for several years mathematically in the years leading up to and including 2005-2006, continued to demonstrate near grade level performance on average with slight increase by the time they have reached the 2009-2010 school year. Furthermore, since the range of scores needed to demonstrate proficiency rises by about four points per school year, each successive class from 2005 – 2010 simply continued to maintain status quo with a slight increase for the two years following the implementation of full-year classes at the college preparatory level.

Additionally, the 7 point increase over the four year interval for High School A represents an overall growth of 2.97% across the interval for an average annual growth of 0.74% per year. When looking at the data year by year, it tells a different story. In the two years prior to the implementation of full-year mathematics classes at High School A, the mean RIT score dipped slightly for two consecutive years posting -0.04% and -0.27% dips for 2006-2007 and 2007-2008 respectively, however in the two years following the implementation, High School A showed positive gains for each year beginning with a 2.59% increase in the 2008-2009 school year and followed by another 0.67% gain in the 2009-2010 school year.

When the 95% confidence interval was applied to the mean RIT scores, there were no significant changes when comparing any one year to any successive year save 2007-2008 and 2008-2009 where significant growth did occur. Furthermore, when the mean RIT scores from the 2008-2009 or 2009-2010 school years were compared to any of the previous three school years, there was significant growth as the confidence intervals did not overlap (See Table 21).

High School B demonstrated an overall one point gain in mean RIT score for college preparatory students over the course of the four-year interval beginning with a mean RIT score of 242 in 2005-2006 and ending with a mean RIT score of 243 in 2009-2010. In fact, this high school showed back and forth growth for the four year span posting two years with positive growth as well as two years of negative growth in alternating school years. Although, none of the percentages are very high, there were slight variations from year to year with the mean RIT scores going from positive to negative to positive to negative growth over the four-year interval. The actual

Table 21

Statistical Significance of Changes to NWEA College Prep Mean RIT Scores by Year

| School/Year | 2006-2007 | 2007-2008 | 2008-2009 | 2009-2010 |
|---------------|-----------|-----------|-----------|-----------|
| High School A | | | | |
| 2008-2009 | | | | + Non-Sig |
| 2007-2008 | | | + Sig | + Sig |
| 2006-2007 | | + Non-Sig | + Sig | + Sig |
| 2005-2006 | - Non-Sig | + Non-Sig | + Sig | + Sig |
| High School B | | | | |
| 2008-2009 | | | | - Non-Sig |
| 2007-2008 | | | + Non-Sig | + Non-Sig |
| 2006-2007 | | - Non-Sig | + Non-Sig | + Non-Sig |
| 2005-2006 | + Non-Sig | + Non-Sig | + Non-Sig | + Non-Sig |

Note . This table compares the college prep mean RIT scores on the NWEA math exam from one school year to the years prior to determine growth or decline as well as whether the change was significant or non-significant based on the 95% confidence interval. Significant growth or decline are evident in the preceding figures when the error bars do not overlap. When error bars are not evident, due to proximity to the mean the observer must use upper and lower bounds to draw comparisons. + = Growth; - = Decline; Sig = Significant; Non-Sig = Non-Significant

percentages were 0.56%, -0.33%, 1.26%, and -0.85% respectively. As was the case with mean scale score from PSSA, High School B posted their highest gain in the 2008-2009 school year, the same year as the full-year college preparatory implementation at High School A yet there was no full-year implementation at High School B for the college preparatory level. When the 95% confidence interval was applied, it confirmed that there was no significant change in the mean RIT scores when comparing any one year in the interval to any other year in the interval (See Table 21).

In summary, each school reported an overall positive gain in the percentage of college preparatory students scoring proficient or advanced on the PSSA exam over the four-year span from 2005-2010. Both schools showed a slight dip in the first year, but this was followed by three consecutive years of substantial growth from the previous school year and significant growth by the second year of implementation. Further, each school reported overall gains in the mean scale scores of college preparatory 11th grade students on the PSSA exam over the four-year interval with High School A posting positive gains in all four years, while High School B posted a loss the first year followed by gains in the next three years. High School A posted its greatest gain in the year prior to the implementation of full-year classes while High School B did not implement the full-year schedule yet also posted substantial growth in the year the full-year schedule was implemented at High School B. Neither school had significant growth in the one year following the implementation of the full year schedule at High School A, however, High School A had a slightly higher percentage of growth than High School B, 1.31% versus 1.05% respectively.

Finally, the mean RIT scores of college preparatory 11th grade students remained virtually unchanged over the four-year interval with each high school posting a very slight overall growth over the four year period. High School A posted only a 7 point mean gain while High School B only posted a 1 point mean gain in RIT scores. Each school showed both negative and positive trends in various years. Recall once again that since these assessments are end-of-course assessments, the retention interval is much shorter than that necessary for the PSSA exam and therefore less impacted by the spacing effect according to Underwood (1961). These data would, however, suggest that there may be other variables in play causing some of the gains in places where the variable being studied in this report was unchanged. Neither growth nor decline were considered to be significant based on the 95% confidence interval.

Three-Year Cohort Data for Each High School at Both the Applied and College Preparatory Levels

The final impact to be reviewed was the effect of the schedule change on a three-year cohort of students as they progressed through Algebra 1, Geometry and Algebra 2 courses. The data used for this analysis were the mean RIT score of students at the time they entered an Algebra 1 course in comparison to the mean RIT score of students when they exited Algebra 2 presumably three years later. These data were also obtained through the Performance Tracker system as there is a feature in its data mining tools that allows the user to separate student data based on class list.

The student data were downloaded and analyzed based on students being in a class that has been determined to be an Algebra 1 class on both the applied and college preparatory levels and then an Algebra 2 class on both the applied and college

preparatory levels for each high school. These data were pulled for Algebra 1 students in the 2005-2006, 2006-2007, and 2007-2008 school years and for Algebra 2 students in the 2007-2008, 2008-2009, and 2009-2010 school years to demonstrate growth over three years. Note that some cohorts were entirely on the full-year schedule, others were a mixture, and still other cohorts were entirely on the block schedule. Time-series graphs were constructed to show both the pre and post assessment scores for a cohort of students entering Algebra 1 in one school year and exiting Algebra 2 two years later. The data are based on the pre and post mean RIT scores from the NWEA MAP assessment for each course as contained in the Performance Tracker program for the school district.

Table 22 represents the pretest and posttest data for the students at High School A. The first line on the table for each cohort shows mean RIT score for all students entering Algebra 1 at the beginning of the first year of the three-year span and the second line represents the mean RIT score for all students exiting the Algebra 2 class during the last year of the three-year span. Since the earliest data available in Performance Tracker by class was the 2005-2006 school year, this table only shows the results of three 3-year cohorts at both the applied and college preparatory levels for High School A.

High School A implemented full-year scheduling for applied-level classes in 2006-2007 and for college preparatory classes in 2008-2009. Therefore the data contained in Table 22 for applied-level students show one cohort which had block schedule for one year and full-year schedule for two years (2005-2008) and two cohorts which had the full-year schedule for all three years (2006-2009 and 2007-2010). For college preparatory students there was one cohort which had block schedule for all three years (2005-2008); one cohort which had the block schedule for two years and the full

year schedule for one year (2006-2009); and one cohort which had the block schedule for one year and the full year schedule for two years (2007-2010).

As the data from Table 22 were reviewed for applied-level students, it was noted that each of the three cohorts entered Algebra 1 at about the same mean RIT score level. Cohort 05-08 entered at 218 in 2005, Cohort 06-09 entered at 219 in 2006, and Cohort 07-10 entered at 218 in 2007. At the time each of these cohorts exits Algebra 2, they have expectedly made gains in mean RIT score and that gain increases with each successive cohort with Cohort 05-08 exiting with a mean RIT score of 224 for an average gain of 6 points; Cohort 06-09 exited with a mean RIT score of 227 for an average gain of 8 points; and Cohort 07-10 exited with a mean RIT score of 237 for an average gain of 19 points. These gains in mean RIT score can also be described by percentage of increase and that being 2.8%, 3.7% and 8.7% respectively. Note once again that each successive year means more years on the full-year schedule for both students and teachers.

Table 22 also contains data from college preparatory students which were downloaded, calculated and analyzed as well. For college preparatory students, it was also noted that each of the three cohorts entered Algebra 1 at about the same mean RIT score level. Cohort 05-08 entered at 233 in 2005, Cohort 06-09 entered at 233 in 2006, and Cohort 07-10 entered at 234 in 2007. At the time each of these cohorts exits Algebra 2, they have expectedly made gains in mean RIT score and that gain increases with each successive cohort with Cohort 05-08 exiting with a mean RIT score of 235 for an average gain of 2 points; Cohort 06-09 exited with a mean RIT score of 241 for an average gain of 7 points; and Cohort 07-10 exited with a mean RIT score of 243 for an average gain of

Table 22

Confidence Intervals for Three-Year Cohorts - High School A

| Variable | N | SD | Mean | 95% CI |
|-----------------------|-----|------|------|---------------|
| Applied 05-08 | | | | |
| Algebra 1 Pretest | 137 | 12.4 | 220 | (218 , 222) |
| Algebra 2 Posttest | 52 | 15.3 | 224 | (219 , 228) |
| Applied 06-09 | | | | |
| Algebra 1 Pretest | 126 | 10.4 | 223 | (221 , 225) |
| Algebra 2 Posttest | 64 | 15.0 | 227 | (223 , 230) |
| Applied 07-10* | | | | |
| Algebra 1 Pretest | 88 | 11.9 | 218 | (216 , 221) |
| Algebra 2 Posttest | 65 | 12.3 | 231 | (228 , 234) |
| CP 05-08 | | | | |
| CP Algebra 1 Pretest | 144 | 10.9 | 233 | (231 , 235) |
| CP Algebra 2 Posttest | 123 | 12.4 | 234 | (232 , 236) |
| CP 06-09* | | | | |
| CP Algebra 1 Pretest | 149 | 10.7 | 234 | (232 , 236) |
| CP Algebra 2 Posttest | 139 | 9.3 | 238 | (237 , 240) |
| CP 07-10* | | | | |
| CP Algebra 1 Pretest | 145 | 9.5 | 234 | (232 , 235) |
| CP Algebra 2 Posttest | 107 | 10.3 | 240 | (238 , 242) |

*Note . The first line for each variable represents the results for the pretest of the first year of the cohort, and the second line is for posttest of the last year of the cohort.
Any cohorts that contain an asterisk represent a cohort that had a significant change in mean RIT score over the length of the three-year interval based on no overlap of the 95% confidence intervals.

9 points. These gains in mean RIT score can also be described by percentage of increase and that being 0.9%, 3.0% and 3.8% respectively. Note once again that each successive year means more years on the full-year schedule for both students and teachers.

The 95% confidence interval was also included on Table 22 to show which changes in mean RIT score were statistically significant over the length of each three-year cohort for High School A. Note that the growth for three out of six cohorts was considered to be statistically significant based on the 95% confidence interval. One out of three applied-level cohorts made significant growth over the three-year span, namely the last of those two cohorts which had the full year schedule for the full length of the interval. In addition, two out of three college preparatory cohorts demonstrated significant growth over the length of the three year interval namely those two cohorts which contained at least one school year of mathematics classes on the full year schedule.

High School B also implemented full-year scheduling for applied-level classes in 2006-2007, but did not implement full-year scheduling for college preparatory classes at all. Therefore the data contained in Table 23 for applied-level students show one cohort which had block schedule for one year and full-year schedule for two years (2005-2008) and two cohorts which had the full-year schedule for all three years (2006-2009 and 2007-2010). For college preparatory students, each cohort was instructed entirely on the 4/4 block schedule for one semester.

As the data from Table 23 were reviewed for applied-level students, it was noted that each of the three cohorts entered Algebra 1 at about the same mean RIT score level. Cohort 05-08 entered at 222 in 2005, Cohort 06-09 entered at 221 in 2006, and Cohort 07-10 entered at 223 in 2007. At the time each of these cohorts exited Algebra 2, they

Table 23

Confidence Intervals for Three-Year Cohorts - High School B

| Variable | N | SD | Mean | 95% CI |
|-----------------------|-----|------|------|---------------|
| Applied 05-08 | | | | |
| Algebra 1 Pretest | 165 | 11.7 | 222 | (220 , 224) |
| Algebra 2 Posttest | 57 | 12.5 | 226 | (223 , 229) |
| Applied 06-09* | | | | |
| Algebra 1 Pretest | 100 | 11.0 | 221 | (219 , 223) |
| Algebra 2 Posttest | 66 | 11.7 | 231 | (228 , 234) |
| Applied 07-10* | | | | |
| Algebra 1 Pretest | 65 | 12.8 | 223 | (220 , 226) |
| Algebra 2 Posttest | 66 | 12.4 | 230 | (227 , 233) |
| CP 05-08* | | | | |
| CP Algebra 1 Pretest | 182 | 9.7 | 235 | (233 , 236) |
| CP Algebra 2 Posttest | 167 | 10.2 | 242 | (241 , 244) |
| CP 06-09* | | | | |
| CP Algebra 1 Pretest | 126 | 9.7 | 236 | (234 , 238) |
| CP Algebra 2 Posttest | 109 | 9.7 | 243 | (241 , 245) |
| CP 07-10* | | | | |
| CP Algebra 1 Pretest | 132 | 9.3 | 234 | (233 , 236) |
| CP Algebra 2 Posttest | 118 | 14.0 | 243 | (241 , 246) |

Note . The first line for each variable represents the results for the pretest of the first year of the cohort, and the second line is for posttest of the last year of the cohort.
 *Any cohorts that contain an asterisk represent a cohort that had a significant change in mean RIT score over the length of the three-year interval based on no overlap of the 95% confidence intervals.

had expectedly made gains in mean RIT score and that gain varies by cohort with Cohort 05-08 exiting with a mean RIT score of 226 for an average gain of 4 points; Cohort 06-09 exited with a mean RIT score of 231 for an average gain of 10 points; and Cohort 07-10 exited with a mean RIT score of 230 for an average gain of 7 points. These gains in mean RIT score can also be described by percentage of increase and that being 1.8%, 4.5% and 3.1% respectively. Note that both groups of applied-level cohorts made substantially better gains than did the cohort with mixed schedules.

Table 23 also contains data from college preparatory students which were downloaded, calculated and analyzed as well. For college preparatory students, it was also noted that each of the three cohorts entered Algebra 1 at about the same mean RIT score level. Cohort 05-08 entered at 235 in 2005, Cohort 06-09 entered at 236 in 2006, and Cohort 07-10 entered at 234 in 2007. At the time each of these cohorts exited Algebra 2, they had expectedly made gains in mean RIT score and that gain increased with each successive cohort with Cohort 05-08 exiting with a mean RIT score of 242 for an average gain of 7 points; Cohort 06-09 exited with a mean RIT score of 246 for an average gain of 10 points; and Cohort 07-10 exited with a mean RIT score of 243 for an average gain of 9 points. These gains in mean RIT score can also be described by percentage of increase and that being 3.0%, 4.2% and 3.8% respectively. Note once again each of these cohorts took all mathematics classes entirely on the 4/4 block schedule for one semester.

The 95% confidence interval was also included on Table 23 to show which changes in mean RIT score were statistically significant over the length of each three-year cohort for High School B. Note that the growth for five out of six cohorts was

considered to be statistically significant based on the 95% confidence interval. Two out of three applied-level cohorts made significant growth over the three-year span, namely those two cohorts which had the new schedule for the full length of the interval. In addition, all three college preparatory cohorts demonstrated significant growth over the length of the three year interval.

Other information which can be drawn from the data contained in Tables 22 and 23 comes from the changes seen in N in the span of a three-year cohort. Notice that the N decreased dramatically between the Algebra 1 pretest and the Algebra 2 post test at the applied level and it is much more prominent in the earlier cohorts than in the later ones. There were several variables that contributed to this drop in enrollment at the applied level the largest of which was the number of students who needed to take Algebra 1 a second time, especially in the 2005-2006 school year. Since both schools were on a block schedule during that school year, it was possible for a student to take Algebra 1 in the fall, fail the course, and be rescheduled into Algebra 1 again in the spring allowing for a single student to be counted into the comprehensive data twice. When the raw data was analyzed it was also noticed that in the earlier years there were data points coming from tenth and eleventh grade students into the Algebra 1 comprehensive data also suggesting that students who had failed Algebra 1 in previous years were being rescheduled into Algebra 1 in a later school year. So failure of students was a large contributor to the drop in population of applied-level classes by the time students got to Algebra 2 classes. Secondly, since applied-level data were consistently improving following the change to the traditional scheduling format, fewer students were qualifying for applied-level classes and were therefore being placed in college preparatory classes.

Additionally, the administrator interviews revealed that the schools did a better job of placing students in the appropriate classes based on student assessment data by the later years and this could have played a role in the population change. Finally, the nature of the transient population that was described earlier caused situations where students would leave school in May, prior to the end of the school year and therefore were not available for post-tests causing that number to be lower especially among the lower achieving population. This phenomenon also could explain why the same was true with college preparatory population decline, but on a much smaller scale. Each school also saw a dramatic population decline between the 2006-2007 and 2009-2010 school years due to economic changes causing families to leave the area as evidenced by the N values in Figures 1 and 2. There were 334 eleventh grade students at High School A who took the PSSA exams in the 2006-07 school year versus 271 eleventh grade students in the 2009-10 school year. For High School B, it was 389 students versus 319 students respectively. It is interesting to note that by the third cohort, the difference between students taking Algebra 1 pretests and Algebra 2 posttests seemed to be much more stable suggesting that fewer students were in need of retaking applied-level Algebra 1 which suggests that they were earning better course grades in correlation with the change in schedule as was also revealed by the teachers and administrators in their interviews.

In summary, each school reported statistically significant gains for applied-level students over the span of three years for the cohorts of students who were entirely on the block schedule versus those who had a mixture of schedules. In addition, High School A showed much higher gains for college preparatory students who were instructed for two years on the full-year model versus those who had a mixture of classes, with the gains

increasing for each successive year. High School B posted similar but undulating growth for all three cohorts at 7, 10 and 9 points respectively. There was no change in schedule and therefore no consistency of achievement data connected to change in schedule, however, the greatest growth for one cohort at High School B (10 points) was greater than the greatest growth for one cohort at High School A (9 points).

Chapter Summary

This chapter sought to answer three research questions which guided this study by presenting both qualitative and quantitative data as well as a review of documents. Data that came from four sources:

- Interviews with administrators,
- Focus groups with teachers,
- Student performance data, and
- Review of policies and the student handbook.

In the data analysis, the characteristics of the spacing effect identified by Underwood (1961), the advantages of block scheduling identified by Canady and Rettig (1995) and the disadvantages of block scheduling identified by Marchant and Paulson (2001) were compared and contrasted among the administrators and teachers. The questions for the interviews and focus groups were resultant from the literature review. The interviews were recorded and transcribed and notes of teacher responses were taken during the focus groups. The focus group and interview data were analyzed and coded in accordance with methodology in relation to qualitative inquiry (Berg, 2004). Themes which emerged from the responses and consistent with the literature were categorized and

tabulated based on congruence with previous studies on spacing effect, advantages and disadvantages of block scheduling.

Both the administrators and teachers reiterated elements revealed in earlier studies pertaining to block scheduling and the spacing effect. It was confirmed by teachers and administrators that the block schedule allowed for a larger variety of instructional strategies, better grades on in-class assignments and short term assessments, better teacher/student rapport, and it allows honors students to double up on mathematics courses. It was also reported by teachers and administrators that for mathematics classes it is better for student achievement if the classes are instructed on a full-year schedule allowing for better use of class time, better student engagement, better retention of skills and content, less loss of class time due to absences, more continuous time spent in mathematics instruction and a longer retention interval.

Further, the teachers and administrators confirmed the theory of the spacing effect in their responses suggesting that the full-year format allows the teacher to present content spread over 180 school days rather 90. The longer spacing of the presentation enables students to digest the information received, to have time to practice, and time to revisit the material again the next day allowing the material to “soak in.” The results of the interviews and focus groups also revealed that at the end of the course, the staff felt the students had retained the skills and content better based on their achievement scores further reinforcing that the retention interval is extended when the presentation and practice are spaced out over time.

Additionally, the student performance data from PSSA and NWEA assessments were compiled and reviewed in accordance with the type of schedule and level of the

course. These data showed significant gains in percentage of students demonstrating proficiency overall, at the applied-level for both schools, and at the college prep level for High School A. Significant gains were also realized in mean scale scores overall and at the applied-level for both schools and at the college preparatory level for high school A. Mean RIT scores also showed that there were significant gains at the applied-level for both schools and at the college preparatory level for High School A.

Finally, school district policies, student handbook and the program of studies were connected to elements from both the interviews and the literature. These document reviews showed that the district had gone to great lengths to minimize other variables in the study by having common curriculum and common assessments based on state standards and assessment anchors. The policies governing curriculum development, graduation requirements, assessments, and student placement in classes were consistent in both schools based on utilization of same policies and procedures. By reducing these variables, the results can more easily correlate with the change in schedule as a possible explanation for the differences in student reaction in class as well as the differences in student achievement data.

In the final chapter of this study, the results reported in this section will be reviewed and explained in accordance with the research questions which guided the study, implications for education will be discussed, limitations which were uncovered during the study will be examined, and suggestions for future studies will be revealed.

CHAPTER 5

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

In a new age of school accountability the achievement of students in all subject areas, especially language arts and mathematics, becomes increasingly important. The way students used to be instructed and achievement was determined does not apply anymore in the 21st century. The educational structure which has guided our school systems for over 100 years simply does not make sense as students are prepared for a changing world with challenges far exceeding those of the industrial age upon which our current structure was founded.

Some of the staples the world of education has grown accustomed to providing, such as bell-shaped curves, assembly-line instructions, limited learning opportunities, averaging grades, an agrarian school calendar, and usage of time in a school day, do not adequately prepare the graduates of this era for the globalization of the market into which they are thrust when they leave the doors of the schoolhouse (Schwahn & McGarvey, 2011). For this reason, educational systems and instructional techniques must change to enable learners to be more marketable when they enter the workforce. “Allowing time rather than learning to be the gatekeeper has the immediate effect of sending some learners out the door who don’t quite understand the concept that was taught” (Schwahn & McGarvey, 2011, p. 9).

Preparation for the world of tomorrow inspires schools to look introspectively at their current practice in an effort to make a sustainable impact on the achievement of students. It was the intent of this study to examine one school district where students

were not meeting with desired success to determine if changing the schedule on which mathematics classes were taught would enable students to achieve more.

The purpose of this case study was to report on differences in the achievement of students when taking mathematics classes on the 4/4 block scheduling model or on the traditional schedule as evidenced by the Pennsylvania System for School Assessment (PSSA) mathematics exams and Northwest Evaluation Association's (NWEA) Measures of Academic Progress (MAP) mathematics assessments. The study attempted to uncover relationships between the variables of the schedule on which courses were taken, the difficulty level of the course, mean scale scores of PSSA mathematics exams, and Rasch Unit (RIT) scores from NWEA mathematics assessments. The study compared PSSA mean scale scores and NWEA RIT scores in mathematics in two high schools within the same school district which had created a modified block schedule allowing some classes to be taken on the 4/4 block schedule and others on the traditional scheduling format. The study also analyzed the responses of teachers and administrators collected in focus groups and interviews in an attempt to further explain conditions causing the change in scheduling, classroom implications facilitated by each scheduling format, and observations of both teachers and administrators regarding student response and achievement.

The literature related to the achievement of students on a block schedule generally focused on the advantages and disadvantages associated with implementing the 4/4 block schedule in a school setting. While the majority of the studies (Knight & DeLeon, 1999; Veal & Flinders, 2001; Zepeda & Mayers, 2001; Hurley, 1997; Staunton, 1997; Marchant & Paulson, 2001) citing the many advantages associated with block scheduling revolved

around varied instructional methods, depth of instruction, student/teacher relationships, better course grades, and acceleration of upper-level students, few examined the impact on long-term retention of knowledge and skills especially related to mathematics courses. There were some studies whose results showed a great deal of disadvantage to using a block schedule (Marchant and Paulson, 2001; Knight & DeLeon, 1999; Trenta and Newman, 2002; Evans, Rice, & McCray, 2002; Lawrence and McPherson, 2000; Thomas, 2001; Hurley, 1997; Gruber & Onwuegbuzie, 2001) including keeping students engaged, poor utilization of class time, less varied instructional practice, too much time between courses, magnification of absences and less long-term retention.

The former studies sought to explore the effects of an entire school changing to the block schedule for all subjects and all difficulty levels. They wanted to employ an all or nothing approach to the block schedule rather than implementing a schedule which allowed for the ability to retain the benefits of the traditional schedule coupled with the benefits of the block schedule. Those studies were based on schools who historically operated on a traditional schedule and made the change to a block schedule, or allowed some courses in all subject areas to test a block schedule, and based on the preponderance of the evidence decided to make a single scheduling method for all subjects even if some of the data suggested otherwise. This current study is different from those studies in that it investigated a school district which only made the change to a new scheduling format based on those areas which were struggling within the block schedule by introducing a hybrid schedule. This new schedule was meant to harness the benefits of block scheduling for certain subjects, difficulty levels, and groups of students while also

attempting to address the needs associated with block scheduling especially pertaining to the low to middle achievers in mathematics.

Since student achievement was the main focus in this study, the theme of less long-term retention which continued to emerge from many studies piqued the interest of this researcher to dig deeper for an underlying cause. Further inquiry led to a theory by Benton Underwood (1961) which had its roots in educational studies dating back as early as 1885. The general principle of this theory was the longer the retention interval expected of students to maintain knowledge and skills, the more spaced the presentation and practice of the content needs to be. This theory speaks directly to the impact of master schedule in that on a 4/4 block schedule students are expected to receive and retain the same instruction over 90 days in 90 minute time frames as they would if they received the same instruction over 180 days in 45 minute time frames on a traditional schedule. Clearly the latter provides more for the spacing effect and according to the theory should result in the content being retained for a longer interval of time which is what is needed for standardized achievement tests.

Using Underwood's (1961) spacing effect theory as the theoretical framework along with the advantages and disadvantages typically associated with block scheduling studies that had been completed in the past, it was the intent of this study to apply the spacing effect to the phenomena observed while teaching on either the block or traditional schedule. The use of a case study combining both quantitative and qualitative inquiry allowed the researcher to connect the data retrieved from student mathematics exams to the observations of both teachers and administrators in the classroom. It was the intent of the qualitative phase of this study, through the interviews with administrators

and the focus groups with teachers, to further clarify and give life to the findings in the quantitative data obtained from student achievement scores (Gay, Arasian, & Mills, 2009). There were three research questions which served as a guide to examine the conditions, perceptions, and correlations between student achievement data and the schedule by which mathematics courses are developed. The questions that framed this study were:

1. What conditions existed that led this particular school district to investigate the need for a change in scheduling format?
2. What were the perceptions of teachers and administrators in regard to changes in instructional technique and student achievement as a result of the change in scheduling format?
3. Were there any changes on PSSA and NWEA student achievement data that correlated with the introduction of full-year classes for applied-level and college preparatory mathematics courses?

Both qualitative and quantitative methodologies were used to address the research questions. The qualitative data were gathered from interviews with three administrators and two focus groups conducted with a total of 15 mathematics teachers. The teachers who participated in the study each had experience teaching mathematics courses on both the 4/4 block and traditional schedules. The teachers were selected for focus groups by the mathematics supervisor from each high school based on the teachers' experiences and their willingness to participate. The administrators involved, the assistant superintendent for curriculum and instruction and the principal from each of the high schools, were the ones directly responsible for the implementation of the new scheduling format. Finally,

the quantitative achievement data of students were taken from a data warehouse called Performance Tracker which houses all of the district data dating back to 2003. The student data were analyzed using mean, standard deviation, and 95% confidence interval for statistical significance. The data used for the analysis were all student data associated with the selected difficulty level of the courses within the school years being studied. Data were analyzed from student achievement scores available from Performance Tracker for the school years 2003-2010.

This chapter contains discussion in reference to the data collected and analyzed by the researcher. The research questions which guided the study will serve as an outline for the conclusions and implications for school administrators and educators to consider with regard to mathematics instruction and the schedule by which courses are structured. The chapter concludes with recommendations for further study.

Summary of Findings

Findings of Research Question One

The conditions in existence which caused the need to modify the master schedule were evident through the interviews of three administrators, focus groups with 15 teachers, and the review of existing student data at the time the change to the modified schedule was made. The observations of the administrators showed low standardized test scores, lack of attention or engagement in class, lag of time between mathematics classes, and less long-term retention, which were characteristics of mathematics classes utilizing the block schedule. The experiences of teachers revealed they were seeing much of the same including lack of attention or engagement of students, less long-term retention, poor utilization of class time, lack of varied instructional strategies, too much time between

courses and magnification of absences. Finally, student data collected from PSSA and NWEA mathematics data showed that students from the applied-level classes were scoring well below grade level with 4.44% and 7.27% demonstrating proficiency at High Schools A and B respectively. The same data also showed that many students from college preparatory classes were also scoring below grade level with 28.57% and 46.36% demonstrating proficiency from High Schools A and B respectively.

These conditions are what prompted teams of teachers and administrators to seek a change and to suggest the implementation of a modified schedule combining both block and traditional formats. The traditional schedule was utilized for the applied-level mathematics classes at each high school and for the college preparatory classes at High School A. High School B did not feel the need to move their college preparatory classes to the traditional format due to higher student achievement and practical restrictions related to a building program taking place at the time. The need to develop a modified schedule resulted from student achievement scores falling short of the mark expected by state regulations. Students were not making the expected growth in mathematics on the block schedule in spite of district efforts to write curriculum in connection with the standards, to provide professional development aimed at effective instructional strategy within a block schedule, requirements for students to take the courses assessed by the PSSA, and consistency in delivering common assessments.

Findings of Research Question Two

The participants in this study revealed several differences that occurred as a result of the change of block schedule to a modified schedule allowing some mathematics courses to be taken for the entire school year for 45 minutes per day. The participants

agreed that block scheduling was still the most effective method for scheduling the upper level, honors, and advanced placement classes as it enabled those students who were more prolific in mathematics to go further into the subject area, thereby allowing for better preparation for their college programs. The teachers and administrators were both in agreement that the traditional full-year format was the best for the applied-level mathematics students. High School A was the only school that tried the traditional format with the college preparatory students. The teachers and administrator from High School A felt strongly that the full-year traditional method was the best for their college preparatory students as well. The teachers and administrator from High School B did not make the change to traditional schedule for their college preparatory classes due to higher existing achievement scores and practical needs involving a building program which was underway in their building at the time.

The changes noted by teachers and administrators with respect to students whose mathematics classes had moved to the traditional format were that they did produce better overall achievement results. They were able to hold student attention better and students were more actively engaged in the activities of the class. The administrators noted fewer distractions in class and better utilization of class time by the teachers, and the teachers reverberated the same sentiments. In addition, absences did not play as large a role in the achievement of the students. Overall, both teachers and administrators felt that the full year format was the best format to allow for long-term retention of concepts and skills, thereby resulting in better achievement scores on standardized achievement tests and end of course exams.

Findings of Research Question Three

The student data from PSSA and NWEA mathematics exams were collected in three ways: the overall data for all students in eleventh grade for each year data were available, the applied-level data for eleventh grade students, and the college preparatory data for eleventh grade students. The data were analyzed for means, standard deviations, percentage of change and significance using a 95% confidence interval. The overall data revealed that the change to a full-year schedule for mathematics classes correlated with significant growth for each high school in terms of their overall student population both in percentage demonstrating proficiency and in mean scale scores on PSSA with results taking two years to come to fruition at High School A and three years at High School B to realize significant growth.

Overall data.

The overall data were one indication that there may have been a benefit to a modified schedule. Contained within these data, however, were the results of students on the PSSA math exams whose variables were unchanged. Since overall data included every student in the school, students in honors, college preparatory, and applied level classes, were averaged together to find mean scale scores. Therefore, if honors or college preparatory students did not do as well in some years, the overall mean may very well be unaffected or negative even if the scores of applied level students increased. A better indication of positive or negative effect based on a change to the schedule of applied-level students would be the overall percentage of proficiency as these data demonstrated the change which occurred amongst groups of students who were not demonstrating proficiency.

In summary, the overall percentage of students proficient indicated significant growth in the years following the implementation of the modified schedule for both schools and since those data were a better indicator of change in achievement of students to whom the modified schedule was applied, those results indicated a potential correlation between the modified schedule and achievement scores of applied-level students. These data also showed that it took several years to achieve significant growth as it is not something that occurs overnight. As Paschler, Rohrer, and Cepeda (2006) indicated the longer the retention interval expected, the more spaced the presentations and practice need to be. It would make sense that those students in the first year of implementation had only had one year of spaced presentation/practice within their math classes while those in the second year would have had two years and by the third year three years. By the third year, the changes were realized in both schools, at least in terms of percentage of proficiency.

If the same data were projected into the future, the expectation would be that overall student achievement would continue to grow significantly until it reached a point of critical mass. As the achievement grows closer to the level of student potential, the rate of growth would slow due to the shortening of the improvement window. At this point, it may require additional variables to be adjusted to show further growth such as instructional practice, assessment strategies, or other factors. To have a clearer picture of the change in student achievement in correlation with the scheduling of applied-level courses, the applied-level data needed to be investigated specifically.

Applied-level data.

The data for the applied-level classes were consistent with the overall data revealing that the change to a full-year schedule correlated with significant growth for each high school in percentage demonstrating proficiency and in mean scale scores on PSSA, also taking two years to be realized at High School A and three years at High School B to realize significant growth. For applied-level students, the mean RIT scores for NWEA exams were also analyzed revealing significant growth after three years at High School A, but no significant growth at High School B.

Overall these data are an indication that there was a benefit to a modified schedule with respect to applied-level student achievement. Five out of six areas investigated initially indicated growth in connection with the modification of the schedule with respect to applied-level math courses. These data were specific to students in applied-level classes while removing the data from students who took math courses in college preparatory or honors level courses. Contained within these data, however, was one set of results on the NWEA math exams where achievement was unchanged. When the data were analyzed deeper to include cohorts of same students, it was revealed that the sixth area also had significant growth when comparing same students. These data indicated that it took two to three years for each school to realize significant changes and the changes were more pronounced when the assessment required a longer retention interval.

In summary, the overall percentage of applied-level students at the proficient level, the mean scale scores of applied level students in PSSA math exams, and the mean RIT scores on NWEA math exams indicated significant growth in the years following the implementation of the modified schedule for both schools. The NWEA mean RIT scores

for applied-level students showed significant growth in one school and initially no change in the other school until the cohort restriction was applied comparing same students and revealing that indeed these students had also made significant gains. As Paschler, Rohrer, and Cepeda (2006) indicated, the longer the retention interval expected the more spaced the presentations and practice need to be. It would make sense that those students in the first year of implementation had only had one year of spaced presentation/practice within their math classes while those in the second year would have had two years and by the third year three years. By the third year, the changes were realized in both schools based on PSSA percentage of proficiency, PSSA mean scale scores, and NWEA mean RIT scores.

Once again, if student achievement for the applied-level classes were projected into the future, the expectation would be that student achievement would continue to grow significantly for applied-level students until the point of critical mass was reached. At this point, the achievement would begin to level and other variables may need to be adjusted to see further growth. In addition to applied-level data being investigated specifically, this study also examined college preparatory student data to determine if there were changes in student achievement in correlation with the modification of the schedule for the college preparatory mathematics courses at High School A.

College preparatory data.

The college preparatory data were somewhat different than applied-level data considering that only High School A made the change to full-year scheduling at this difficulty level, but the same data were analyzed as with applied-level students. The college preparatory data revealed that the change to a full-year schedule for mathematics

classes correlated with significant growth for High School A in percentage demonstrating proficiency on PSSA. High School B also showed significant growth over the same interval even though they did not make the change to the traditional schedule. The mean scale scores for PSSA revealed no significant growth at High School A when the two years following implementation of the full year schedule were compared with one year prior to implementation of the new schedule, however, if compared to two or three years prior to implementation there was significant growth. There was not significant growth at High School B during the same interval, though they did not change their schedule for college preparatory classes. The mean RIT scores for NWEA exams, however, were also analyzed revealing significant growth in each year following the implementation of the modified schedule at High School A, while High School B showed no significant growth during the same interval.

High School A showed significant growth in percentage of proficiency and mean RIT scores in both years following the implementation of the traditional schedule for college preparatory classes when compared to one year prior to implementation and with mean scale scores when compared to two or three years prior to implementation. High School B also showed significant growth in percentage of proficiency for PSSA over the corresponding interval even though their schedule was not altered. There was not significant growth, however, for PSSA mean scale scores or mean RIT scores at High School B over the same interval. The changes that occurred at the applied and college preparatory level also positively impacted the overall data for each school. The percentage of students achieving proficiency demonstrated significant gains, but there were variables included within mean scale scores untouched by this study. These

variables included data from honors level courses and college preparatory scores in the years preceding implementation of full-year scheduling which are averaged into the mean scale score, yet were untouched by the change in schedule. Overall these data indicate that there may have been a benefit to a modified schedule with respect to college preparatory student achievement, however, it may be dependent upon the needs and abilities of the students.

For college preparatory students already demonstrating higher achievement, it may bode well to continue with the block schedule, while the traditional schedule may better suit the college preparatory students who are on the low average level. As Marchant and Paulson (2001) revealed in their study, the highest achievers were most complimentary of the block schedule while the lower achievers were the most critical. The data investigated with regard to modification of the schedule upon which college preparatory classes were taken revealed that significant growth occurred at High School A in each of the areas either compared to either one or two years prior to the implementation of the new schedule. The data also showed that High School B had significant growth in percentage of students demonstrating proficiency, but not at the other two data points. Each school had some significant growth at the college preparatory level regardless of whether classes were taken on the block or on the full-year format. In short, the higher the achiever, the better the block schedule seemed to function. Since the college prep students at High School B were in the higher average range based on the mean PSSA and RIT scores, the block schedule seemed to be the better option for those students. Since the college prep students at High School A were in the lower average range, the traditional schedule seemed to be the better choice for those

students. Consider, however, that High School A did show significant growth at all three data points measured, while High School B only showed significant growth on one data point. As indicated earlier, the schedule may not be the only variable at play; other participants such as instructional practice, assessment strategies, student population, placement of students, or remedial classes could also have played a role.

Had more longitudinal data been available, more differences may have been revealed. If data were projected into the future, the expectation would be continued significant growth in correlation with the traditional schedule due to students having more years on that schedule as well as teachers becoming more effective within the time frame allotted. Based on the small window available to this investigation it is difficult to conclude that the schedule made any definitive difference to student achievement at the college preparatory level. For college preparatory students, the traditional schedule correlated with significant gains at High School A and the block schedule correlated with some significant gains at High School B and therefore is cause to consider the potential of college preparatory courses continuing to be scheduled using the traditional format for the purpose of positively affecting student achievement.

Three-year cohort data.

The final data analyzed were the results of three-year cohorts of same groupings of students at both the applied and college preparatory levels comparing their pretest data from Algebra 1 to their posttest data from Algebra 2 after three years of mathematics instruction. The mean RIT scores from NWEA assessments were compared to reveal significant growth at a 95% confidence level for applied-level students at each high school who had taken all three mathematics courses on the full year schedule versus those

who had one or more years on block. In addition, the college preparatory cohorts were also examined revealing significant growth at each school regardless of whether they utilized the full-year or block schedule as the mode for structuring mathematics classes, in fact, High School B had consistent significant growth for all three cohorts, while High School A only had significant growth for the final cohort which incorporated two years of mathematics classes on the traditional schedule.

Additionally these data revealed that, after several years on a traditional schedule for the applied-level classes, there were fewer students who needed to repeat Algebra 1 courses either in the same year or in a subsequent year as evidenced by the changes in N over the three-year interval. In the first cohort, which contained students who had one year of math classes on the block schedule, there were a large number of students taking the pretest for Algebra 1 compared to the number of students taking the posttest for Algebra 2. As one studies the same data for subsequent cohorts, the disparity between the numbers of students greatly reduced suggesting less failures occurring as students have more years of instruction utilizing a full-year format. It is important to also note the following in regard to the cohorts. While the cohorts attempted to compare the same groups of students as they moved from year to year, the data available were solely groups of students in the same courses from year to year rather than the specific tracking of individual students. This was in accordance with the procedures for data collection reflecting the need to protect human subjects. The inclusion of students who had previously failed the course and were repeating it may have been contained in the data. There is also no account for transiency of the population where students may have moved in or out of these classes.

Although other variables may also impact the data contained in the cohorts, the cohorts showed continued growth and significant growth directly correlated to more years within the traditional schedule for applied-level students at both schools and applied-level students at High School A. College preparatory students at High School B also showed significant growth while continuing to remain on the block format. If these data continued to be projected into the future, the expectation would be continued significant growth until the point of critical mass where other variables may need to be considered such as further improvement of instructional effectiveness or assessment strategies.

Conclusions

The purpose of this study was to determine whether the change of the structure by which mathematics courses are scheduled from block format to traditional format would correlate to changes in the achievement of students taking these courses. The findings in this study provide information to school personnel in regard to actions they may take to enhance student achievement in mathematics.

This study revealed there were differences in achievement data that occurred in connection with the change in schedule. The data suggested there was improvement with the response of students in the classroom as well as the overall ability of students to retain content and skills due to the spacing of the presentation and practice. For example, this study showed significant growth in the overall student achievement as well as significant growth at the applied and college preparatory levels. This growth supports the research by pioneers in the spacing effect (Underwood, 1961; Hintzman, 1974; Dempster, 1988) as well as supporting findings of more recent researchers who were able to draw

connections specifically to achievement testing (Pavlik & Anderson, 2005; Pashler, Rohrer, & Cepeda, 2006) where the retention interval directly correlated to the spacing interval.

It is essential to note that while the findings revealed in this study would appear to show causality, they are only an indication of a correlation between student growth and the change to the master schedule. It must be conceded that other variables may have been at play which impacted this growth as revealed by the interviews of both teachers and administration. Administrator interviews revealed that there were many commonalities in the school district which served to neutralize many variables such as standards-aligned curriculum, graduation requirements, assessments utilized, and professional development. While these commonalities were in existence, the administrators indicated that data-based placement of students into courses of appropriate difficulty were also improved along with the implementation of the new schedule.

The math Edge program, which began during the 2003-2004 school year, may also have been partially responsible for the improvement of student achievement though this program had been in existence for three year prior to the modification to the schedule and certainly in existence at the time the baseline data in 2005-2006 were collected from which the comparisons were drawn. Teachers revealed that instructional practice may have had an impact as it was difficult to maintain student attention and to keep students engaged, especially with the lower level classes. When teacher instructional practice was compared, in many cases the instructional practice was similar in 90 minute classes to 45 minute classes save the number of topics introduced within a single period.

Teachers also suggested that students needed to have more practice time, soak time, or rumination in order for them to retain concepts for a longer period of time which spoke directly to the issue of formative assessment as a practice to allow for more student practice in an effort to attain mastery. In addition, these findings support research further connecting mathematics instruction in relationship to the spacing effect (Rohrer & Taylor, 2006) and introspection on assessment strategies as a disadvantage to block scheduling (Staunton, 1997).

The research reviewed in this study also demonstrated that there were many disadvantages incurred by the use of the block schedule especially when related to students in mathematics courses (Marchant & Paulson, 2001; Veal & Flinders, 2001; Evans, Rice, & McCray, 2002). These disadvantages included, among other items, the need to maintain the attention of students and to keep them actively engaged in the instruction while using classroom activities designed to provide them with the learning necessary to succeed on their assessments. The teachers felt that when the students were more attentive and involved in the classroom activities it had a direct impact on how well they were able to achieve, and teachers felt they were better able to maintain attention when utilizing a 45-minute full year schedule. The research detailing the advantages of block scheduling (Canady & Rettig, 1995; Hurley, 1997) also suggested that block scheduling better provides educators with the time necessary to vary their instructional strategies, thereby making it more possible to maintain attention and keep students engaged in learning. It is apparent that both the research and the findings in this study put much of the responsibility for success into the hands of the teacher with regard to

instructional effectiveness that serves to engage students and keep them active in their learning.

Although the findings in this study did not specifically address the issue of how and why assessments are given as was suggested by Staunton (1997), it does not mean that assessment technique does not have a role to play in how well students achieve in mathematics. While the study only uncovered procedural implications for delivery of assessments through school district policies and procedures, the method of assessment delivery and the purpose driving the need for assessment certainly has merit and should be investigated further by school and district officials. Finally, the administrators' interviews alluded to the notion that student engagement, attention, and variety of instructional technique were areas observed both before and after the change to the scheduling method suggesting some responsibility on the part of administration to ensure that teachers are effective in their practice. The implication here would be that supervisory practice may also serve a role in the achievement of students by setting standards for planning, preparation, instruction, and professional responsibility which need to be met on a daily basis within the classroom.

There are several implications which also emerge from the findings and discussion which suggest that student achievement may be impacted by a variety of variables, one of which is the need to have a schedule conducive to lengthening the retention interval by spacing the time between presentation and practice. District administrators, building principals, teachers, and other school personnel can now place a greater importance on mode of scheduling, the practice of instruction, the delivery of assessments, and the supervision of staff in an effort to see student achievement blossom.

There are several implications which now emerge from this study making the understanding of student achievement more clear as well as isolating some factors which serve to establish a greater awareness of how instruction is delivered, how learning is assessed, and how teaching practice is enhanced. Once again, it is important to concede that these implications suggest other variables playing a role in the success of students in addition to schedule change. The change in schedule was not a causal factor, but rather only a correlation to the significant growth in student achievement that occurred following the schedule change.

Implications for Practice

“Given the diversity in public schools and the growing trend toward requiring the successful completion of Algebra 1 for graduation, a schedule that allows students to complete courses in different amounts of time may be one key to success” (Rettig and Canady, 1998, p. 56). Student achievement is one of the primary measures of the success of a school that is now used to rank a school using a report card system in Pennsylvania. In this age of accountability where schools are expected to demonstrate proficiency and growth in all students, it becomes increasingly important to ensure that structures and systems promote the ability for students to continue to achieve more, especially in mathematics. The building administrator can control the structure of the schedule to facilitate the instruction in the classroom to ensure that presentation of content is spaced over time promoting a longer retention interval. The traditional schedule is one way to assist the teacher in spacing the learning so that it can be absorbed into long term memory.

The world of education used to see time as a constant and learning as a variable based on how well the student was able to regurgitate what was presented to him/her. The world of education today sees the student as taking ownership of his/her own learning with the teacher as the facilitator. Time is becoming the variable, while the expectations for learning based on standards have become the constant. Schwahn & McGarvey (2011) note, “The further that learners get behind in a group-paced, time-driven system, the quicker and the further they will continue to fall behind” (p. 9). For this reason, it is incumbent upon teachers and administrators to ensure that learning remains the constant by incorporating strategies that keep students engaged in learning on their level using assessment data for placement or planning for instruction. Especially in the mathematics classroom, this new world of variability in terms of time requires that teachers are using varied strategies to differentiate the learning based on the needs of the learner and administrators have to ensure that these practices are happening in every classroom by encouraging Professional Learning Communities and supervising teachers in such a way that leads to better instructional practice. For these reasons, the implications for this study are divided into two major categories: structuring the schedule to promote longer retention intervals, and instructional practices guided by administrative supervision to promote student learning and thereby better student achievement. While there are many variables which may play a role in the promotion of student achievement, the implications in this study will be limited to the findings obtained in this research.

Schedule Modification

Rettig and Canady (1998) were correct when they wrote that “if students are to be expected to master higher level mathematics courses successfully, schedules must be

devised in which time becomes the variable and not achievement” (p. 65). Studies which measure student achievement based on standardized state testing in connection with creative scheduling techniques may continue to inform school and district personnel how best to facilitate the learning of students. Consideration of the effect the spacing of content presentation and practice has on student achievement also needs to be considered by curricular teams and practitioners in the classroom as they determine scope and sequence of their mathematics courses and incorporating opportunities for review so that students are able to retain the information for periods of time. While PSSA exams are still the standard by which student achievement is measured in grades 3-8 in Pennsylvania, the Keystone exams have now replaced the PSSA exams for measures of achievement in high school.

Specifically in the area of mathematics, students are currently expected to demonstrate mastery on the Keystone exam for Algebra 1 as a demonstration of meeting the state requirements for graduation from high school in addition to the minimum credit attainment requirements. Since Keystone exams are taken at the conclusion of the course rather than in eleventh grade, the retention interval required to demonstrate proficiency is the end of the course. This concept mirrors the data in this study pulled from the NWEA mathematics assessments based on mean RIT score since these were end of course exams to determine student achievement for the school district considered in this case study. Moving forward, it is still incumbent upon school and district administration to determine the best use of time in relation to mathematics instruction to ensure they are considering all variables before determining the best way to schedule their mathematics courses. As Childers and Ireland (2005) remarked, “Neither all block nor all traditional schedules best

serve all students, teachers and subjects” (p. 49). Administrators must be committed to doing what is best for their particular schools and most importantly for their students, within the confines of the variables allotted to them. While the Keystone exams only expect an end of course retention interval, college placement exams would require a much longer retention interval to guarantee success. As Rohrer and Taylor (2006) found, distributed practice is twice as effective as massed practice for any retention interval that is longer than four weeks. This premise is also consistent with the feedback from teachers in this study that the students whose courses changed to traditional schedule were scoring better on end of course exams thereby demonstrating higher achievement.

For states which utilize other forms of assessment to substantiate student achievement or growth in mathematics, a study of the schedule could also prove to be a valuable undertaking. It is the intent of all educators to ensure that the learning taking place in the classroom is able to extend to practical application within life itself requiring that retention of mathematics content and skill is long-term. The more distributed the presentation and practice, the longer the retention interval (Hintzman, 1974). This finding would suggest that regardless of what accountability may be placed on a school, whether federal, state, or local regulation, it behooves the leadership of the school to match a schedule with the needs of the student so that the student is best able to retain what has been learned to use in life application. Both the student data found in this study and the feedback from teachers and administrators indicated that a more distributed presentation and practice yields a longer retention interval, especially with the lower achieving students.

The findings of this study would suggest that the continued goal of schools and districts should be to ensure that the learning of mathematics takes place all year to maximize the retention interval through the high school years in preparation for college and even further into lifelong mathematics capacity. It should wake the imagination of school leadership to realize that schedules can and should be differentiated, just like teaching strategies, to meet the needs of the particular subject being instructed, the abilities of the students, and the aptitude of the teachers. Perhaps a block schedule for upper level mathematics classes and a traditional schedule for the applied-level mathematics classes is the right way to go with further conversation as to best method with the college preparatory students.

One might think about using a mixed scheduling method for college preparatory classes based on the students and teachers assigned to those classes; especially since the results were inconclusive with regard to whether traditional or block scheduling works best with college preparatory classes. Further pondering may reveal that block scheduling is fine as long as the program of studies stipulates that students take two mathematics classes successively each school year or that a single math course is taken all year, but spread over two school years such as an Algebra 1A and 1B scenario. As Marchant and Paulson (2001) and Staunton (1997) revealed, students need to have math classes every day in order to maintain the skills and practice necessary to be successful in a math class. One teacher in this study also shared that he/she felt math courses needed to be held for 60 minutes every day.

Finally, it was noted by Evans, Rice, and McCray (2002) that one of the concerns which led to the development of the block schedule initially was that teacher course loads

were high making it difficult to adequately plan for classes so that student could be more actively engaged. The design of the block schedule was to lighten the load on teachers giving them more time to plan since they were not planning for as many classes and thereby could devote more time to development of outstanding lessons. Regardless of the scheduling method, it is plausible for administration to consider teacher workload as schedules are developed. Schedules should be developed based on what is best by subject and difficulty level, the needs of the students, but also the feasibility for teachers to have adequate time to plan should be considered as well. If possible, it would be incumbent upon schedule developers to consider the number of courses for which a teacher has to prepare to keep the number of preparations low so that teachers can adequately plan for lessons that are more engaging. As Hurley (1997) shared in his study, teachers have more time to focus when they are responsible for fewer preparations. In this study, both administration and teachers shared that the most important factor to the promotion of student achievement was the ability to keep students engaged and focused in class. This realization points directly to the problem sought to be solved in this study as well as its purpose. Schools which are experiencing lack of growth in student achievement have the option of making changes to schedules in an effort to affect positive change in the achievement of students.

Whatever the mode of scheduling determined by a school or district, it is important to keep in mind that full-year scheduling of mathematics courses only facilitates the teacher with maintaining attention and keeping the students actively engaged. The teacher must also be willing to embrace instructional technique that is

appealing and that demonstrates best practice in order for students to effectively make the intended growth.

Instructional Technique

Based on the findings of this study as well as the research of others (Canady & Rettig, 1995; Marchant & Paulson, 2001; Evans, Rice, & McCray, 2002), it is absolutely essential that teachers utilize methods within the classroom designed to hold the attention of students by using a variety of instructional strategies to pique their interest of mathematics. For teachers, this becomes a paradigm shift from the way they were taught mathematics through lecture, formulas, and a specific set of steps to follow all in the correct order to a more inquiry-based approach that expects students to not only solve a problem, but be able to discuss how they solved the problem, which may have multiple approaches, as well as why they chose the approach they did. Danielson's (2013) Framework for Teaching suggests that the indicators of students being engaged in learning are that "students are actively working, rather than watching while their teacher works" (p. 71). Engagement also requires that "learning tasks have multiple correct responses or approaches and/or encourage higher-order thinking" in which "students are invited to explain their thinking as part of completing tasks" (p. 73).

Fuson, Kalchman, and Bransford (2005) reveal three principles that must guide the mathematics classroom in order for depth of learning to occur and for students to make meaning of their learning to the point of evaluating the correctness of an answer on their own. These principles are that teachers must build on what students already know, that instruction is a blend of factual knowledge and conceptual understanding, and that students are able to use metacognition as a means to monitor their own practice.

Pragmatically speaking, these principles require the mathematics teacher of today to change the methods by which mathematics instruction is delivered in order to develop mathematics within the student body. It requires developing a community of learners who work as a team to solve problems through inquiry, who discover methods to a solution on their own, and who talk about how and why those solutions were reached with their peers while the teacher listens and offers feedback as a facilitator.

This “new” method of mathematics instruction may require the teacher to reorganize how time is utilized within the classroom by having students receive the direct instruction through a podcast or by studying examples for homework as preparation for the “work session” that will now happen in the classroom. This is one way for time to be a variable, while learning is constant (Schwahn & McGarvey, 2011). Ultimately, the teacher should be striving to place a balance on the three areas of mathematics proficiency including a strong fact base, a conceptual understanding of how numbers work, and the ability to pull both together in order to solve problems in an efficient and correct manner.

Teachers and administrators revealed that varied instructional strategies and higher level of engagement of students were the most important concepts related to student achievement. These sentiments echo the findings from earlier research by Knight and DeLeon (1999) and Hurley (1997) who both shared that teaching methods were paramount to students achieving well. Both studies found that teaching needed to have variance to hold student attention and thereby promote more active engagement. If school districts want to see student achievement improve, then the methods used by teachers to instruct must also improve. Methods of instruction, however, need to be

coupled with a specific knowledge of the abilities of students in connection with their preconceptions in order for instruction to be properly planned and effectively delivered.

Assessment Strategies

The findings of this study also revealed that the school district had made strides in both policy and procedures to ensure that assessments were commonly produced and delivered in an effort to maintain consistency across the school district allowing for data to be used to develop and revise core curriculum based on student response to standards and assessment anchors. The previous research also noted that assessment strategies have an impact on how students achieve (Staunton, 1997). Until this point all assessments discussed which had been used to gather data on student achievement were summative in nature and designed to determine how much information and skills students had retained from their instruction. If used properly, formative assessments can also have a tremendous impact on the instruction of students enabling a teacher to ensure that instruction is connecting with student preconceptions and skill base to more actively engage their minds in the learning process.

Marzano (2010) defines formative assessment as “a process that narrows the scope by requiring that the assessments be used for the purpose of modification” (p. 34). The implication here is that teachers are assessing what students know and are able to do so that they can more accurately design instruction intent on moving students forward from where they currently are. Formative assessment allows a teacher to develop a knowledge base for their students, their strengths and their needs, so that activities and resources can be gathered to assist them to overcome their needs by using their strengths and to close the gaps that may exist in their knowledge base while enriching the areas

where they have already demonstrated mastery. Knowledge of students allows the teacher to develop data-based goals for their class by identifying patterns or trends in their core instruction and determining what the root cause is for areas of discrepancy. Once the causes are found, the teacher can then develop goals for the class as well as strategies to utilize to achieve those goals. Finally, the teacher puts the plan into action by delivering the lesson plans to the students while adjusting for individual differences by providing both interventions and enrichment to students where appropriate (Hall, 2008). Assessment used in this way informs instruction and enables the students to be more engaged in their work since they are receiving instruction at a difficulty level appropriate to both support and challenge them.

Danielson (2013) also notes that in order for effective instruction to take place the teacher must be using assessment as a means for instruction. This plan calls for teachers to share with students the expectations for achievement by utilizing tools and rubrics specifically designed to communicate responsibilities, but to also gather data on how well the students have mastered the material. The rubric can be used by students as a bar to attain as well as a self-assessment tool to know how they measure in relationship to the expectations. Using assessment in instruction also calls for the teacher to place students into instructional groups based on the data collected either homogeneously or heterogeneously. While the students are working in these groups, which accomplish some of the engagement goals noted in the previous implication, the teacher can be circulating the classroom to gather more data on student acquisition of the material while providing feedback to students of how they may improve.

One element of the spacing effect shared by Rohrer and Taylor (2006) states that if presentation and practice are properly spaced then the results of assessments (meaning summative) will be improved especially for retention of skills for longer than four weeks. Formative assessment speaks to the heart of the spacing effect because it enables a teacher to continue to space both the presentation and practice of concepts until the student is able to demonstrate mastery. As Pavlik and Anderson (2005) exposed, with intermittent practice sessions, or formative assessments, there may be a possibility where a student will yield lower results, but ultimately the long-term achievement should be positively impacted by mastery of the concept. Once a student masters the concept, they should be able to demonstrate that mastery on a summative assessment for achievement. Staunton's (1997) study of teachers surveyed showed that new methods of testing and assessing allowed teachers to be more knowledgeable of the needs of their students and thereby making them better able to provide more relevant instruction. This was one area which the scheduling method enabled and a principle that was also shared by administrators in their interviews within this study. Teachers are encouraged to ensure that their assessments are formative and summative and that they also use higher-level thinking skills and Bloom's taxonomy so that students are thinking and applying the content.

If assessment were used in such a way as to inform instruction while at the same time collecting data to demonstrate mastery, it would enable the teacher to provide instruction tailored to meet the individual needs of students and would enable the student to have a safety net with which to fail during practice only to promote better success in the end. So it becomes important to have each of these facets in place, working in

concert with one another for student achievement to improve. It now becomes necessary for administration to develop a system of checks and balances to ensure these facets are in place and being utilized consistently.

Staff Supervision

The final implication relevant to this study is the onus now put onto administrators to create a system which expects and encourages the staff to be more introspective of their own practice so they can more effectively instruct the students thereby promoting better student achievement. This study revealed that administrators drew their opinions of change to student achievement based on their observations of classroom activity and teacher instructional delivery. Danielson and McGreal (2000) suggest that “teacher evaluation systems in which educators not only achieve the dual purposes of accountability and professional development, but can merge them” (p. 10). This implies the need to develop supervisory systems that allow for collaboration between teacher and administrator as well as provide a means to collect evidence used in teacher evaluation.

It would behoove administrators to place a strong focus in their buildings on improving instructional effectiveness, student engagement in the classroom, teacher preparation for instruction based on individual student needs and opportunities for staff to collaborate for the development of team goals to which they are able to tie their individual goals. The administrator should commit to using staff meeting time for the purpose of professional development keeping all communication and training throughout the year connected to the building goals designed to improve instruction. Grade level teams or subject departments should then develop team goals that extend the building

goal to their particular subject area or grade level as core teams. Core teams should follow the same process described for the individual teacher with regard to pulling data, looking for trends, seeking for causes, identifying goals, and putting action steps together to achieve those goals. “These are some of the steps a leader can take to empower a core team by passing of ownership of an individual vision to the larger team” (Graham & Ferriter, 2010, p. 29).

This sharing of a vision and expectations for teams to meet with one another to develop and carry out a plan will require some structural changes to facilitate communication. Administrators should find time in the school day for teams to be able to have common planning time to enable teams to meet. A differentiated supervision plan may also need to be put into place where teachers have the ability to peer observe, work on action research or develop portfolios to encourage a professional learning community. Priority should be given to professional responsibilities inherent to excellent instruction which expect teachers to reflect on their teaching with a constant search for self and team improvement. They should be challenged to participate in professional development as a staple for developing efficacy whether at a conference, a faculty meeting, peer observation, or online research. Finally, participation in the professional community should become the norm so that the expectation of teamwork is evident in every facet of the educational program (Danielson, 2013). Through development of expectations, the monitoring and communication about those expectations, and feedback given to staff on a regular basis, the administrator can help to ensure that the vision is being executed and that instructional practice is outstanding. Administrators in this study revealed that

observation and conversation with staff were the primary methods by which they ensure that curricular practices are being carried out properly.

Administratively we sit down with the teacher, we collaborate with them and go through a variety of questions which we discuss, we review their utilization of technology within the classroom, we may assess their communication with students and parents, it goes far more than just us looking at what we visibly take in during that window of time. In addition, we have also implemented learning walks within our building in which on no scheduled structured time, we will go in and visit various classrooms throughout the course of the year on a daily basis if possible, to assess particular things which our staff have identified as items that we should see when we come into their classroom. Those include that the students are engaged, that the teacher is engaged, and that the instruction is in alignment with the curriculum. So those are a couple of ways that we can assess and monitor that what we expect to be delivered is, in fact, occurring. (Personal communication, Administrator 3, July 15, 2009)

This revelation from one administrator reverberated the principles that desired practices must be communicated, facilitated and consistently monitored to ensure expectations are being fulfilled. As Veal and Flinders (2001) reveal in their study faculty need to be provided with “time to apply innovative practices, receive feedback, and collaborate with other teachers” (p. 30). If given this time, it will certainly facilitate the opportunities for innovation which in turn will serve to raise the achievement of students.

Limitations of the Study

One limitation inherent in this study was the small window of achievement data available to the researcher which were specific to the difficulty levels of the classes. With both applied-level and college preparatory data, there were weaknesses with how many years were available with which to compare changes in order to draw conclusions. With applied-level data, there was only one year of student achievement results prior to the implementation of the modified schedule with which to compare the achievement scores following the implementation. One could extrapolate based on the overall achievement data from the two years prior to assume that those years would have been even lower than the data in 2005-2006, but one does not know for sure.

With the college preparatory data, while there were more data available prior to the implementation of the modified schedule, there were only two years of data available following the implementation. While these two years did produce significant differences from the data available before the implementation of the modified schedule at High School A, there were not enough years to notice a pattern that may have differentiated the two schools from one another. As was revealed with the applied-level data, it took up to three years to realize the full potential of the modified schedule and the same could have been true with the college preparatory data. There were indications the modified schedule may have contributed to increased performance by students, but there were not enough data to substantiate a certainty at the college prep level.

Another potential limitation to this study, as revealed by the interviews with administrators, was the addition of the Edge classes for students who were not meeting with proficiency and the focused attention on scheduling students into classes of a

difficulty level consistent with the individual student's achievement data. While both of these additions to the school environment served to benefit the needs of students in an effort to achieve greater success, these variables may have also impacted the growth in student achievement thereby making it difficult to determine whether the modified schedule or the Edge class or the appropriateness of student placement made the most difference in the resulting student achievement data. It was revealed that Edge classes were in existence as early as the 2003-2004 school year and therefore had been a part of the data used to compare student achievement prior to schedule modification with the achievement data after modification. The response of students within the classroom based on teacher feedback in the focus groups in connection with the research on spacing effect is the only way to know that the modified schedule was beneficial, though these other variables may certainly have contributed and so it must be conceded that these variables may also have played a role in the changes in student achievement which occurred after the change to the schedule.

While the qualitative nature of the interviews and focus groups echoed much of what had already been written about the effects the block schedule may have on mathematics instruction in accordance with the spacing effect, the interviews and focus groups were limited in several ways. First, respondent bias could have been a limitation because the staff and administration chose this method of scheduling in the hopes that it would produce better achievement results. Since the collection of teacher data was not a random sampling of teachers, but teachers could choose whether or not to participate could have drawn only those teachers who were in favor of the move to traditional scheduling and thereby not a true cross-section of the entire mathematics department.

Other influences that might factor into this bias could be the fact that the researcher was an employee of the school district at the time the focus group data were collected. Though the attempt was made to neutralize this bias by having a third party collect the teacher responses as well as providing anonymity for the staff, the teachers' perceptions and responses potentially could have been guarded due to the nature of this phenomenon.

Finally, interview and focus group data were limited by the fact that the interviews and focus groups only included administrators and teachers without the input student voice. During this study it was revealed that student input may have given further insight into how well students felt they were achieving based on the change in the schedule, how the instruction had changed, and whether they felt they were able retain information and skill better. At the time of this realization, it was improbable for the researcher to change the methodology and therefore student voice is missing from this study.

Recommendations for Further Study

Future research potentially could be a study of how other variables may play a role in the overall achievement of students such as the transiency of the population. If the school has a more transient population, is there a schedule that works better for those students whether block or traditional? Perhaps some of the structural changes to the school environment play a role such as the institution of the additional class time for students who did not demonstrate proficiency in the way or who are predicted to not be proficient at the time of testing in the way of Edge classes or some other form of remedial program. Additionally, what role did the focus on better placement of students into

courses with difficulty levels more pertinent student data play in the achievement of students. A future study could seek to focus on those variables.

With the institution of the Keystone exams now at the state level, a future study could replicate this study using the Keystone exam for Algebra 1 as an instrument in connection with the achievement and growth models now required by the Pennsylvania Value Added Assessment System (PVAAS) which informs a School Performance Profile (SPP). It would be a valid pursuit to determine if the same phenomena exist with an end of course exam versus one that is given in eleventh grade requiring the students to maintain content knowledge and skill for three years. Rohrer and Taylor (2006) suggest that for any retention interval longer than four weeks, distributed practice should be used as it is twice as effective as massed practice. A study of this nature would seek to discover if this proposition holds true for end of course exams as it did with a retention interval of three years in this study.

Another potential study could further include the honors level classes to the investigation as well to determine if students at those levels would also benefit from the institution of a modified schedule. The PVAAS growth model now in existence brings students at all levels into play with achievement data as the SPP is determined by students achieving well, demonstrating growth year to year, and percentage of students who score advanced on the corresponding PSSA or Keystone exam. The assumption in this study was that most honors level students take double mathematics courses in a school year, but there are some who only take one mathematics course in a school year. A study of this nature would seek to uncover whether a full year schedule would also

correlate with improvement in student achievement, growth, and increased percentages of students scoring advanced at the honors level.

The study of student data potentially could be gathered by individual student rather than by classes to determine if individually students have benefitted from a full-year schedule versus a traditional one. As was revealed by the three-year cohort data, the numbers of students changed dramatically from the beginning of a cohort to the end indicating that while a group of students were followed from year to year with data, the data were not necessarily attached to same students and therefore only provided a limited view of actual growth. A study of this nature would extend the portion of this study that looked at cohort data and thereby the impact on the same students. If the data were collected individually by student, the impact could be more telling than the general student population data.

Additionally, it is suggested that the focus groups could be replaced by individual interviews with the respective teachers. The group setting may have allowed some of the participants' responses to be skewed by the responses of others in the room and therefore interviews, while taking a lot more time, could gather more valid perceptions from teachers. The collection of student input as a result of the schedule changes may have also revealed new insights and implications for educational practice which this study left undiscovered. A future study should consider both expanding the participant base and the method by which participant feedback is obtained to further enhance the findings of the study.

Finally, further research should consider the environments of the classrooms in which the students took the classes as well as teacher efficacy and effectiveness in

instructing in those classes. While the curriculum, assessments, policies, and training may be common among all teacher and classes in a school district, each teacher is an individual and brings with them a varied level of mathematics knowledge and skill to instruct which continues to be variable regardless of the district or school attempts for consistency.

Chapter Summary

The purpose of this study was to investigate how changing the schedule within which mathematics classes are taken would affect the instruction in the classroom and the achievement of students. The indications from the analysis of the data gathered in this study are as follows:

- the daily 45 minute class all year allows for presentation of content and practice of skills to be more distributed over time and therefore results in a longer retention interval;
- student achievement at the applied-level was significantly increased by the change of mathematics classes from block to traditional format;
- student achievement at the college preparatory level may also have been increased significantly, but more time and data were necessary to substantiate; and
- for mathematics classes, the traditional schedule facilitates better utilization of class time, less time of hiatus between mathematics courses, and less of an impact due to absenteeism.

There were factors that emerged from this study that would serve as guidance to a school in developing a schedule conducive to promoting better student achievement in mathematics. First it is important to put policies and procedures into place that connect

the curriculum with the content standards expected at the state, district, and school level, provide for assessment procedures that work to neutralize variables, put requirements into place that guide students through the appropriate coursework to prepare for assessments, and utilize assessment data, coursework, and teacher recommendation to place students into courses designed to be at their ideal instructional level.

Next, schools need to facilitate the instruction that occurs within the classroom by providing an appropriate schedule which assists the teacher in utilizing class time effectively and assists the student with receiving instruction and opportunity for practice in a manner that allows retention of the information and skills for a longer interval of time. As Childers and Ireland (2005) remarked, this is not a one-size fits all approach, but must be considered in light of the needs of the teachers, students, subject areas being instructed as well as difficulty level of those subjects. Responses from this study revealed that teachers felt it was important to approach the applied-level classes with the full year in mind and some teachers also felt the same about college preparatory level classes. This was consistent with other studies revealing that mathematics teachers felt the full year classes were most important for the continuation of knowledge and skills pertaining to a course where skills build upon one another, like mathematics (Marchant & Paulson, 2001; Lawrence & McPherson, 2000; Trenta & Newman, 2002; Hurley, 1997a; and Staunton, 1997).

Finally, the findings of this study resulted in implications for school administrators, teachers, and other staff to be reflective about instructional practice looking for ways to keep students more actively engaged in authentic classroom instruction that incorporates collaboration, communication, and reflection on

mathematics practice. Implications regarding the delivery of assessments and usage of data to inform instruction so that lessons are planned around the needs and abilities of students are essential for student to connect new learning to preconceptions. This focus on instructional practice also puts a greater importance on staff supervision to encourage professional communities, teamwork in developing goals, and an overall commitment to professional inquiry as a means to enhance instructional delivery and professional practice.

Teachers will have to acquire new instructional skills in order to bring the standards to life for their students. Teaching for deep conceptual understanding, for argumentation, and for logical reasoning have not, after all, been high priorities in most school districts or preparation programs. In most classrooms, students don't take an active role in their own learning, nor do they (respectfully) challenge the thinking of their classmates. All of this will represent a major departure, and therefore a major challenge, for many teachers (Danielson, 2013, p. 5).

Schools and districts must also continue their strides toward meaningful professional development allowing them to provide best instructional practice in their delivery of content by using varied instructional strategies to meet the individual needs of students based on assessment data to maximize their teacher effectiveness.

REFERENCES

- Alderman, D. (2000). *A comparison study of the relationships of 4/4 block scheduled schools and 7-period traditional scheduled schools on the standards of learning tests for Virginia public secondary schools*. (Doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA. Retrieved from <http://www.buenabands.org/block-schedule/Alderman-dissertation.pdf>
- Arnold, D. (1998). *Comparison of achievement in 7a/b block scheduled schools and 7-period traditional scheduled schools in Virginia*. (Doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA. Retrieved from <http://scholar.lib.vt.edu/theses/available/etd-32298-9044/unrestricted/ETD.PDF>
- Berg, B. (2004). *Qualitative Research Methods for the Social Sciences* (5th ed). Boston, MA: Pearson.
- Bresciani, M., Zelna, C., & Anderson, J. (2004). *Assessing student learning and development: A handbook for practitioners*. Washington, DC: NASPA.
- Canady, R. L., & Rettig, M. D. (1995). *Block scheduling: A catalyst for change in high schools*. Princeton, NJ: Eye on Education.
- Canady, R. L., & Rettig, M. D. (2001). Block scheduling: More benefits than challenges. *NAASP Bulletin*, 85, 78-86.
- Castillo, J. J. (2009). Convenience Sampling. Retrieved from <http://explorable.com/convenience-sampling>
- Childers, G. L., & Ireland, R. W. (2005). Mixing block and traditional scheduling. *NAASP Bulletin*, 71(3), 43-49.

- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing from among five traditions*. Thousand Oaks, CA: Sage.
- Crowl, T. K. (1996). *Fundamentals of educational research*. (2 ed.) Madison, WI: Brown & Benchmark.
- Danielson, C. (2013) *The Framework for Teaching Evaluation Instrument*. Princeton, NJ. Retrieved from <http://www.danielsongroup.org>
- Danielson, C., & McGreal, T. L. (2000). *Teacher Evaluation: To Enhance Professional Practice*. Princeton, NJ: ETS.
- Data Recognition Corporation (DRC). (2007). *Technical report for the Pennsylvania system of state assessment: 2007 reading and mathematics*. Harrisburg, PA: Dept. of Education. Retrieved from <http://www.pde.state.pa.us>
- Dempster, F.N. (1987). Effects of variable encoding and spaced presentations on vocabulary learning. *Journal of Educational Psychology*, 79(2), 162-170.
- Dempster, F. N. (1988). The spacing effect: A case study in the failure to apply the results of psychological research. *American Psychologist*, 43(8), 627-634.
- Dempster, F. N., & Farris, R. (1990). The spacing effect: Research and practice. *Journal of Research and Development in Education*, 23(2), 97-101.
- Evans, W., Rice, S., & McCray, A. (2002). Block scheduling: An evaluation of outcomes and impact. *The Clearing House*, 75(6), 319-323.
- Fuson, K. C., Kalchman, M., & Bransford, J. D. (2005). Mathematics understanding: An introduction. Retrieved from <http://www.bsd405.org/portals/0/curriculum/mathadoption/Bransford%20Ch%205.pdf>

- Garson, D. (2004). *Quantitative Methods in Public Administration: Focus Group Research*. Retrieved from <http://www2.chass.ncsu.edu/garson/pa765/focusgroups.htm>
- Gay, L. R. (1973). Temporal position of reviews and its effect on the retention of mathematics rules. *Journal of Educational Psychology*, 64(2), 171-182.
- Gay, L. R., Mills, G. E., and Airasian, P. (2006). *Educational research: Competencies for analysis and applications*. Upper Saddle River, NJ: Pearson.
- Gibbs, A. (1997). *Focus Groups*. Retrieved from <http://www.soc.surrey.ac.uk/sru/SRU19.html>
- Grady, M. P. (1998). *Qualitative and action research: A practitioner handbook*. Bloomington, IN: Phi Delta Kappa.
- Graham, P., & Ferriter, W. M. (2010). *Building a Professional Learning Community at Work: A Guide to the First Year*. Bloomington, IN: Solution Tree Press.
- Gruber, C. D., & Orwuegbuzie, A. J. (2001). Effects of block scheduling on academic achievement among high school students. *High School Journal*, 84(4), 32-42.
- Hall, S. L. (2008). *Implementing Response to Intervention*. Thousand Oaks, CA: Corwin Press.
- Hintzman, D. L. (1974). *Theories in Cognitive Psychology: The Loyola Symposium*. Oxford, England: Lawrence Earlbaum.
- Hurley, J. C. (1997a). The 4 x 4 scheduling model: What do students have to say about it? *NASSP Bulletin*, 81, 64-72.
- Hurley, J. C. (1997b). The 4 x 4 scheduling model: What do teachers have to say about it? *NASSP Bulletin*, 81, 53-63.

- Jenkins, E., Queen, A., & Algozzine, B. (2002). To block or not to block: That's not the question. *The Journal of Educational Research*, 95(4), 196-202.
- Knight, S. L., DeLeon, N. J., & Smith, R. G. (1999). Using multiple data sources to evaluate an alternative scheduling model. *High School Journal*, 83(1), 1-13.
- Kramer, S. L. (1997). What we know about block scheduling and its effects on mathematics instruction. *NASSP Bulletin*, 81, 18-82.
- Lagemann, E. C. (2000). *An elusive science: The troubling history of education research*. Chicago, IL: Chicago Press.
- Lawrence, W. W., & McPherson, D. D. (2000). A comparative study of block scheduling and traditional scheduling on academic achievement. *Journal of Instructional Psychology*, 27(3), 178-182.
- Marchant, G. J., & Paulson, S. B. (2001). Differential school functioning in a block schedule: A comparison of academic profiles. *High School Journal*, 84(4), 12-20.
- Marzano, J. (2010). *Formative Assessment & Standards-Based Grading: Classroom Strategies that Work*. Bloomington, IN: Marzano.
- Maxwell, J. A. (2005). *Qualitative research design: An interactive approach*. Thousand Oaks, CA: Sage.
- Moore, D. S. (2010). *The Basic Practice of Statistics*. New York, NY: W. H. Freeman.
- Mulroy, P. (2008). *School related factors and experiences that influence high school graduation rate*. (Doctoral dissertation). Retrieved from DSpace Indiana University of Pennsylvania, Indiana, PA. (2069/135)

- National Academy of Sciences. (2005). *The Concerns Based Adoption Model (CBAM): A Model for Change in Individuals*. Washington, DC. Retrieved from <http://www.nas.edu/rise/backg4a.htm>
- National Association of Secondary School Principals (NASSP). (1996). *Breaking ranks: Changing an American institution*. Reston, VA: NASSP.
- National Commission on Excellence in Education (NCEE). (1983). *A nation at risk: The imperatives for educational reform*. Washington, DC: U.S. Government Printing Office.
- National Commission on Time and Learning (NCTL). (1994). *Prisoners of time: Report of the National Education Commission on Time and Learning*. Washington, DC: U.S. Government Printing Office.
- Northwest Evaluation Association (NWEA). (2004a). *About us*. Retrieved from <http://www.nwea.org>
- Northwest Evaluation Association (NWEA). (2004b). *Measures of academic progress (MAP): Overview*. Retrieved from <http://www.nwea.org>
- Northwest Evaluation Association (NWEA). (2004c). *Reliability and validity estimates: NWEA achievement level tests and measures of academic progress*. Retrieved from <http://www.nwea.org>
- Northwest Evaluation Association (NWEA). (2004d). *Research-based accuracy*. Retrieved from <http://www.nwea.org>
- Pennsylvania Department of Education (PDE). (2011). *2011 Keystone Exams Technical Report*. Retrieved from <http://www.pde.state.pa.us>

- Pennsylvania Department of Education (PDE). (2008). *Understanding AYP 2008*. Retrieved from <http://www.pde.state.pa.us>
- Pennsylvania Department of Education (PDE). (2007). *Academic standards for mathematics*. Retrieved from <http://www.pde.state.pa.us>
- Pennsylvania Department of Education (PDE). (2007). *Mathematics grade 11 assessment anchors and eligible content*. Retrieved from <http://www.pde.state.pa.us>
- Pashler, H., Rohrer, D., & Cepeda, N. J. (2006). Temporal spacing and learning. *APS Observer*, 19(3), 225-226.
- Patton, P. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Pavlik, P. I., & Anderson, J. R. (2005). Practice and forgetting effects on vocabulary memory: An activation-based model of the spacing effect. *Cognitive Science*, 29, 559-586.
- Rettig, M. D., & Canady, R. L. (1998). High failure rates in required mathematics courses: Can a modified block schedule be part of the cure? *NASSP Bulletin*, 82, 56-65.
- Riches, N. G., Tomasella, M., & Conti-Ramsden, G. (2005). Verb learning in children with SLI: Frequency and spacing effects. *Journal of Speech, Language, and Hearing Research*, 48, 1397-1411.
- Rohrer, D. & Taylor, K. (2006). The effects of overlearning and distributed practice on the retention of mathematics knowledge. *Applied Cognitive Psychology*, 20, 1209-1224.

- Rohrer, D., Taylor, K., Pashler, H., Wixted, J. T., & Cepeda, N. J. (2005). The effect of overlearning on long-term retention. *Applied Cognitive Psychology, 19*, 361-374.
- Schwahn, C., & McGarvey, B. (2011). *Inevitable: Mass Customized Learning: Learning in the Age of Empowerment*. Lexington, KY: CreateSpace.
- Slate, J. R., & Craig, H. J. (2000). Students' perspectives on block scheduling: reactions following a brief trial period. *High School Journal, 83*(3), 55-65.
- Spring, J. (2005). *Conflict of interests: The politics of American education*. New York NY: McGraw-Hill.
- Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
- Staunton, J. (1997). A study of teacher's beliefs on the efficacy of block scheduling. *NASSP Bulletin, 81*, 73-81.
- Thomas, C. (2001). What is wrong with block scheduling? *NASSP Bulletin, 85*, 74-77.
- Trenta, L., & Newman, I. (2002). Effects of a High School Block scheduling program on students: A four-year longitudinal study of the effects of block scheduling on student outcome variables. *American Secondary Education, 31*(1), 54-66.
- U.S. Department of Education (USDOE). (2004). *A guide to education and No Child Left Behind*. Washington, DC: U. S. Department of Education.
- Underwood, B. J. (1961). Ten years of massed practice on distributed practice. *Psychological Review, 68*(4), 229-246.
- Veal, W. R., & Flinders, D. J. (2001). How block scheduling reform effects classroom practice. *High School Journal, 84*(4), 21-31.
- Weller, D. R., & Leskey, J. M. (2000). Block scheduling and inclusion in a high school. *Remedial and Special Education, 21*(4), 209-219.

Wronkovich, M., Hess, C. A., & Robinson, J. E. (1997). An objective look at mathematics outcomes on new research into block scheduling. *NASSP Bulletin*, 81, 32-41.

Zepeda, S. J., & Mayers, R. S. (2001). New kids on the block schedule: Beginning teachers face challenges. *High School Journal*, 84(4), 1-11.

APPENDICES

Appendix A

SUPERINTENDENT/DISTRICT LETTER OF APPROVAL

A Study of the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

An East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania Doctoral Dissertation

W. Anthony Parks, Assistant Principal, East Stroudsburg Area School District

Dear Superintendent:

As you are aware, I currently serve as the Assistant Principal in the East Stroudsburg Area School District. Educationally, I have been working to obtain my doctoral degree at East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania. I am currently seeking permission to gather data in reference to my study and would greatly appreciate it if you could set aside a few minutes of your valuable time to review this document. I am hoping that you will support my research by approving the request to have Improved Mathematics Achievement High School staff members participate in this study. If so, please sign the approval form and return it to my attention in the self-addressed, stamped envelope.

Sincerely,

W. Anthony Parks
Assistant Principal
East Stroudsburg Area School District
Educational Leadership Doctoral Student
East Stroudsburg University of Pennsylvania
Indiana University of Pennsylvania

This project will be submitted for approval by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects

Dr. Shala B. Davis, IRB Administrator, (570) 422-3536 x3336

Appendix B

INFORMED CONSENT - SUPERINTENDENT

Research Description:

Currently, there are many school districts in Pennsylvania who are utilizing the block schedule format for instructing students based on very compelling research done in the 1980's and 1990's. These studies were based on studies done by the National Commission on Excellence in Education and National Commission on Time and Learning. In 2001, Congress reinstated the Elementary and Secondary Education Act of 1964 and repackaged that legislation with a new name entitled *No Child Left Behind (NCLB)* which gives very specific benchmarks which students must achieve in mathematics, reading, writing and science. Many of the school districts who bought into the idea of block scheduling are now noticing that their students are not demonstrating the achievement levels mandated by NCLB, especially in the area of mathematics.

This study will be a case study of two high schools within the East Stroudsburg Area School District. The sample population participants will be high school mathematics students at both the applied and college-preparatory levels from each of the high schools. Student data will be compared in connection to the type of schedule upon which they took their classes. The research I will be conducting will be both quantitative and qualitative in nature. Quantitatively, the current overall High School Achievement levels will be compared to previous years when students were solely on block schedule in mathematics to determine if there have been improvements overall based on schedule. In addition, sample population participants' PSSA and MAP test data will be compared based on schedule within and between schools to determine which schedule yields the best results. Qualitatively, the Assistant Superintendent for Curriculum and Instruction, each building principal, and selected mathematics teachers will be asked to take part in an interview. The interviews will focus directly on policies governing curriculum, graduation requirements, professional development, scheduling of students, achievement of students, instructional methods, curriculum coverage, and percentage of time students are on task based on schedule. The interview participants will determine the location of the interview.

Risks and Benefits:

There are no foreseeable risks to you from participating in this study. However, there are several benefits. The research will provide valuable information in reference to education programs preparing students in mathematics. The results of the analysis of the data can be useful to administrative educational programs when designing future master schedules especially for the mathematics department. The results will also be beneficial to superintendents and principals in providing professional development for their mathematics teachers based on the schedule the school district chooses to employ.

Compensation:

There is no compensation involved in any component of the research design.

Confidentiality:

The data for the use in this study will be kept strictly confidential with student test score data, identities of the teachers, schools, and school districts remaining confidential. During the interview process the identities of the participant, school and school district will remain confidential. Specific to the north campus will be a research assistant who will conduct the teacher focus group according to the script I have created. This provision is being put into place as a result of doing a study involving individuals which I directly supervise in an effort to allow the responses to have more validity and to further protect the subjects from identification. Individuals seeking the results of the study will be asked to complete a separate self-addressed, stamped envelope indicating their desire to receive the study material. Through the process of interviewing teachers in focus groups utilizing Teacher A, Teacher B, ... etc, separate mailings for the willingness to participate in the interview process and request for study results; confidentiality will be maintained. All student data will be kept securely locked in a file cabinet with the respective identification codes kept in a separate location. At the conclusion of the study, the code sheets will be destroyed.

For More Information:

For answers to questions in reference to the research you may contact the Principal Investigator of the Research Study, W. Anthony Parks at 570-872-4117; tparks@esasd.net. If you have a concern with the study, please contact Dr. Mary Ann Matras, ESU co-chair at 570-422-3440; MMatras@po-box.esu.edu or Dr. Jennifer Rotigel, IUP co-chair at (724) 357-2400; Jennifer.Rotigel@iup.edu.

Voluntary Participation/Right to Withdraw:

Your participation in the study is voluntary; refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. The subjects may withdraw at any time without penalty. You may discontinue participating at any time without penalty or loss of benefits to which you are otherwise entitled.

- o Yes, I agree to have my school district participate in this doctoral research study.
- o No, I do not agree to have my school district participate in this doctoral research study.

| | | |
|-------------------|-------|------|
| Signature | Title | Date |
| Witness Signature | Title | Date |

Please return the entire document in the self-addressed, stamped envelope.
An entire second copy has been provided for your records.

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects
Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix C

INFORMED CONSENT - ASSISTANT SUPERINTENDENT FOR CURRICULUM AND INSTRUCTION

Research Description:

Currently, there are many school districts in Pennsylvania who are utilizing the block schedule format for instructing students based on very compelling research done in the 1980's and 1990's. These studies were based on studies done by the National Commission on Excellence in Education and National Commission on Time and Learning. In 2001, Congress reinstated the Elementary and Secondary Education Act of 1964 and repackaged that legislation with a new name entitled *No Child Left Behind (NCLB)* which gives very specific benchmarks which students must achieve in mathematics, reading, writing and science. Many of the school districts who bought into the idea of block scheduling are now noticing that their students are not demonstrating the achievement levels mandated by NCLB, especially in the area of mathematics.

This study will be a case study of two high schools within the East Stroudsburg Area School District. The sample population participants will be high school mathematics students at both the applied and college-preparatory levels from each of the high schools. Student data will be compared in connection to the type of schedule upon which they took their classes. The research I will be conducting will be both quantitative and qualitative in nature. Quantitatively, the current overall High School Achievement levels will be compared to previous years when students were solely on block schedule in mathematics to determine if there have been improvements overall based on schedule. In addition, sample population participants' PSSA and MAP test data will be compared based on schedule within and between schools to determine which schedule yields the best results. Qualitatively, the Assistant Superintendent for Curriculum and Instruction, each building principal, and selected mathematics teachers will be asked to take part in an interview. The interviews will focus directly on policies governing curriculum, graduation requirements, professional development, scheduling of students, achievement of students, instructional methods, curriculum coverage, and percentage of time students are on task based on schedule. The interview participants will determine the location of the interview.

Risks and Benefits:

There are no foreseeable risks to you from participating in this study. However, there are several benefits. The research will provide valuable information in reference to education programs preparing students in mathematics. The results of the analysis of the data can be useful to administrative educational programs when designing future master schedules especially for the mathematics department. The results will also be beneficial to superintendents and principals in providing professional development for their mathematics teachers based on the schedule the school district chooses to employ.

Compensation:

There is no compensation involved in any component of the research design.

Confidentiality:

The data for the use in this study will be kept strictly confidential with student test score data, identities of the teachers, schools, and school districts remaining confidential. During the interview process the identities of the participant, school and school district will remain confidential. Specific to the north campus will be a research assistant who will conduct the teacher focus group according to the script I have created. This provision is being put into place as a result of doing a study involving individuals which I directly supervise in an effort to allow the responses to have more validity and to further protect the subjects from identification. Individuals seeking the results of the study will be asked to complete a separate self-addressed, stamped envelope indicating their desire to receive the study material. Through the process of interviewing teachers in focus groups utilizing Teacher A, Teacher B, ... etc, separate mailings for the willingness to participate in the interview process and request for study results; confidentiality will be maintained. All student data will be kept securely locked in a file cabinet with the respective identification codes kept in a separate location. At the conclusion of the study, the code sheets will be destroyed.

For More Information:

For answers to questions in reference to the research you may contact the Principal Investigator of the Research Study, W. Anthony Parks at 570-872-4117; tparks@esasd.net. If you have a concern with the study, please contact Dr. Mary Ann Matras, ESU co-chair at 570-422-3440; MMatras@po-box.esu.edu or Dr. Jennifer Rotigel, IUP co-chair at (724) 357-2400; Jennifer.Rotigel@iup.edu.

Voluntary Participation/Right to Withdraw:

Your participation in the study is voluntary; refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. The subjects may withdraw at any time without penalty. You may discontinue participating at any time without penalty or loss of benefits to which you are otherwise entitled.

I have read and understand the information in this letter and have had the opportunity to ask questions related to the study and my participation. I agree to participate in this study.

Date _____ Participant Signature _____
(You will receive a copy of this document for your records)

Please return the entire document in the self-addressed, stamped envelope.

An entire second copy has been provided for your records.

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects

Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix D

BUILDING PRINCIPAL LETTER OF APPROVAL

A Study of the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

An East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania Doctoral Dissertation

W. Anthony Parks, Assistant Principal, East Stroudsburg Area School District

Dear Principal:

As you are aware, I currently serve as the Assistant Principal in the East Stroudsburg Area School District. Educationally, I have been working to obtain my doctoral degree at East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania. Your Superintendent has approved for my study to be conducted within your district. I would greatly appreciate it if you could set aside a few minutes of your valuable time to review these documents. A self-addressed/stamped envelope has been included with each document to ensure confidentiality. There are three documents:

- 1) Informed Consent . This document details the description of the study, the risks and benefits involved, confidentiality, compensation, the right to not participate or voluntarily withdraw, and other pertinent information to the study
- 2) Suggestion of Mathematics Teacher Participants. Please suggest up to twelve teachers in your building that may be willing to participate in the interview process. Please utilize the selection criteria in suggesting the teachers and fill out the grid including the requested data for each. **Please return the suggestions by DATE.**
- 3) Request for study results. I will be more than happy to provide you with the results of my study. Simply indicate that you wish to receive this information and return the document separately in the self-addressed/stamped envelope.

In closing, I am hopeful that you will support my research by participating in this study.

Sincerely,

W. Anthony Parks
Assistant Principal
East Stroudsburg Area School District
Educational Leadership Doctoral Student
East Stroudsburg University of Pennsylvania
Indiana University of Pennsylvania

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects
Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix E

INFORMED CONSENT - BUILDING PRINCIPAL

Research Description:

Currently, there are many school districts in Pennsylvania who are utilizing the block schedule format for instructing students based on very compelling research done in the 1980's and 1990's. These studies were based on studies done by the National Commission on Excellence in Education and National Commission on Time and Learning. In 2001, Congress reinstated the Elementary and Secondary Education Act of 1964 and repackaged that legislation with a new name entitled *No Child Left Behind (NCLB)* which gives very specific benchmarks which students must achieve in mathematics, reading, writing and science. Many of the school districts who bought into the idea of block scheduling are now noticing that their students are not demonstrating the achievement levels mandated by NCLB, especially in the area of mathematics.

This study will be a case study of two high schools within the East Stroudsburg Area School District. The sample population participants will be high school mathematics students at both the applied and college-preparatory levels from each of the high schools. Student data will be compared in connection to the type of schedule upon which they took their classes. The research I will be conducting will be both quantitative and qualitative in nature. Quantitatively, the current overall High School Achievement levels will be compared to previous years when students were solely on block schedule in mathematics to determine if there have been improvements overall based on schedule. In addition, sample population participants' PSSA and MAP test data will be compared based on schedule within and between schools to determine which schedule yields the best results. Qualitatively, the Assistant Superintendent for Curriculum and Instruction, each building principal, and selected mathematics teachers will be asked to take part in an interview. The interviews will focus directly on policies governing curriculum, graduation requirements, professional development, scheduling of students, achievement of students, instructional methods, curriculum coverage, and percentage of time students are on task based on schedule. The interview participants will determine the location of the interview.

Risks and Benefits:

There are no foreseeable risks to you from participating in this study. However, there are several benefits. The research will provide valuable information in reference to education programs preparing students in mathematics. The results of the analysis of the data can be useful to administrative educational programs when designing future master schedules especially for the mathematics department. The results will also be beneficial to superintendents and principals in providing professional development for their mathematics teachers based on the schedule the school district chooses to employ.

Compensation:

There is no compensation involved in any component of the research design.

Confidentiality:

The data for the use in this study will be kept strictly confidential with student test score data, identities of the teachers, schools, and school districts remaining confidential. During the interview process the identities of the participant, school and school district will remain confidential. Specific to the north campus will be a research assistant who will conduct the teacher focus group according to the script I have created. This provision is being put into place as a result of doing a study involving individuals which I directly supervise in an effort to allow the responses to have more validity and to further protect the subjects from identification. Individuals seeking the results of the study will be asked to complete a separate self-addressed, stamped envelope indicating their desire to receive the study material. Through the process of interviewing teachers in focus groups utilizing Teacher A, Teacher B, ... etc, separate mailings for the willingness to participate in the interview process and request for study results; confidentiality will be maintained. All student data will be kept securely locked in a file cabinet with the respective identification codes kept in a separate location. At the conclusion of the study, the code sheets will be destroyed.

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Voluntary Participation/Right to Withdraw:

Your participation in the study is voluntary; refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. The subjects may withdraw at any time without penalty. You may discontinue participating at any time without penalty or loss of benefits to which you are otherwise entitled.

I have read and understand the information in this letter and have had the opportunity to ask questions related to the study and my participation. I agree to participate in this study.

Date _____ Participant Signature _____
(You will receive a copy of this document for your records)

Please return the entire document in the self-addressed, stamped envelope.

An entire second copy has been provided for your records.

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects

Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix G

INFORMED CONSENT - TEACHER - HIGH SCHOOL A

A Study of the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

An East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania
Doctoral Dissertation

W. Anthony Parks, Assistant Principal, East Stroudsburg Area School District

Research Description:

Currently, there are many school districts in Pennsylvania who are utilizing the block schedule format for instructing students based on very compelling research done in the 1980's and 1990's. These studies were based on studies done by the National Commission on Excellence in Education and National Commission on Time and Learning. In 2001, Congress reinstated the Elementary and Secondary Education Act of 1964 and repackaged that legislation with a new name entitled *No Child Left Behind (NCLB)* which gives very specific benchmarks which students must achieve in mathematics, reading, writing and science. Many of the school districts who bought into the idea of block scheduling are now noticing that their students are not demonstrating the achievement levels mandated by NCLB, especially in the area of mathematics.

This study will be a case study of two high schools within the East Stroudsburg Area School District. The sample population participants will be high school mathematics students at both the applied and college-preparatory levels from each of the high schools. Student data will be compared in connection to the type of schedule upon which they took their classes. The research I will be conducting will be both quantitative and qualitative in nature. Quantitatively, the current overall High School Achievement levels will be compared to previous years when students were solely on block schedule in mathematics to determine if there have been improvements overall based on schedule. In addition, sample population participants' PSSA and MAP test data will be compared based on schedule within and between schools to determine which schedule yields the best results. Qualitatively, the Assistant Superintendent for Curriculum and Instruction, each building principal, and selected mathematics teachers will be asked to take part in an interview. The interviews will focus directly on policies governing curriculum, graduation requirements, professional development, scheduling of students, achievement of students, instructional methods, curriculum coverage, and percentage of time students are on task based on schedule. The interview participants will determine the location of the interview.

Risks and Benefits:

There are no foreseeable risks to you from participating in this study. However, there are several benefits. The research will provide valuable information in reference to education programs preparing students in mathematics. The results of the analysis of the data can be useful to administrative educational programs when designing future master schedules especially for the mathematics department. The results will also be beneficial to superintendents and principals in providing professional development for their mathematics teachers based on the schedule the school district chooses to employ.

Compensation:

There is no compensation involved in any component of the research design.

Confidentiality:

The data for the use in this study will be kept strictly confidential with student test score data, identities of the teachers, schools, and school districts remaining confidential. During the interview process the identities of the participant, school and school district will remain confidential. Specific to the north campus will be a research assistant who will conduct the teacher focus group according to the script I have created. This provision is being put into place as a result of doing a study involving individuals which I directly supervise in an effort to allow the responses to have more validity and to further protect the subjects from identification. Individuals seeking the results of the study will be asked to complete a separate self-addressed, stamped envelope indicating their desire to receive the study material. Through the process of interviewing teachers in focus groups utilizing Teacher A, Teacher B, ... etc, separate mailings for the willingness to participate in the interview process and request for study results; confidentiality will be maintained. All student data will be kept securely locked in a file cabinet with the respective identification codes kept in a separate location. At the conclusion of the study, the code sheets will be destroyed.

For More Information:

For answers to questions in reference to the research you may contact the Principal Investigator of the Research Study, W. Anthony Parks at 570-872-4117; tparks@esasd.net. If you have a concern with the study, please contact Dr. Mary Ann Matras, ESU co-chair at 570-422-3440; MMatras@po-box.esu.edu or Dr. Jennifer Rotigel, IUP co-chair at (724) 357-2400; Jennifer.Rotigel@iup.edu.

Voluntary Participation/Right to Withdraw:

Your participation in the study is voluntary; refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. The subjects may withdraw at any time without penalty. You may discontinue participating at any time without penalty or loss of benefits to which you are otherwise entitled.

I have read and understand the information in this letter and have had the opportunity to ask questions related to the study and my participation. I agree to participate in this study.

Date _____ Participant Signature _____
(You will receive a copy of this document for your records)

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects
Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix H

INFORMED CONSENT - TEACHER - HIGH SCHOOL B

A Study of the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

An East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania
Doctoral Dissertation

W. Anthony Parks, Assistant Principal, East Stroudsburg Area School District

Research Description:

Currently, there are many school districts in Pennsylvania who are utilizing the block schedule format for instructing students based on very compelling research done in the 1980's and 1990's. These studies were based on studies done by the National Commission on Excellence in Education and National Commission on Time and Learning. In 2001, Congress reinstated the Elementary and Secondary Education Act of 1964 and repackaged that legislation with a new name entitled *No Child Left Behind (NCLB)* which gives very specific benchmarks which students must achieve in mathematics, reading, writing and science. Many of the school districts who bought into the idea of block scheduling are now noticing that their students are not demonstrating the achievement levels mandated by NCLB, especially in the area of mathematics.

This study will be a case study of two high schools within the East Stroudsburg Area School District. The sample population participants will be high school mathematics students at both the applied and college-preparatory levels from each of the high schools. Student data will be compared in connection to the type of schedule upon which they took their classes. The research I will be conducting will be both quantitative and qualitative in nature. Quantitatively, the current overall High School Achievement levels will be compared to previous years when students were solely on block schedule in mathematics to determine if there have been improvements overall based on schedule. In addition, sample population participants' PSSA and MAP test data will be compared based on schedule within and between schools to determine which schedule yields the best results. Qualitatively, the Assistant Superintendent for Curriculum and Instruction, each building principal, and selected mathematics teachers will be asked to take part in an interview. The interviews will focus directly on policies governing curriculum, graduation requirements, professional development, scheduling of students, achievement of students, instructional methods, curriculum coverage, and percentage of time students are on task based on schedule. The interview participants will determine the location of the interview.

Risks and Benefits:

There are no foreseeable risks to you from participating in this study. However, there are several benefits. The research will provide valuable information in reference to education programs preparing students in mathematics. The results of the analysis of the data can be useful to administrative educational programs when designing future master schedules especially for the mathematics department. The results will also be beneficial to superintendents and principals in providing professional development for their mathematics teachers based on the schedule the school district chooses to employ.

Compensation:

There is no compensation involved in any component of the research design.

Confidentiality:

The data for the use in this study will be kept strictly confidential with student test score data, identities of the teachers, schools, and school districts remaining confidential. During the interview process the identities of the participant, school and school district will remain confidential. Individuals seeking the results of the study will be asked to complete a separate self-addressed, stamped envelope indicating their desire to receive the study material. Through the process of interviewing teachers in focus groups utilizing Teacher A, Teacher B, ... etc, separate mailings for the willingness to participate in the interview process and request for study results; confidentiality will be maintained. All student data will be kept securely locked in a file cabinet with the respective identification codes kept in a separate location. At the conclusion of the study, the code sheets will be destroyed.

For More Information:

For answers to questions in reference to the research you may contact the Principal Investigator of the Research Study, W. Anthony Parks at 570-872-4117; tparks@esasd.net. If you have a concern with the study, please contact Dr. Mary Ann Matras, ESU co-chair at 570-422-3440; MMatras@po-box.esu.edu or Dr. Jennifer Rotigel, IUP co-chair at (724) 357-2400; Jennifer.Rotigel@iup.edu.

Voluntary Participation/Right to Withdraw:

Your participation in the study is voluntary; refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. The subjects may withdraw at any time without penalty. You may discontinue participating at any time without penalty or loss of benefits to which you are otherwise entitled.

I have read and understand the information in this letter and have had the opportunity to ask questions related to the study and my participation. I agree to participate in this study.

Date _____ Participant Signature _____
(You will receive a copy of this document for your records)

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional Review Board for the Protection of Human Subjects
Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix I

REQUEST FOR STUDY RESULTS

A Study of the Effects of 4/4 Block Scheduling on Achievement in Mathematics on State Standardized Testing in Pennsylvania for High School Students

An East Stroudsburg University of Pennsylvania and Indiana University of Pennsylvania
Doctoral Dissertation

W. Anthony Parks, Assistant Principal, East Stroudsburg Area School District

**ONLY RETURN THIS DOCUMENT IF YOU DESIRE TO
RECEIVE THE RESULTS OF THE STUDY.**

I would like to request the results of the study.

(signature)

(date)

NAME, Title
Address Line 1
Address Line 2
Address Line 3

This project has been approved by the East Stroudsburg University of Pennsylvania Institutional
Review Board for the Protection of Human Subjects

Dr. Shala Davis, IRB Administrator, (570) 422-3536 x3336

Appendix J

INTERVIEW PROTOCOL FOR TEACHERS IN FOCUS GROUPS

Project: Effects of Schedule on Mathematics Achievement

Time of Interview:

Date:

Place:

Interviewer:

Position of Interviewee(s):

- Interviewer will place name cards reading “A”, “B”, etc. at the seats available in the focus group room
- Teachers will be allowed to sit behind any card they so choose
- Interviewer will ask a question according to the script given
- Each teacher will be given the opportunity to respond to the question in alphabetic succession, interviewer will rotate starting position for each question
- Interviewer will take notes on responses by each teacher’s identified letter
- Interviewer will ask follow up questions as needed.

Questions:

From your experience:

- How many years have you been teaching mathematics?
- How many years have you taught mathematics utilizing the 4/4 block schedule?
- How many years have you taught mathematics utilizing the full-year schedule?
- Which level of mathematics classes have you taught on the 4/4 block schedule?
- Which level of mathematics classes have you taught on the full-year schedule?
- In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the applied-level classes?
- In your opinion, what academic changes have come from modifying the mathematics schedule to have 45 minute periods for the college-preparatory classes?
- Which model do you believe to be the best for mathematics instruction as it pertains to student achievement? Why?
- Are there levels of students for whom the traditional schedule is better suited? Are there levels of students for whom the block schedule is better suited?
- What might a typical day look like for a student in your class on the block schedule? What might a typical day look like for a student in your class on the traditional schedule?

- What type of instructional methods do you employ in your mathematics classes? Are they different based on the schedule on which you are teaching?
- Are there differences in the amount of curriculum that is covered in the courses you teach based on the schedule?
- What differences exist, if any, in the amount of time in which students are on task, based on the schedule?

Appendix K

INTERVIEW PROTOCOL FOR ADMINISTRATORS

Project: Effects of Schedule on Mathematics Achievement

Time of Interview:

Date:

Place:

Interviewer:

Position of Interviewee(s):

Questions:

- Do you consent to have your responses to this interview tape recorded for the purpose of later transcription?
- What are the district/building policies/procedures governing the development/implementation of mathematics curriculum?
- What are the district/building policies/procedures governing graduation requirements for students?
- What are the district/building policies/procedures governing the scheduling of students in particular classes?
- What are the district/building policies/procedures governing the delivery of assessments for both PSSA and NWEA at the high school level?
- What are the district/building policies/procedures governing the professional development of teachers for instructional practices within the schedule being utilized?
- What circumstances led to the development of the master schedule as it exists today?
- What had been the history of the master schedule prior to these circumstances?
- Do you continue to consent to have your responses to this interview tape recorded for the purpose of later transcription?
- Is the district/building showing any overall differences in student academic achievement since the implementation of the new method of scheduling?
- Have there been any other district/building changes as a result of the new scheduling method?
- Do teachers vary their instructional practices based on the schedule upon which they are instructing?
- What are the district/building policies/procedures governing the accountability of students with respect to results in testing?

- Are there any mechanisms in place for remediating students who do not demonstrate proficiency on the assessments?