DISSERTATION

THE EFFICACY OF SCHEDULING FORMATS ON ACHIEVEMENT OF HIGH SCHOOL STUDENTS

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY JED R. BOWMAN ENTITLED *THE EFFICACY OF SCHEDULING FORMATS ON ACHIEVEMENT OF HIGH SCHOOL STUDENTS* BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

THE EFFICACY OF SCHEDULING FORMATS ON ACHIEVEMENT OF HIGH SCHOOL STUDENTS

The purpose of this dissertation was to contribute an empirically sound longitudinal study on the effects of scheduling formats on high school student achievement as measured by performance on ACT mathematics and reading subtests. School of choice allowed a unique longitudinal design to explore achievement and schedule format combination. Secondary schools utilized traditional, AB block, and 4x4 block schedule formats resulting in nine junior/senior high school combinations. Two combinations were eliminated from the final sample due to small *n*'s.

An analysis of covariance (ANCOVA) was used, and achievement was controlled using 6th grade mathematic and reading Achievement Level Tests before students entered the schedule format combination intervention. Before using ANCOVA, assumptions were tested and when violated, a forward multiple regression analysis was conducted.

In mathematics, a statistically significant post hoc result for one schedule format combination showed students with the traditional schedule format had higher mean scores than students with the 4x4 block schedule format. Effects were examined by gender and FRL status, and there were no interactions. In reading, two statistically significant post hoc results showed students in the traditional schedule format had higher mean scores than students with either block schedule format schools. These effects were examined by gender and FRL status, and no interactions were found.

Supplemental analyses conducted to study the effect of schedule format stability used the same outcome measures. Results showed students who changed formats had higher mean scores in mathematics than students who remained in the same format.

When these effects were examined by gender and FRL status, there were no interactions. In reading, there were no significant findings.

Results suggest higher achievement in mathematics and reading in the traditional format school; however, caution should be exercised as no definitive trends or patterns were observed across samples and few pairwise contrasts contributed. Broad generalizations are difficult to make as this study utilized archived results from one school district. Statistically robust longitudinal studies are recommended. Additionally, replication studies are encouraged to observe patterns over time.

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CHAPTER 1: INTRODUCTION

Since the release of *A Nation at Risk: The Imperatives for Educational Reform* in 1983, public schools in the United States have faced increased scrutiny from many different sectors of society (National Commission on Excellence in Education, 1983). In February 2005, at the National Education Summit, the National Governor's Association addressed the "apparent failings" of public high schools. At the Summit, Bill Gates, founder of Microsoft Corporation, stated, "America's high schools are obsolete, they are the wrong tool for the wrong time" (Olson, 2005, p. 12). Given the unlikely result of complete reformation of public high schools in America, the conference emphasized the growing need to adequately prepare all students for success in college and the workplace (Olson, 2005). Educators contended that in order to address Mr. Gates' concerns, "the governors must be willing to tackle such tough issues as teacher preparation and working conditions, student engagement, school organization, and support for students to accelerate their learning" (p.12). The National Governor's initiative is just one of many in the past two decades to address perils of public schooling in America.

Today, nearly all campaigns for public office are replete with candidates touting their educational platform, and politics are now interwoven into the fabric of public school domain. In 2001, Public Law 107-110, more commonly known as the *No Child Left Behind Act* (*NCLB*), was passed. This legislation has impacted public schools and will continue to do so in the near future. Specifically, by 2005 schools are required to empirically show that each student has gained an adequate year of academic progress (AYP) as measured by their performance on standardized tests.

Over the years, schools have scrambled to find ways to maximize efforts to effectively and positively impact student achievement either with or without

governmental influence. *A Nation At Risk* (1983), published by the National Commission on Excellence in Education, describes the demise of academic performance among students in the United States compared to students from other countries. Although findings from this report have been disputed, a movement towards national educational reform gained momentum (Bracey, 1994). Most early reform efforts focused on content standards, teaching pedagogy, and student learning styles. Even though one of the Commission's recommendations centered on restructuring schools for more effective use of time, the issue of classroom time was largely ignored until the 1990s (Evans, Tokarczyk, Rice, & McCray, 2002).

In 1994, the National Commission on Time and Learning released *Prisoners of Time* and addressed national concerns regarding allocations of time for school day instructional purposes. Key recommendations of this report focused on time usage in the classroom. The commission challenged educators to analyze the use of time in the following ways: (a) reinvent schools around learning, not time; (b) fix the design flaw, use time in new and better ways; (c) keep schools open longer to meet children and communities needs; and (d) give teachers the time they need (p. 29). Moreover, the Commission (1994) proposed the use of block scheduling as a means for promoting increased student learning and subsequent student achievement. Block scheduling is defined as 75–120-minute class periods versus the traditional 40–55 minute class period (Trenta & Newman, 2002; Canady & Rettig, 1995).

Additionally, *Breaking Ranks: Changing an American Institution* (1996), a report released by the National Association of Secondary School Principals (NASSP), recommended the use of block scheduling to establish longer periods of uninterrupted time for learning and instruction. Schools heeded the call for educational reform and many responded by changing their scheduling format to block schedules. Nearly 50 percent of all public secondary schools in the United States have adopted some form of

block scheduling to address student-learning concerns (Canaday & Rettig, 1996; Zepeda, 1999). This percentage is likely to increase as public schools across the nation discover how block scheduling can address some of the difficult issues raised at the National Governor's Conference.

Problem Statement

Many studies based on administrator, teacher, and student perceptions have been published regarding the efficacy of block scheduling (Nichols, 2000). In contrast, fewer studies have been conducted regarding longitudinal and quantitative effects of this educational reform strategy (Nichols, 2000). Even though many schools have changed to some form of block scheduling, empirical data is lacking on the impact these changes have had on student achievement (Evans et al., 2002). Existing studies reveal inconsistent results. Some empirical studies show that adopting block scheduling improves student achievement in varying content areas (Beaver, 1998; Hess, Wronkovich, & Robinson, 1999; Nichols, 2000; The College Board, 1998). In contrast, others show block scheduling decreases student achievement in various subject areas (Bateson, 1990; Cobb, Abate, & Baker, 1999; Veal & Schreiber, 1999; Lawrence & McPhearson, 2000; Gruber & Onwegbuzie, 2001). Yet, other studies show no statistical difference in student achievement in various subjects after adopting block scheduling (Baker, 2001; Ford, 2001).

Most empirical studies on time and achievement show the effect of the scheduling format by using outcome variables such as Grade Point Average (GPA), ACT exam scores, or results of other standardized testing measures (Carter, 2003; Lewis, Dugan, Winokur, & Cobb, 2004a; Thayer & Shortt, 2000). Additionally, some studies focus on the effect of the scheduling format changing from one format to another. For example, numerous schools with traditional schedules have adopted block scheduling as an educational reform measure. In these cases, studies attempt to show the effect of

transitioning from a traditional schedule to a block schedule (Hansen, Gutman, & Smith, 2000; Lawrence & McPherson, 2000; Trenta & Newman, 2002). A recent search of academic journals and dissertations resulted in few studies showing the longitudinal effects of changing scheduling formats (Harmston, Pliska, & Hackmann, 2001; Nichols, 2000; Trenta & Newman, 2002). In most of these studies, the focus was on the length of time the scheduling format had been implemented at the school(s) and not on the length of time students had attended schools with the same scheduling format. No literature was found showing the effect of combinations of junior and high school scheduling format on student achievement.

Choosing a scheduling format is one of many critical decisions educators face in addressing student achievement. In the Mountain West school district used in this study, eight junior high schools with traditional, alternating block (AB), and 4x4 block scheduling formats serve as feeder schools for three local high schools. Schedule formats in the high schools of interest include a traditional format, a modified AB block format, and a 4x4 block format. The school district has three alternative high schools with small enrollments excluded from this study.

The purpose of this study is to investigate the efficacy of schedule format combinations in secondary schools as measured by ACT scores in mathematics and reading. By studying the schedule format combination in junior high and high school, it is hoped empirical evidence may help decision-makers conclude which combination of scheduling formats impacts student achievement in high school. Additionally, gender and socioeconomic status of students are of interest. Because if profound differences exist in either of these groups, the information may help practitioners implement scheduling formats to meet not only the needs of all students, but also specific disaggregated groups of students.

Research Questions

This study investigates the efficacy of combinations of secondary school scheduling formats over a five-year period from 1999-2004 to determine which one(s), if any, produce higher student achievement than others. ACT subtest results in mathematics and reading are used to measure student achievement. Nine possible combinations exist with three scheduling formats in junior high and three scheduling formats in high school. Following the ACT High School Profile reporting guidelines, samples with less than 30 participants were eliminated (Ziomek, 2000). As a result, no comparison is made between two of the groups, resulting in seven combinations of secondary school scheduling formats. In addition to the effects of combining junior high and high school scheduling formats with regard to student achievement; gender and socioeconomic factors are also of interest.

The primary research questions are:

1. What is the effect on student achievement as measured by the average score on the ACT mathematic subtest and the combination of junior high and high school scheduling format?
2. What is the effect on student achievement as measured by the average score on the ACT reading subtest and the combination of junior high and high school scheduling format?
3. How do these effects vary by gender?
4. How do results vary by socioeconomic status as measured by participation in the federally subsidized FRL program?

Definition of Terms

The listed terms are used throughout the study and defined as follows:

4x4 JH – A junior high school with a 4x4 block scheduling format.

4x4 HS – A high school with a 4x4 block scheduling format.

AB JH – A junior high school with an AB or alternate day block schedule format.

AB HS – A high school with an AB or alternate day block schedule format.

Accelerated or 4x4 Block - A block schedule where students attend the same four 90-minute classes every day of the week for an entire semester. At the end of the first semester, students attend a new set of four classes. Also known as *Copernican* scheduling.

Achievement Level Test (ALT) - A standardized district-developed, achievement exam given to 6^{th} grade (elementary school) students in reading and mathematics that are used as a covariate.

American College Test (ACT) - The ACT is a state-mandated college entrance exam that all high school juniors are required to take during spring semester, and is designed to predict success in college. All 11^{th} grade students are required to take the ACT, and the district pays for test costs.

ACT subtest - The ACT is divided into four sections called subtests. The four subtests are English, mathematics, reading, and science reasoning. In this study, only the subtests in mathematics and reading are used.

ANCOVA – Analysis of covariance.

Block Schedule - A scheduling format for secondary schools that organizes at least part of the school day into larger blocks of instructional time (more than 60-minute periods).

Class – A course requiring 36 weeks (2 semesters) to complete in a traditional/AB block scheduling format or 18 weeks (1 semester) in a 4x4 block scheduling format.

FRL – Free and reduced lunch status is used to measure socioeconomic status of students. Student's families voluntarily participate in the federally subsidized program.

High School - In the district studied, a high school has students enrolled in grades 10-12.

Junior High School - In the district studied, a junior high school has students enrolled in grades 7-9.

Modified AB Block – A schedule offering students classes in a traditional format and a block format. In this study, students attend eight classes on Mondays (traditional) for approximately 45 minutes each and take four 90-minute classes on Tuesday and Thursday, and the remaining four 90-minute classes on Wednesday and Friday (block) for the entire school year.

Secondary Schools - High school and junior high school students (grades 7-12) in the school district studied.

Semester - Eighteen weeks; the time defined to complete a class in an accelerated block schedule or half a class in an AB/traditional format.

Trad JH – A junior high school with a traditional schedule format.

Trad HS – A high school with a traditional schedule format.

Traditional Schedule – A schedule where students attend five to seven 45-50 minute classes every day for one school year (2 semesters or 36 weeks).

Delimitations

The delimitations of the study are:

1. The three scheduling formats used are those used by the secondary schools in this Mountain West school district.
2. Students enrolled in 11^{th} grade at the end of the 2003-2004 are used in this study because their 2004 ACT and 1999 NWEA Achievement Level Test (ALT) results are available as archived data. ACT results are used as outcome measures and are controlled for in mathematics and reading by using ALT results as covariates.

3. Achievement scores used in this study are delimited to mathematics and reading results on the ALT and ACT standardized tests. The reason for this delimitation is ALT tests were only given in mathematics and reading.
4. Participants chosen for this study were selected based upon attendance in this Mountain West school district from 1999-2004.
5. Participants in this study were selected based upon attending the same high school from 2002-2004.
6. Participants in this study were selected based upon attendance at a junior high school with the same scheduling format from 1999-2001.
7. Participants in this study were selected based upon completing the district and state-mandated assessments during the 1998-1999 and 2003-2004 school years.

Assumptions and Limitations

The assumptions and limitations of the study are:

1. Students who took ALT and ACT tests performed to the best of their ability.
2. In this *ex post facto* design, it is not possible to control for the impact of quality teaching or how teachers use time in the classroom.
3. There is no control for staff development and quality of leadership for any school in this study.
4. These results only explore the efficacy of scheduling formats in the context of this study and are limited to one school district.
5. The populations in the three high schools are demographically similar enough to draw conclusions and possibly make generalizations.
6. Student achievement is measured using the ACT, yet many other variables also contribute to a student's success.

7. The results of this study are limited to achievement in mathematics and reading; therefore, the findings should not be transferred to other subject areas.

Significance of the Study

An unpublished study by Lewis et al. (2004a) found that high school students in a 4x4-semester block schedule had greater gains in mathematics and reading than students in traditional and AB block schedule formats. The researchers matched students by attendance in the same scheduling format over a three-year period in junior high (9^{th} grade only) and high school (grades 10 and 11). For example, a student attending both a 4x4 block schedule format junior and senior high school was included in the study. Additionally, the interaction effects of gender and ethnicity were factors of interest. and results showed females with higher achievement in reading than males.

Similarly, this study controls for initial student achievement using 6^{th} grade elementary school scores on ALTs in reading and mathematics as covariates. These test results were selected because they were administered before students were exposed to the treatment (schedule format combination in secondary schools). The effects of differing combinations of secondary school scheduling formats on achievement are measured by ACT subtest scores in mathematics and reading. Moreover, this study investigated the interaction of socioeconomic status and gender adding data to the current research base. A review of the literature showed no empirical longitudinal studies similar to this study.

Currently, many qualitative studies exist on administrator, teacher, student, and parent perceptions about the block scheduling format in secondary schools (Hurley, 1997a; Hurley 1997b; Staunton & Adams, 1997). However, fewer scholarly studies exist statistically comparing student achievement to the type of schedule format in secondary schools. Existing studies reveal varied results and have not tracked junior high and high school achievement based on the consistency of schedule formats. The significance of

this study is to add empirically based evidence to the body of existing knowledge on the topics of student achievement and school schedule formats. Implications of this study provide data to school district personnel to make decisions about scheduling formats in secondary schools.

Researcher's Perspective

Having worked as both a teacher and administrator in schools with traditional, 4x4, and alternating day (AB) scheduling formats, the type of schedule format has an impact on students. Personal experiences in a school community with similar demographics to the one in this study revealed that student achievement in a school with the 4x4-semester block schedule surpassed achievement in schools with either a traditional schedule format or an alternating day block schedule format. This study compares similar student populations across three test schools to determine if scheduling format positively impacts, negatively impacts, or has no impact on achievement as measured by ACT reading and mathematics results.

The district in this study has eight junior high schools with different scheduling formats. One school has a 4x4 block schedule, three schools utilize traditional schedules, and four schools have modified AB block schedules. This school district does not operate a pure feeder system model: nearly twenty eight percent of students and families use school of choice as an option to select their school of attendance. Consequently, it is possible to explore the combined effects of the various junior high and high school scheduling formats on student achievement. Although the accessible student sample prevented using all nine of the possible combinations of secondary school scheduling formats, the results yield an empirically sound study focusing on the longitudinal effects of schedule format on student achievement in one Mountain West school district.

Organization of the Study

This study consists of five chapters. Chapter one contains an introduction providing vital background information with national significance regarding public school reform and block scheduling in the context of educational literature. Additionally, chapter one includes a problem statement, research questions, definition of terms, delimitations, assumptions and limitations, significance of the study, and researcher's perspective. Chapter two provides a review of literature outlining this study within the larger framework of research literature on schedule formats and achievement. Chapter three is devoted to the methodology of this study. Chapter four gives the results and summary data used to answer research questions. Chapter five consists of conclusions, interpretations, limitations, and recommendations for future study.

CHAPTER 2: LITERATURE REVIEW

The first part of this literature review focuses on the chronological development of educational reform leading to the development of the block scheduling format. A primary focus is on national reports and legislation leading this reform effort. The second part focuses on literature discussing the use of time in schools and how block scheduling affords schools more academic learning time. In this section, the importance of staff development and student learning is shown. Next, a review of the active independent variable (schedule format combination in secondary schools) of interest in this study is explored. Attention is given to the advantages and disadvantages of each scheduling format. Additionally, empirical student achievement research on block scheduling is emphasized. The chapter conclusion includes a summary of the literature.

Historical Context and National Significance of Schedule Formats

The discussion of educational excellence in the United States has become a recurring theme. Schedule formats have been an area that schools across the United States have scrutinized in an effort to increase student achievement. Quality time spent on student learning is presumed central to increased student achievement (Rice, Croninger & Roelke, 2002). Even though empirical research is inconsistent, block scheduling is used in nearly 50 percent of all high schools in the United States (Canaday & Rettig, 1996; Zepeda, 1999). In response to heavy political pressures in the 1980s and 1990s, many schools changed their scheduling format from traditional 45-50 minute classes to block scheduled classes—courses that generally meet anywhere from 80–120 minutes.

The concept of block scheduling existed since the 1930s and first appears in the literature as the block-time concept (Vars, 1965). The block-time concept was defined as follows: "a block-time program is one in which two or more subjects that are ordinarily taught separately are combined or replaced, and scheduled for a block of time longer than the usual single subject class" (Vars, 1965, p. 384). During the 1930s and 1940s, the block-time concept was used to promote and enrich the core subjects of literature, mathematics, and science.

One of the pioneers of block scheduling was Joseph Carroll who introduced the *Copernican Plan* in the early 1980s. This plan was the culmination of an idea formulated in the 1960s when Carroll served as an assistant superintendent for the District of Columbia Public Schools. During his tenure, he proposed the concept of offering remedial summer school classes in mathematics and English that would meet for four hours per day, five days per week, for six weeks. Using a pre-test, post-test analysis, average student academic gains were equal to academic gains achieved in nearly two years of traditional classes (Carroll, 1994). In the 1970s, Carroll became superintendent at a school district in New Mexico and again introduced what he later coined "macro classes" to non-remedial summer school students (Carroll, 1994). Again the results were favorable.

The catalyst for the *Copernican Plan* implementation was passage of a tax limitation referendum forcing a Massachusetts school district to lose about one sixth of its staff. This impending reduction forced the school district to seek innovative ways to meet the newly created, strained demands on staffing (Carroll, 1994). As a result, Carroll introduced the *Copernican Plan* calling for a paradigm shift in the way school districts used time to schedule classes. More specifically, instead of the traditional approach, classes were scheduled and taught in much longer time periods (90-minute, two-hours, or four-hours). The school year was also altered so classes were scheduled in increments.

Some schools met for part of the school year in formats of 30, 45, 60, or 90 days (Carroll, 1994).

The *Copernican Plan* was named after the 16th century astronomer, Nicholas Copernicus, who daringly revived an ancient Greek idea of a heliocentric (Sun-centered) solar system as opposed to the time honored geocentric (Earth-centered) theory (Goldsmith & Tobias, 1992). Even though the heliocentric model could more easily explain the motions of the planets, Copernicus' theory was not embraced because it challenged the religious-backed belief of an Earth-centered solar system. Similarly, Carroll's initial ideas around scheduling were not fully embraced and were viewed as a serious challenge to the status quo. Initiating such a novel idea would result in a fundamental change from the time-honored traditional schedule format approach to school scheduling.

Even though Carroll may be considered a progenitor of block scheduling during the 1960s, modular scheduling, flexible scheduling, or modular flexible scheduling appeared in the literature in the 1970s (Stewart & Shank, 1971; Wood, 1970). Under this format, the school day was divided into numerous small modules of 10, 15, or 20-minutes, and classes were flexibly scheduled according to the number of modules deemed necessary for content instruction (Trump & Baynham, 1961). With this flexibility, classes can be scheduled in a variety of meeting formats: daily; on alternating days; or in varying lengths throughout the year, depending upon the learning activities of the class. According to Canaday and Rettig (1995), modular scheduling was abandoned due to lack of parental support, poor academic achievement, a rise in discipline referrals, and inadequate teaching. Block scheduling became a viable scheduling option for many secondary schools in the 1980s and 1990s.

The increase in block scheduling coincided with the release of two key governmental reports—*A Nation at Risk* and *Prisoners of Time*. In 1983, the National

Commission of Excellence in Education published *A Nation at Risk.* This report gave claim to a deteriorating public school system and became the stimulus for reform efforts aimed at improving the quality of education for America's children. *A Nation at Risk* (1983) began: "Our Nation is at risk...the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (p. 5). The release of this report, coupled with an ensuing media frenzy on the demise of public education in America, spawned a back-to-basics movement similar to the one experienced after the Soviet Union launched Sputnik in the late 1950s.

A Nation at Risk provided objective indicators sparking a debate about what students should be learning, what schools should be teaching, and to some extent, what schedule format schools should be using (Cizek, 1999). The report also offered many initiatives for school reform, including restructuring for more effective use of school time, and an increasing emphasis on core academic subjects. Most schools addressed the core academic subjects while few focused on recommendations relating to time management (Evans et al., 2002).

In 1994 the National Commission on Time and Learning released *Prisoners of Time*. The commission spent 24 months studying time management and its relationship to learning. Time usage was a key component in four of the commission's eight recommendations. The Commission invited educators to reestablish priorities around time in the following ways: (a) reinvent schools around learning, not time; (b) fix the design flaw, use time in better ways; (c) keep schools open longer to meet the needs of children and communities; and (d) give teachers the time they need (p. 29). Additionally, they proposed using block scheduling to promote increased student learning. In summary, the Commission stated, "Both learners and teachers need more time—not to do

more of the same, but to use time in new, different, and better ways. The key to liberating learning lies in unlocking time" (p. 10).

In response to the political pressures generated from the back-to-basics campaigns that swept through public schools in America, the National Association of Secondary School Principals released *Breaking Ranks: Changing an American Institution* (1996). This report confirmed students in the United States spent significantly less time on core academic subjects than students in countries with higher achievement scores in the same academic subjects. Two major concerns highlighted were the quality and quantity of classroom time use. To address these concerns, it was recommended that: "Schools develop flexible scheduling allowing for more varied uses of time" (p. 45). Block scheduling would establish longer periods of uninterrupted time for learning as well as instruction.

In 2001, Public Law 107-110, commonly known as the *No Child Left Behind Act* (*NCLB*), was passed and requires all public school students in the United States to reach a proficient level on standardized state exams in reading and mathematics by 2014 (Baker, Linn, & Herman, 2002). Using 2002 achievement scores as baseline data, schools are required to increase the percentage of students at the proficient level by an amount sufficient enough to guarantee that 100% of the students will attain proficiency by 2014 (Baker et al., 2002). In essence, schools are challenged to hit a moving target, one that moves every three years towards 100% proficiency. Failure to meet this proficiency may result in a loss of federal funds. This legislation has had a tremendous impact on public schools as they strive to find ways to move all students to this federally-mandated level of proficiency or risk the loss of significant money. Immediately after the release of *A Nation at Risk,* block scheduling was sparsely implemented; however, with the release of *Prisoners of Time* and *NCLB*, over 50% of secondary school in the United States began using some form of block scheduling (Canaday & Rettig, 1996; Zepeda, 1999).

In summary, block scheduling has become a viable school schedule format in the past 70 years. The block-time concept was introduced in the 1930s. Modular or flexible scheduling appeared in the 1960s. The *Copernican Plan* was introduced in the 1980s. According to research, key reports and legislation have surely precipitated the rise in the implementation of block scheduling; specifically, *A Nation at Risk* (1983), *Prisoners of Time* (1994), and *Breaking Ranks* (1996) have had an impact. Additionally, *The No Child Left Behind Act of 2001* has mandated student achievement in public schools. Scheduling format is just one of many factors scrutinized by schools as they seek ways to address student achievement.

Time Use in Schools

As many educational reform efforts gain momentum, the use of time in schools continues to be a focus, but increasing time, as accomplished with block scheduling, is not enough to improve achievement. The quality of instruction, often improves with adequate staff development, and ongoing support must also accompany any transformation to block scheduling.

The National Commission on Time and Learning (1994) reported that despite long-term interest in expanding the amount of instructional time for students, schools have adhered to the same schedule formats for generations. The Commission reported that most secondary school students attended classes no more than 51 minutes in length and schools continued to be controlled by the clock (National Commission on Time and Learning, 1994). Given the apparent inflexibility of many schools schedules nationally, researchers have focused on how successful schools have reallocated time to improve organizational effectiveness and student performance (Darling-Hammond, 1997). Most reform efforts challenge schools to adopt alternative school calendars and scheduling practices (Rice et al., 2002). For example, *A Nation at Risk* (1983) recommended

increasing allocated time from the average of 180 days to 210 or more days in a school year.

The fiscal resources required to add days to the school year have failed to materialize. The National Education Commission on Time and Learning (1994) predicted that to increase the school year to 200 days would cost the nation between $34.4 and $41.9 billion annually. Since the attack on the United States on September 11, 2001, many states have faced financial hardships. Increasing funding for schools became less of a priority as the nation faced an unexpected economic downturn. As a result, most reform efforts focused on changing the allotted time within the current framework of the average 180-day school year.

One critical assumption made by educational reformists was that increasing class time correlated to increased student achievement. According to Cotton and Wikeland (1990), research on the relationship of educational time to student achievement reveals a fairly consistent pattern: there was little or no relationship between *allocated time* and student achievement; there was some relationship between *engaged time* and achievement; and there was a larger relationship between *academic learning time* and achievement. *Allocated time* was defined as the total number of days or hours students were required to attend school; *engaged time* was defined as the time students were attentive, on task, and participating in learning activities; while *academic learning time* was defined as the time when learning was actually occurring (Aronson, Zimmerman, & Carlos, 1998). Not surprisingly, the most significant gains in achievement occur when schools increase the amount of *academic learning time* (Marzano, 2000). Therefore, any reallocation of time should focus on improving this specifically defined use of time.

A weakness in the literature on time use in the classroom exists because most researchers' focus on allotted instructional time versus the quality of instructional time. The propensity to look primarily at the total amount of school time exists, in part,

because quantity is easier to measure than quality (Moore and Funkhouser, 1990). In essence, measuring academic learning time and student engaged time is somewhat subjective. Using only allocated time to measure student learning is risky at best because this method fails to address how schools, teachers, and students use time.

A large portion of each school day is devoted to non-instructional activities. Passing periods, school announcements, lunch, recess, poor classroom management, assemblies, and advisement are just a few examples of non-instructional activities. A study conducted by Karweit (1985) showed that students were engaged in learning activities only 28 to 56 percent of the total time spent in school in a given year. Moreover, no consistent relationship is shown in the literature between the amount of allotted time for instruction and the amount of time students actually spend engaged in learning activities (Karweit, 1985). As a result, a common approach used by many districts is to increase the amount of allocated time by adding length to the school day or adding more days to the school year. However, simply adding more length to the school day or days to the school year does not necessarily equate to an increase in *academic learning time*.

Before school district officials assume the added financial burden of increasing days to the school year, or lengthening the school day without the predicted promise of improved student achievement, consideration should be given to making better use of currently allotted time. As stated, the back-to-basics movement gained momentum through the 1980s and remains strong with the implementation of *NCLB*. It is assumed that decreasing non-instructional activities and increasing time for instructional activities, specifically in the core academic areas, will lead to increased achievement. Knowing that increasing *academic learning time* increases student achievement, school officials should do everything in their power to maximize instructional time currently available to them (Marzano, 2000).

Block scheduling provides one example of reallocating time to create more time for student learning. Queen (2000) indicated fewer passing periods lead to more available instructional time in the block schedule format. Canaday and Rettig (1995) pointed out eliminating three class changes per day provided nearly an additional hour of instructional time per week. The following example is provided to add clarity to Canaday and Rettig's claim. Under the traditional schedule students attend seven 45-50 minute periods each day, and six passing periods would exist. If the average passing period is five minutes long, that equates to 30 minutes per day (6 passing periods x 5 minutes) and 2.5 hours per week (5 days x 30 minutes). Conversely, in the 4x4 block format students attend four 90-minute periods each day. In this format, only three passing periods exist equating to 15 minutes per day (3 passing periods x 5 minutes) and 1.25 hours per week (5 days x 15 minutes). In this example, 1.25 hours of instructional time becomes available each week, or 15 minutes per day within the block schedule format supporting claims by Queen (2000) and Canaday and Rettig (1995).

Critics contend that although block scheduling may increase available instructional minutes per day that there would be an overall reduction to the total instructional time per class (Hamm, 1999; Wallinger, 2000). They argue the reduction occurs as a result of the class meeting fewer days (90) in the block schedule versus more days (180) in the traditional schedule. However, Hackmann and Waters (1998) showed that total time lost is negligible, and not as large as critics contended. They argued the time spent on administrative tasks (e.g., attendance, classroom management, collecting papers) was halved in a block schedule format compared to a traditional schedule format. As a result, the total minutes available for instruction in both formats were essentially the same (Hackmann and Waters, 1998).

However, simply maximizing or reallocating the currently allotted instructional time is not enough. In order to advance student achievement, quality instruction must be

embedded in the educational community. A study conducted by Sanders and Horn revealed substantial achievement gains for students with "most effective" teachers compared to students with "least effective" teachers (cited in Marzano, 2003). Darling-Hammond (2001) identified the following variables presumed to be indicative of teacher competence: (a) measures of academic ability; (b) years of education, years of teaching experience; (c) measures of subject matter and teaching knowledge; (d) certification status; and (e) teaching behaviors in the classroom. Her study showed that knowledge of teaching and learning, and teacher behaviors and practice, had the most significant impact on student learning (Darling-Hammond, 2001). According to Doyle, teachers who are able to adjust their teaching to fit the needs of different students and the demands of different instructional goals, topics, and methods were considered most effective (cited in Darling-Hammond, 2001). Unless the reallocation of allotted instructional time is coupled with quality instruction, then increased time cannot be expected to have the intended major impact on student achievement.

If time is reallocated to provide more instructional time, then in order to improve the quality use of the newly found time, it must be coupled with teacher training. Otherwise, the intended positive impact on student achievement may be lost. Professional development is central to maintaining teachers' effectiveness, and it should parallel professed teaching benefits of the block schedule format (Miller, 2003).

According to proponents of block scheduling, with longer blocks of time, instruction can be more student-centered and more interactive (Dougherty, 1998; Hackmann, 1999). Teachers can utilize strategies to encourage more hands-on, active learning and less lecture-centered, passive learning (Canaday & Rettig, 1999; O'Neil, 1995). Extending the length of the class period allows the role of the teacher to change. Hackmann (1999) stated, "They [teachers] assist students in creating their own knowledge structures instead of passively receiving them from the teacher through direct

instruction" (p. 70). Without adequate staff development, students would simply receive *more of the same*. Unless more time was devoted to instruction, with students engaged in well-designed learning activities, providing additional time cannot be expected to have positive effects on achievement (Aronson et al., 1998).

Teaching strategies to promote active student engagement were plentiful in the literature and staff development should be centered on them. Use of Socratic seminar, the collaborative classroom, cooperative learning, concept attainment, simulations, learning centers, and integrated technology are a few strategies promoting active leaning (Canady & Rettig, 1996; Queen, 2000). Other researchers recommend using group activities and cooperative teaming to encourage student participation (Fitzgerald, 1996; Hackmann & Schmitt, 1997). Other identified strategies were engage students with a short video clip, use dramatic skits, use creative thinking activities, employ authentic assessment methods, and encourage resource sharing with colleagues (Fitzgerald, 1996; Hackmann & Schmitt, 1997; Wyatt, 1996). When developing lessons, researchers point out the importance of having two or more learning activities per class (Fitzgerald, 1996; Queen, 2000). In order to take full advantage of the increased length of class periods, staff development needs to focus on strategies promoting active student learning.

The underlying assumption of utilizing staff development to improve teaching strategies is that these strategies best match how students learn. Throughout the 1990s much attention was given to brain-based research and student learning styles. According to Jensen (1995), students can generally focus for a number of minutes equal to their age plus two. For example, a 16-year-old can focus for about 18 minutes. After this time, the brain needs time to process the information in a different way (Sprenger, 1999). Hence, using multiple activities within a single class period, as recommend, gives students a better opportunity to process information. In fact, Queen (2000) recommended teachers to use different instructional strategies every 10 to 15 minutes.

Not only are multiple activities within a class period advantageous to how the brain processes information, but the chosen mode of delivery also has an impact. According to Sprenger (1999), information enters the brain through one's senses. As a result, "different brains favor different sensory stimulation" (p. 95). Therefore, instructional strategies should also appeal to the senses. Visual learners need to *see,* auditory learners need to *hear,* and kinesthetic learners need to *do.* Rose and Nicholl (1997) pointed out that matching teaching delivery styles to student learning styles gives students a better opportunity to learn.

Multiple instructional strategies appealing to the senses to present students a better opportunity to learn should be used regardless of the type of schedule format. However, to take advantage of the extended learning opportunity afforded with block scheduling, student learning must take center stage. In the block format, students have greater opportunity to study subjects in-depth and make connections to their learning (Canaday & Rettig, 1995). Queen (2000) reported that teachers spent 70% of their time actively engaging students, and they were better able to engage students with in-depth study than in a traditional schedule format. Even though all teachers should utilize multiple teaching strategies, changing to the block format coupled with adequate staff development has resulted in more use of effective strategies by teachers.

This section examined time use in schools. Block scheduling was shown as a viable option to increase available time within the school day without more costly measures such as lengthening the school day or school year. As shown by Marzano (2000), increasing the amount of *academic learning time* has the greatest impact on student achievement. In order to optimize the newly found time in the block schedule format, it was shown that an emphasis should be made on staff development centered on the use of multiple teaching strategies. Teachers should use multiple modes of delivery

to match student-learning styles. Increased time coupled with high quality teaching could potentially have profound impacts on student learning.

School Scheduling Formats

There are three primary types of schedule formats (traditional, alternate day [AB] block, and 4x4 block) used in public schools. In addition to defining each type of format, reported advantages and disadvantages are shared. Because of the volume and similarity of findings between the AB and 4x4 block schedule formats, they are presented under the same heading. For clarity, the reported advantages and disadvantages of block scheduling are categorized for schools, teachers, and students.

The use of a traditional scheduling format has a long history in the United States. With an emphasis on scientific management prevalent in the earlier portion of the 20th century, traditional schedule formats evolved as being effective in promoting an efficient approach to teaching (Harmston et al., 2001). However, later in the 20th century, this traditional approach came under scrutiny with critics contending traditional schedule formats resulted in fragmented, harried instructional days, promoted over-reliance on lecturing, discouraged interdisciplinary teaching, and led to superficial understanding of complex curricular concepts (Canaday & Rettig, 1995; Wilson, 1995).

With traditional schedule formats under attack, the use of block scheduling emerged. As educators adapted to longer class periods, they embraced methods that allowed for more active engagement and better accommodations for individualized learning styles (NASSP, 1996). As a result, teachers were more creative and were stimulated to develop student-centered instructional strategies to promote student learning (Canaday & Rettig, 1995; O'Neil, 1995). Consequently, block scheduling has gained momentum in the educational community as a viable alternative to traditional scheduling formats.

Traditional schedule. Traditional school schedules have been the norm in the United States for most of the 20th century (Queen, 2000). In this format, students usually attend from five to seven 45-55-minute classes per day and complete a class after two semesters or approximately 180 days of instruction (Carter, 2002). Traditional schedules have been relatively static for decades in American high schools requiring the successful completion of a prescribed number of Carnegie units for graduation (Queen, 2000). In 1909, the Carnegie Foundation proposed 120 hours in one subject as the standard time unit to measure the worth of a high school credit (Pisapia & Westfall, 1997). Under this model, students attend from five to seven classes during the school day with each one lasting 50 minutes (Moore, Kirby, & Becton, 1997). The Carnegie unit is largely based on accumulated seat time in a class (Canaday & Rettig, 1995). As stated, nearly 50 percent of secondary schools in the United States have adopted some form of block scheduling; the other 50 percent continue utilizing the traditional format.

Even though half of America's public secondary schools employ traditional scheduling formats, research literature is limited on the espoused advantages or disadvantages. As a result, only a few common anecdotal ones are listed here. The literature shows that classes in a traditional schedule are allotted more total minutes for instruction than block scheduled classes (Hamm, 1999; Wallinger, 2000). For example, one 90-minute block class replaces two 50-minute traditional classes resulting in a loss of ten minutes of available instructional time (DiBiase & Queen, 1999). A completed class in the traditional format theoretically would have about 15 hours more time available for student learning than a block class. However, as shown by Hackmann and Waters (1998), this extra time may be used up by daily administrative tasks conducted by teachers.

Another common advantage of traditional schedules is continuity between sequential courses (Staunton & Adams, 1997; Thayer & Short, 1999). For example a

student taking Spanish I and Spanish II would only have the summer months between each class. However, in the 4x4 block schedule format it is possible to take Spanish I in the fall semester of one school year and not take Spanish II until spring semester of the next school year—leaving a time lag of one year between classes. As a result, some teachers of language arts, performing arts, and mathematics are strong proponents of students attending class every day for shorter periods of time (Rettig & Canaday, 1996; Staunton, 1997; Wallinger, 2000). Other advantages of traditional schedules can be inferred from listed disadvantages of both types of block scheduling formats.

Although advantages of traditional schedules have not been a focus in the literature, studies on block scheduling afford some criticisms of the traditional format (e.g., Wilson & Stokes, 2000). Perhaps one of the major disadvantages of traditional scheduling is the lack of ability to vary time for individualized instruction (Black, 1998; Irmsher, 1996). Research supports the differential rate of learning exhibited by students (Tomlinson, 1999). Teachers contend that students learn at different rates; some students take longer to learn specific content, while others take less time (Tomlinson, 1999). Without tracking students, the average secondary school class is geared toward the average student in the class (Canaday & Rettig, 1996). Sadly, students who need more time often fail to meet course requirements; while, students who need less time are bored (Evans et. al., 2002). In either case, students are not engaged in the learning process. According to the National Commission on Time and Learning (1994), "Conscientious teachers discover that the effort to motivate the most capable and help those in difficulty robs them of time for the rest of the class" (p. 15). As schools continue to rely on the Carnegie (seat time) approach, this problem will continue.

Several other disadvantages are related to the number of classes a student attends in a day. Students attend five to seven 45-55-minute classes in most traditional schedule format schools (Carter, 2002). Consequently, students must adjust to five, six, or seven

sets of discipline styles, grading policies, teaching styles, and homework requirements (Canaday & Rettig, 1996). Under the traditional schedule format, teachers are expected to teach anywhere from 100-180 students per day (p. 4). Students who attended schools in both traditional formats and block schedule formats indicated they preferred fewer classes per day (Hurley, 1997b; Matarazzo, 1998). According to *Breaking Ranks* (1994), if schools are to improve, teachers need to work with fewer students and students need to work with fewer teachers.

In summary, traditional schedule formats are used in about 50 percent of all public high schools. Classes taught over the course of a school year in a traditional schedule format theoretically have more minutes available for instruction and would result in the opportunity to cover more content than block schedule format classes. The traditional format was shown to have less time between sequential courses than in the block schedule format. Because of shorter periods in the traditional schedule format, it was shown that teachers do not individualize instruction to adjust for the differential rate of student learning. Students reported they enjoyed having fewer classes per day in the block format implying they did not enjoy more classes in the traditional format.

Block schedules (4x4 and AB). Many similarities exist between the two most popular forms of block scheduling, the 4x4 format and the alternate day or AB format (George & McEwin, 1999). As a result, this section discusses both of them together. Definitions of each format are followed by advantages and disadvantages. Most advantages and disadvantages are germane to both formats and are discussed accordingly. Whenever possible, distinct advantages/disadvantages of 4x4 or AB formats are shared. For clarity, these advantages/disadvantages are categorized by the impact on schools, teachers, or students.

The most common block scheduling format is the 4x4 semester or "accelerated block" (Lewis et. al., 2004a). In the 4x4 format, students attend the same four 90-minute

classes every day of the week and complete each class at the end of one semester (Queen, 2000). Students attend a different set of four 90-minute classes the second semester; hence, four classes first semester by four classes second semester or the 4x4 format. Teachers usually teach three classes per semester and students usually attend four classes per semester in this format (Edwards, 1995). In this study, the 4x4 block format high school has four 90-minute periods scheduled Tuesday through Friday. On Mondays, classes are 70-minutes long to allow for staff development and enrichment one day per week before the student school day begins.

The next most common block scheduling format is the alternate day, AB, or Even/Odd block. In this format, students attend eight 90-minute classes with four classes meeting on an "A" day and four different classes on a "B" day (Cobb et al., 1999). Classes in the AB format are completed at the end of the school year (two semesters). The AB high school in this study uses a modified AB block format. Students attend eight classes three days per week and attend alternating day block classes two days per week.

The type of schedule described for the AB high school in this study is often referred to as a modified block or "hybrid." Many schools across the nation have adopted these hybrids because they combine elements of traditional schedule formats and block schedule formats. Often times, foreign language, mathematics, performing arts, and physical education teachers resist the implementation of "pure" 4x4 or AB block schedules (Staunton & Adams, 1997; Wallinger, 2000). Usually hybrids are implemented to appease advocates and opponents alike. The literature is sparse on hybrid models and mostly represents pure 4x4 or pure AB block schedule formats.

Advantages/disadvantages for schools. Proponents of block scheduling indicate attendance rates improve, grades improve, graduation rates improve, discipline referrals decrease, drop out rates decrease, and the school climate improves when this schedule format is implemented. Several studies confirm these claims (Eineder & Bishop, 1997;

Guskey & Kifer, 1995; Mistretta & Polansky, 1997; Nichols, 2000; O'Neil, 1995). Satisfaction survey data were plentiful and showed that, when compared to the traditional format, positive changes occurred in the school climate as a result of block scheduling (Buckman, King, & Ryan, 1995; Fletcher, 1997; Wilson & Stokes, 2000). In the 4x4 block schedule fewer textbooks are required because students may use the same books for classes scheduled each semester (Canaday & Rettig, 1996).

Fewer school wide disadvantages of block scheduling exist in the literature. One disadvantage of the 4x4 block often cited is the potential lag time between sequential courses (Hamdy & Urich, 1998; Hamm, 1999; Wronkovich, Hess, & Robinson, 1997). Teachers in mathematics, foreign languages, and performing arts contend that continuity is compromised in the block format (Staunton & Adams, 1997). Most conversions from traditional scheduling format to block scheduling format result in a reduction of overall instructional minutes (Hamm, 1999). A concern associated with this reduction in instructional time is how to adjust curriculum in the block schedule format in each class to compensate for the loss (Dougherty, 1998). However, as shown by Hackmann and Waters (1998), this loss of time is debatable.

Advantages/disadvantages for teachers. Teacher related advantages of block scheduling include fewer students per day, fewer course preparations, increased planning time, increased contact time with students, increased daily instructional time, and decreased stress (Hamm, 1999). As a result of fewer course preparations, teachers reported more time for individualized instruction with students (Rice et al., 2002; Shortt & Thayer, 1999). Theoretically, teachers are able to be more innovative because of having fewer students and more time available for instruction (Brown, 1996). Teachers in a survey study conducted by Hurley (1997a) identified fewer preparations, more time for planning, less students per semester, and less paper work as advantages of 4x4 block

scheduling. Carroll (1994) highlights substantially reduced teaching loads as a primary benefit of block scheduling.

Even though Hamdy and Urich (1998) showed that class sizes may slightly increase, teachers in the 4x4 block format have considerably fewer total students per day resulting in less paper work (Canaday & Rettig, 1995; Hurley, 1997a). Other instructional benefits of longer blocks of time were the ability to increase opportunities for hands-on learning and to provide teachers with the flexibility to differentiate instruction (Dougherty, 1998). In a survey of 286 Virginia schools, administrators noticed an improvement in teacher morale and a more relaxed atmosphere after implementing block schedules (Shortt & Thayer, 1999).

Block scheduling disadvantages for teachers include possible increases in class size, student make-up work, learning new teaching strategies, and reduction of curriculum (Hamm, 1999). Hamdy and Urich (1998) reported teachers felt the 4x4 block schedule contained the potential for time gaps for teaching foreign language, English, and math. In addition, Canaday & Rettig (1996) shared that teachers of year-long Advanced Placement (AP) courses were concerned about the effect the 4x4 block schedule format would have on the AP testing. More specifically, AP exams are given during spring of each school year, and in the 4x4 format; it is possible to complete a class in winter. Doing so leaves a long period of time between course completion and administration of the AP exam.

Staunton & Adams (1997) reported teachers had concerns about interruptions and continuity issues. One potential disadvantage to teachers is the lack of staff development opportunities before and during the implementation of block scheduling. Queen (2000) boldly stated, "Principals and staff development personnel are crucial [to the success of block scheduling] and must provide initial and continuing training for teachers to master instructional strategies" (p. 221). In addition, Adams, Salvaterra and Thorneburg found

that staff development prior to implementation of block scheduling was required for success (cited in Queen, 2000). Conversely, inadequate staff development is not only a disadvantage, it may lead to unsuccessful implementation of block scheduling.

Advantages/disadvantages for students. Advantages for students in the block scheduling format are decreased stress, fewer classes per day, less homework per day, increased opportunities to earn credit (4x4 only), increased time for learning, higher GPAs, possibility to take more classes (4x4 only) and improved scores on final exams. Wilson and Stokes (2000) reported students felt the greatest advantage of block scheduling was the ability to earn more credits for graduation (4x4 only). Additionally, students can accelerate their academic program more easily as a result of being able to take more courses in the block schedule format (Thayer & Shortt, 1999). Students indicated teachers utilized a greater number of teaching strategies in the block schedule format than in the traditional schedule format (Rice et al., 2002; Wilson & Stokes, 2000). One strategy employed more often in block scheduling was the use of group instruction (Pisapia & Westfall, 1997). A survey study by Hurley (1997b) reported student advantages included getting better grades, participating in school-sponsored clubs during the day, having less homework (due to fewer classes), and being able to graduate early (4x4 only).

Disadvantages to students from block scheduling include difficulty paying attention within longer classes; difficulty in making up missed classes, especially with extended absences; transferring into or out of schools with block schedules; balancing schedules by difficulty each semester (4x4 only); and scheduling of Advanced Placement courses (Hamm, 1999; Wallinger, 2000). According to Hurley (1997b), student disadvantages included length of class, uneven schedules, course sequencing, and difficulty making up missed work. Students reported that making up missed work, the

length of classes, and too much busy work were some of the disadvantages to block scheduling (Wilson & Stokes, 2000).

Summary. This section examined the literature on traditional, 4x4 block, and AB block scheduling formats. Traditional schedule formats have dominated American public schools for most of the 20th century. The literature was sparse regarding advantages and disadvantages of this format. The key advantages were maintaining continuity in sequential courses and students attending class every day. One of the more significant disadvantages results from the disjointed nature of attending anywhere from five to seven class periods per day. As a result, teachers were less likely to tailor instruction to meet individual needs.

The two most popular types of block scheduling (AB and 4x4) were presented under the same heading because of their similarities. Many school wide advantages were presented with the improvement to the school climate being of utmost importance. Teacher morale was improved in block scheduling primarily as a result of fewer preparations, fewer students per day, less paperwork per day, increased planning time, and decreased stress. One key disadvantage was the potential for students to have one year between sequential courses. Making up missed work was not only problematic for teachers but was also one of the primary disadvantages cited by students. With block scheduling, students enjoyed fewer classes, reduced homework, the ability to take more classes (4x4 only), and the opportunity to graduate early (4x4 only). In all, more advantages were noted than disadvantages for the block scheduling format.

Empirical Evidence for Student Achievement

This section focuses on empirical research measuring student achievement outcomes and the type of scheduling format used in schools. Limited empirical research was available on achievement and schedule formats. Studies for this review were chosen

by the outcome measure used to report student achievement. Specifically, use of standardized tests such as ACT, SAT, or state-developed assessments were given higher priority than studies using GPA, end of course tests, and AP test results.

Results of studies in this review of quantitative research measuring student achievement relative to scheduling format of the school were inconsistent. In many cases, the findings within a given study varied. For example, Cobb et al. (1999) found students in a traditional format outperformed students in a 4x4 block format in mathematics using the Iowa Test of Basic Skills; however, there was no significant difference in Iowa Test reading scores. Some studies showed students in schools with block schedules had statistically significant higher achievement than students in schools with traditional schedules (Beaver, 1998; Cantu, 2002; College Board, 1998; Hess et al.1999; Lewis et al. 2004a; Nichols, 2000;). Other studies showed no statistically significant difference in student achievement (Baker, 2001; Cobb et al., 1999; Ford, 2001; Owings, 2002; Stewart, 2003; Wallinger, 2000; Wronkovich et al., 1997). Yet other studies showed students in schools with traditional schedule formats had statistically significant higher achievement scores than students in schools with block schedules (Cobb et al. 1999; Dunnan, 2001; Fowler, 2002; Veal & Schreiber, 1999).

Research studies on block scheduling have become increasingly popular and as a result, several studies synthesizing the research have been conducted. Canaday and Rettig noted increased student grades, increased honor roll students, increased graduation rates, increased attendance rates, and fewer discipline referrals as positive results for block scheduling (cited in Lewis, Winokur, Cobb, Gliner, & Schmidt, 2004b). Applying the rigorous methodological criteria of the *What Works Clearinghouse*, Lewis et al. (2004b) found a small negative effect of block scheduling on student achievement in mathematics, English, and science. However, as stated, "the magnitude of the effect sizes was small enough to have little or no practical consequences" (p. 24). Syntheses of block

schedule research on student achievement parallels the research it purports to coalesce—it is inconsistent.

Student achievement: schools with block schedule formats. Studies showing higher student achievement scores in schools with block schedule formats compared to schools with traditional formats were limited. Beaver (1998) showed achievement gains in reading and language arts using the Indiana statewide test as the outcome measure. Another study by Cantu (2002) used an analysis of covariance (ANCOVA) and showed reading and mathematics scores were significantly higher on the Texas Assessment of Academic Skills (TAAS). Hess et al. (1999) used the Otis-Lennon Scholastic Aptitude test as a covariate and conducted a regression analysis on pre- and post-tests finding higher achievement in English and Biology classes using the SAT II as the outcome measure. A study by Lewis et al. (2004a) found statistically significant gains for block schedule high school students on the ACT subtests in reading and mathematics using a factorial analysis of variance.

Limited results showing higher student achievement in block schedule format schools versus traditional schedule format schools could be a result of several factors. Use of block scheduling has increased in the past 20 years; however, research studies have lagged behind. Although more scholarly works have been conducted since 2000, a growing need for more research in this area exists. Additionally, few studies revealed block schedule formats producing statistically significant results compared to traditional schedules, and these findings may represent emerging trend.

Student achievement: schools with traditional schedules. The College Board (1998) reported that students enrolled in traditional schedule format classes had higher results on Advanced Placement exams in Calculus and U. S. History than students in 4x4 block schedule format classes. Veal and Schreiber (1999) conducted a study resulting in

varied outcomes. The researchers used an ANCOVA to show that mathematics scores, as measured by the Indiana statewide test, were higher for students in a traditional schedule format versus those in a block schedule format. However, in the same study, no statistical difference was noted in reading. Cobb et al., (1999) conducted a study comparing high school students with a block schedule format to those with a traditional format. The results revealed students with the traditional schedule format outperformed students with the block schedule format in mathematics using the Iowa Test of Basic Skills as the outcome measure. In 2002, Fowler completed a study comparing traditional, 4x4, and AB schedules using South Carolina Basic Skills Assessment Test as the outcome measure. Although the results were inconsistent (there was no difference in math), statistically significant reading results were shown for students in schools with the traditional format. Moreover, these results showed an interaction effect by gender. Male and female students in the traditional format had higher reading achievement than those in the 4x4 block format.

Student achievement: studies with no statistical difference. Several of the studies cited revealed varied results. For example, Cobb et al. (1999) showed significance in mathematics when comparing traditional schedule to block schedule formats; however, the same study showed no statistical difference in reading. Likewise, Veal and Schreiber (1999) also showed no difference in reading. Studies conducted between 2000 and 2005 were more plentiful using standardized outcome measures of student achievement. Given the focus of this study, studies showing no statistical difference with ACT scores as the outcome measures were highlighted. Although Dunnan (2001) showed a significant result for mathematics using the ACT, the study also revealed no statistical significance in reading scores. Two similar studies were conducted in Tennessee and Missouri respectively examining student achievement before and after implementation of the block schedule format (Ford, 2001; Stewart, 2003). Neither study found any statistical

differences on any of the ACT subtest scores. While foreign language teachers often criticize changing from a traditional schedule format to a block schedule format, one interesting study showed no statistical difference in French reading, writing, speaking, or listening when the schedule format changed (Wallinger, 2000). In summary, no definitive trends in the findings exist.

Student achievement: comparison of 4x4 to AB scheduling formats. The studies above focused on comparing block scheduling format and traditional scheduling format schools. However, an area of interest also exists within the different block scheduling formats. For example, how does the 4x4 block schedule compare to the AB block schedule in the empirical literature? Not surprisingly, AB block schedule format, and 4x4 block schedule format studies were sparse and inconsistent. Fowler (2002) showed higher student achievement in reading for students in the AB block format but no difference in mathematics using the South Carolina Basic Skills Assessment Test. Two studies took an in-depth look at the scheduling formats of students in Virginia (Pisapia & Westfall, 1997; Thayer & Shortt, 1999). Students in the AB block schedule format showed greater gains on the Scholastic Aptitude Test (SAT) than students in the 4x4 schedule format (Pisapia & Westfall, 1997). The other study provided only descriptive statistics requiring readers to draw their own conclusions (Thayer & Shortt, 1999). The students' mean gain scores in reading and mathematics on the Virginia Assessment Program tests were slightly higher in the AB format (Thayer & Shortt, 1999). In contrast, Carter (2003) showed the mean ACT scores in mathematics of students in the 4x4 format were higher than the mean scores of students in the AB format. Again, no statistical significance was shown. In summary, the literature comparing schools with AB and 4x4 schedule format schools was limited. The few studies that were explored revealed inconclusive results making it difficult to conclude if achievement in one block format is better than the other.

Summary

An exhaustive search of the literature has been conducted covering the topics of the development of block scheduling, the use of time in schools, the advantages and disadvantages of scheduling formats, and empirical evidence for student achievement. As this study is quantitative, research focused on empirical studies on student achievement using standardized tests as outcome variables.

As public education continues to be under the spotlight of accountability, changes are inevitable. Recent evidence of increased accountability occurred during the 2005 National Education Summit, where the National Governor's Association endorsed an agenda to improve America's high schools (Perkins-Gough, 2005). The agenda calls for comprehensive plans to improve high schools to adequately prepare graduates for college or the workforce (p. 89). This agenda may nudge more schools into block scheduling.

Providing extended periods of time beyond the traditional 45-55-minute class periods has become a popular and viable option for schools today. Block scheduling was shown to have many advantages compared to traditional schedules. Perhaps the most important one was the possibility of increasing the amount of *academic learning time* (Aronson et al., 1998). Research revealed the most significant gains in achievement could be expected when this type of time is increased (Marzano, 2000). Reallocating the available instructional time into blocked periods coupled with adequate staff development provides the foundation to support instructional reform efforts.

Nationally, nearly half of secondary schools have adopted some form of block scheduling. The most notable increases in the use of this schedule format mirrored the release of *A Nation at Risk, Prisoners of Time*, and *Breaking Ranks* in the 1980s and 1990s. Consequently, the promulgation of educational research regarding the effectiveness of this scheduling format ensued and has revealed inconclusive results. Empirical research on student achievement has been varied, some results show positive

gains in achievement, some show declines in achievement, and some show no difference in achievement. One of the most robust synthesis of the research revealed that block scheduling does have a small negative effect on student achievement (Lewis et al., 2004b). However, the magnitude of the effect was small and students were shown to not be adversely affected by the block scheduling format. Because of the inconsistency in studies, it is difficult to draw specific conclusions.

Although the literature was replete with studies on block scheduling, no studies were found showing the relation of junior high school scheduling format in combination with the high school scheduling format on student achievement. A few studies statistically matched students using standardized tests from their last year in junior high school (Cobb et al., 1999; Lewis et al., 2004a).

This study investigates the efficacy of combinations of junior high school scheduling formats and high school scheduling formats on achievement of high school students using ACT subtest scores in mathematics and reading as the outcome measures. This unique longitudinal research enhances the existing knowledge base of the impact combinations of secondary school scheduling formats have on student achievement.

CHAPTER 3: METHOD

This chapter delineates the research method and rationale for the design approach. Participants, setting, and treatment are described. In addition, the outcome measures and the covariate are described with their associated reliability and validity. The chapter also describes both data collection procedures and statistical analysis of the data.

Research Approach and Rationale

This *ex post facto* study is a quantitative study using a post-test only design with covariates. When intact groups are used and it is not possible to randomly assign participants, the use of a post-test research approach is appropriate (Gliner & Morgan, 2000). In this study, participants are self-assigned to the scheduling format. Analysis of covariance statistically matches participants prior to the intervention and helps reduce bias inherent to using intact groups (Stevens, 1999; Mertler & Vannatta, 2002). The statistical match is accomplished by adjusting the means of dependent variables to what they would be if all groups scored equally on the covariate. According to Mertler and Vannatta (2002), "instead of the ideal situation consisting of subjects randomly assigned to groups/treatments, the researcher now has two (or more) groups containing subjects that have been matched based on the covariate scores" (p. 94). The specific research design model for this study is shown in Table 1. The assignment of participants to the treatment as shown in Table 1 is non-random, and there are seven levels on the active independent variable of schedule format combination.

The ACT subtest scores in reading and mathematics of 11^{th} grade students during the 2003-2004 school year are used as the post-test. Sixth grade results on the Achievement Level Tests (ALT) in reading and mathematics from the same students are

used as the covariate in this study. In addition to statistically matching participants, additional purposes of using the covariate strengthen the study by controlling for the initial student achievement and also to increase the likelihood of similar participant characteristics in relation to the outcome variable (Mertler & Vannatta, 2002).

Table 1

Design Model

Schedule Format Combination	Assignment	Group	Post-test
Trad JH & Trad HS	NR	E_1	O
Trad JH & AB HS	NR	E_2	O
Trad JH & 4x4 HS	NR	E_3	O
AB JH & Trad HS	NR	E_4	O
AB JH & AB HS	NR	E_5	O
AB JH & 4x4 HS	NR	E_6	O
4x4 JH & 4x4 HS	NR	E_7	O

Sampling Design

Sampling frame. The final sample in this study is the result of a three stage selection. The first stage includes all high school 11^{th} grade students who were enrolled in one of three high schools in the school district of interest at the end of the 2003-2004 school year. In this stage, participants who attended any of the district's alternative schools are excluded. In stage two, students who did not attend the same school in high school in 2002-2003 and 2003-2004 are eliminated. Additionally, students who did not attend a junior high school with the same scheduling format for the 1999-2000, 2000-2001, and 2001-2002 school years are also eliminated. Stage three reduces the sample further by eliminating participants who did not have complete data for the period

of study. Specifically, participants must have had results from the 2004 ACT and the 1999 ALT in reading and mathematics.

Theoretical population. According to Gliner and Morgan (2000), the theoretical population includes all participants to whom the research is generalizable. The theoretical population for this *ex post facto* study is students who attend high schools in moderately sized, university centered, cities in the Mountain West region of the United States. In addition, these students have taken the ACT exam, as it provides the outcome measures for student achievement in reading and mathematics.

Final sample. The actual sample for this study was 1705 students who attended one of the three high schools and one of eight junior high schools in a Mountain West city of approximately 130,000. In stage one, 131 students were eliminated who attended one of the district's three alternative schools. The sample included 11^{th} grade students who were enrolled in one of the three high schools in the Mountain West district at the end of the 2003-2004 school year. From these numbers, data were collected from the district's database on these students to include ACT subtest scores in reading and mathematics for spring 2004. The original sample size of 1705 was reduced to 1320 (Stage 2) because of students who did not attend the same high school or have the same schedule format in junior high school for the length of time allotted for this study. The sample was further reduced to 1100 students (Stage 3) due to missing data from students who did not have scores for the 1999 ALT exams in reading and mathematics or the ACT exam in 2004.

Setting

The district in this study is located in a moderately sized city with a population of about 130,000. The leading employer in this city is a state supported university. Three comprehensive high schools, eight junior high schools, and 26 elementary schools comprise this district. In 2004, the total enrollment for the district was 24,891 (Kindergarten – 12th grade) who were overseen by nearly 3,300 professional educators. As shown in Table 2, the district was comprised of 79.9% Caucasian students, 13.7% Hispanics and the remaining 6.4% were combined African Americans, Asian/Pacific Islanders, and Native Americans. Due to the small numbers, the latter three ethnicities were combined.

Table 2

District Demographic Data 2003-2004

	Ethnicity			Gender		
Factor	Caucasian	Hispanic	Other	Male	Female	Total
Enrollment	79.9%	13.7%	6.4%	51.5%	48.5%	24,891
Attendance Rate	95.3%	93.5%	95.0%	95.2%	95.0%	95.1%
FRL[a]	10.6%	8.3%	1.9%	11.1%	9.8%	20.9%
Graduation Rate	94.7%	83.5%	89.6%	92.4%	94.8%	93.6%
Suspensions	2.4%	5.7%	3.5%	4.1%	1.5%	2.9%
Expulsions	.05%	.1%	.3%	.1%	0%	.1%
Dropout Rate	1.5%	4.3%	1.7%	2.1%	1.5%	1.8%

[a] FRL refers to Free and Reduced Lunch and is used as a measure of the socioeconomic status.

Table 2 shows Caucasian students have a more favorable attendance rate (95.3%) and graduation rate (94.7%) than other ethnic groups. Also, Caucasian students had

fewer suspensions (2.4%), fewer expulsions (.05%), and the lowest dropout rate (1.5%) compared to other ethnic groups. In a stereotypical fashion, females had fewer suspension and expulsions, as well as a lower dropout rate than males. Additionally, females had a higher graduation rate and lower attendance rate than their male counterparts. The district had 5,128 (20.9%) students who voluntarily optioned into the federally subsidized FRL program. Of the students in this program, Caucasians and males participated the most. This district also served 2,265 (9.1%) special education students. Furthermore, school of choice was an option exercised by nearly 28% of the student population. If space is available in a school other than the prescribed neighborhood school, students may choose to attend a different school.

High schools. The high school in this study with the traditional schedule format (Trad HS) is also the oldest high school in the district having existed for 113 years. This 10-12-grade high school had 1642 students enrolled at the end of the 2003-2004 school year with 48.7% male and 51.3% female (Table 3). The school was comprised of 86.9% Caucasians, 8% Hispanics, and the remaining 5.1% were combined African Americans, Asian/Pacific Islanders, and Native Americans. Nine percent of students voluntarily participated in the federally subsidized FRL program. Trad HS offered a comprehensive curriculum with a wide variety of course offerings to meet varied student interests and needs. This school offered 15 Advanced Placement classes. The school schedule is a traditional one with eight 50-minute classes offered every day. A typical course in this school is completed at the end of the school year after 36 weeks or two semesters of study. Students may take anywhere from five to eight classes with a school wide average of 5.87 classes per year.

The high school in this study with the modified AB schedule format (AB HS) is the second oldest high school in the district and opened in 1964. The AB scheduling format has been in place for 8 years. This school, inclusive of 9-12 grades, had 1871

students enrolled at the end of the 2003-2004 school year with 49.8% male and 50.2% female (Table 3). The school was comprised of 81.3% Caucasians, 12.5% Hispanics and 6.2% combined African Americans, Asian/Pacific Islanders, and Native Americans. Thirteen percent of students attending AB HS participated in the FRL program.

Table 3

Student Demographic Data

		Student Enrollment 2003-2004					Free and Reduced Lunch	
School	Yrs. in Format	Total	Male	M%	Female	F%	*N*	FRL%
Trad HS	113	1642	800	48.7%	842	51.3%	100	6.1%
AB HS	8	1871	932	49.8%	939	50.2%	211	11.3%
4x4 HS	11	1849	930	50.3%	919	49.7%	94	5.1%
Trad JH[a]	28.3	2234	1173	52.5%	1061	47.5%	476	21.3%
AB JH[b]	6.5	2594	1350	52.1%	1244	47.9%	222	8.6%
4x4 JH[c]	9	606	313	51.7%	293	48.3%	140	23.1%

[a] Trad JH included pooled data from three junior high schools.

[b] AB JH included pooled data from four junior high schools.

[c] 4x4 JH included data from one junior high school.

In addition to offering a similar comprehensive curriculum as the Trad HS, this school houses an International Baccalaureate (IB) program for students in grades 9-12. The only 9th grade students enrolled in AB HS were participants in the IB program. In addition to the IB program, 15 AP courses were offered. The schedule format in this school consists of eight 50-minute periods three days per week with four alternating 90-minute block periods two days per week. Students may take anywhere from five to eight classes with a school wide average of 6.12 classes per year.

The third comprehensive high school in this district utilized a 4x4 block scheduling format (4x4 HS) and opened in 1973. The 4x4 format had been in place since 1993. This 10-12-grade high school had 1849 students enrolled at the end of the 2003-2004 school year with 50.3% male and 49.7% female (Table 3). The school was comprised of 87.5%, 7.3% Hispanics, and the remaining 5.2% were combined African Americans, Asian/Pacific Islanders, and Native Americans. Eight percent of the students attending 4x4 HS participated in the FRL program. This school offered a similar curriculum to Trad HS where students chose from a wide variety of course offerings. This school offers 19 AP courses for students. The schedule format consists of four 90-minute periods four days per week, four 70-minute periods one day per week, and was considered a 4x4 semester block schedule. In this format, a class is completed in one semester or 18 weeks. Students may take anywhere from five to eight classes with an average of 7.44 classes per student.

Table 3 and Table 4 provide demographic data for the participating schools in this study. In Table 3, there are two points to note; there were more males in the junior high schools and FRL percentages were lower in the high schools. Table 4 indicates number of years in the scheduling format, stability rate, average number of years of teaching experience, percentage of instructors who are teaching in their subject area, percentage of teachers with advanced degrees (masters or above), and average number of students per teacher. In general, stability rate, teaching experience, and percentage of instructors teaching in their subject area were similar across all groups. However, the percentage of teachers with advanced degrees and the student to teacher ratio was greater for high schools.

Junior high schools. In addition to the three comprehensive high schools, students in this study must have attended one of the eight junior high schools populating the high schools. Junior high schools in the school district enrolled students in

grades 7-9. Although each junior high was unique, they were grouped by schedule format as traditional, AB, and 4x4 schedule format schools. Three junior high schools had traditional schedules, four had AB block schedules, and one had a 4x4 block schedule format. Figure 1 shows the feeder system structure that was used to pool the populations from schools with the same scheduling format.

Three junior high schools had traditional schedules (Trad JH) during the time frame for this study; however, one of them converted to an AB scheduling format for the 2004-2005 school year. Figure 1 shows that 2234 students were enrolled in this pooled group with the smallest school (JH-B) contributing 629 students and the largest (JH-A) contributing 928 students. The average Trad JH male population was slightly greater than females with 52.5% and 47.5% respectively (Table 3). This group had the highest variation of FRL students ranging from 18.7% to 48.9% with an average of 29.7%. All of these schools had classes meeting for 45-50 minutes five days per week. Students in the junior high schools were required to take eight classes each year.

Table 4

School Demographic Data

School	Yrs. In Format	Stability Rate	Teacher Experience (Years)	% Teaching in Subject	% Teachers with Advanced Degrees	Student Teacher Ratio
Trad HS	113	93.8%	15	79%	65.5%	20.9:1
AB HS	8	95.4%	12	65%	50.5%	20.2:1
4x4 HS	11	93.8%	14	81%	56%	21.3:1
Trad JH[a]	28.3	95.5%	13.5	64.7%	57.6%	15.5:1
AB JH[b]	6.5	97.3%	13	66.5%	50.6%	15.4:1
4x4 JH[c]	9	96.7%	11	76%	48.9%	19.7:1

[a] Trad JH included the pooled data from three junior high schools.

[b] AB JH included the pooled data from four junior high schools.

[c] 4x4 JH included the data from one junior high school.

There were four junior high schools with AB block scheduling (AB JH) during the time frame for this study. This group's enrollment was 2594, making it the largest population of pooled groups. The gender breakdown was nearly the same as the traditional group with 52% male and 48% female (Table 3). There were considerably less FRL students compared to the traditional schedule group. All schools in this pooled group used some variation of AB block scheduling where students attended eight classes one day per week for approximately 45-minutes and then four classes on alternating days for 90-minutes. Students in this format completed eight classes in 36 weeks or one school year.

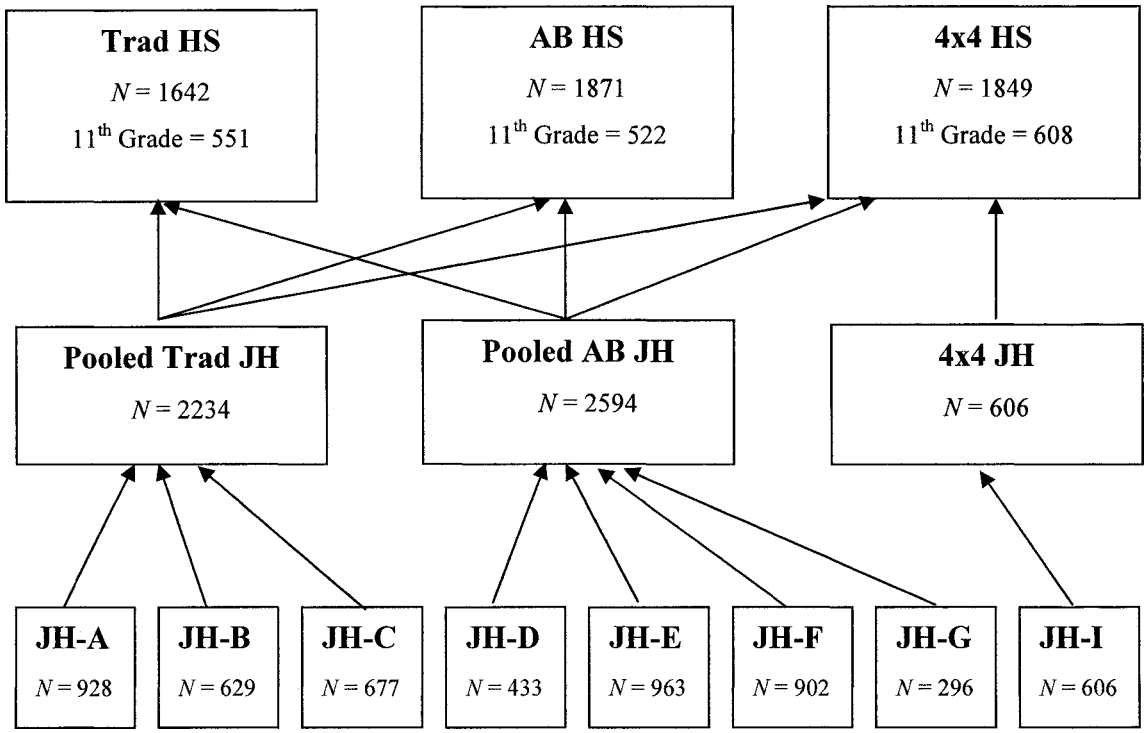

Figure 1. Feeder system structure.

One junior high school in the district studied had a 4x4 block schedule (4x4 JH) format in place during the time frame for this investigation. However, this school had adopted an AB format during the 2003-2004 school year. The enrollment at this school was 606 students with 51.7% male and 48.3% female (Table 3). Twenty-three percent of the students were FRL. In this school, students attended four classes per day for 90-minutes each. Within this format, a class was completed at the end of 18 weeks or one semester. All students took eight classes in a school year—four the first semester and four the second semester.

Treatment

In this study of nine theoretically possible combinations of schedule formats, only seven remain comparable due to attrition of the sample size. Students who attended 4x4 JH and AB HS (n = 18) as well as students who attended a 4x4 JH and Trad HS (n = 2) are eliminated because of small sample sizes (Ziomek, 2000). In this study, 6th grade

students' scores on the ALT tests in reading and mathematics are used to statistically match the accessible sample. Twenty-six elementary schools (K-6) populate into eight junior high schools that in turn populate three high schools. Furthermore, the junior high schools are grouped by their scheduling format: one had a 4x4, three had traditional, and four had AB (Figure 1). All schools of interest in this district had the same scheduling format in place for the duration of the study.

The following interventions are based on possible combinations of junior high school scheduling format and subsequent high school scheduling format. Students must have attended all years in both formats. For example, a student who attended a 4x4 JH for three years and a 4x4 HS for 2 years is included in the sample. However, a student who transferred schools within the study period is excluded from the final sample. The following seven interventions are of interest:

1) 4x4 JH and 4x4 HS,
2) AB JH and 4x4 HS,
3) AB JH and AB HS,
4) AB JH and Trad HS,
5) Trad JH and 4x4 HS,
6) Trad JH and AB HS, and
7) Trad JH and Trad HS.

Variables

Outcome Variables and Covariates. The outcome variables in this study are ACT subtest scores in mathematics and reading. The ACT scores are normal or interval, and results approximate a normal distribution. In this study, all 11^{th} grade students participate in the ACT exams as required by legislative action in the state where the study district is located. According to the state's department of education, the ACT is closely aligned to

the state's model content standards (State Department of Education, 2001). As a result, this assessment not only is a robust nationally-normed test but also has elements of a criterion-referenced test—in this case, the criteria are state standards. Only two states in the United States require ACT testing; whereas, students voluntarily participate in other states.

The ACT has been used since the late 1950s primarily to help students make decisions about which colleges to attend and to provide useful information to colleges both in the process of admission and predicting success after enrollment. Even though ACT was designed to predict success in college, studies commonly use ACT scores as an outcome variable (Dunnan, 2001; Ford, 2001; Lewis et al., 2004a; Stewart, 2003). According to ACT (1997), high scores on the ACT reflect a level of achievement that has been earned as a result of hard work and dedication. ACT states, "The tests are designed to determine how skillfully students solve problems, grasp implied meaning, draw inferences, evaluate ideas, and make judgments in subject-matter areas important to success in college" (p. 2). Given the common use of ACT composite and subtest scores in the literature, as well as ACT's own assertions about achievement levels, its use as the outcome measure in this study is appropriate. However, since the ACT assessment is not intended to assess facets of achievement unrelated to college preparedness, its use as a measure of achievement is limited.

The covariates in this study are scores on the Northwest Evaluation Association (NWEA) Achievement Level Test (ALT) in reading and mathematics. NWEA helps school districts develop local tests centered on either state standards or district standards. The ALT tests are normally distributed and are intended to measure year-to-year achievement in mathematics and reading. Students attending the district in this study were required to take the ALT assessment in reading and mathematics in 6^{th} grade (elementary school) during spring of 1999. As a result, these scores are used to control

achievement before entering the schedule format combination intervention. Additionally, since the ALT was only given in mathematics and reading, the outcome measure is limited to these subjects as well.

The ALT assessments were developed in the 1970s and are used in school districts in at least 24 states (Kingsbury, 2003). Level tests were developed to alleviate a common problem associated with grade level standardized assessments. These assessments, also called wide-range tests by NWEA, consist of items (questions) with a wide range of difficulty. Some items are too easy, some items are reasonably difficult, yet others are too difficult. As a result, the difference between high achieving students and low achieving students is large (Kingsbury, 2003). Often, the high achievers find these kinds of tests too easy while low achievers find them too difficult.

To counter this problem, Level tests were designed around the difficulty of the content (items) rather than the grade level of the student. As a result, multiple levels of assessments were created for testing students in school districts. The resulting series of tests systemically increase in difficulty from one level to the next. With the different levels of difficulty, it is possible to give each student in the district a test appropriate to his or her achievement level. Students new to this testing format take a brief locater test to determine the appropriate level of the test for the first administration of the assessment.

Independent variables. The active independent variable in this study is the secondary school schedule format combination of the participants from 1999-2004. In addition, two attribute independent variables; gender and socioeconomic status are of interest. The active, nominal independent variable is schedule format combination with seven levels (Trad JH & Trad HS, Trad JH & AB HS, Trad JH & 4x4 HS, AB JH & Trad HS, AB JH & AB HS, AB JH & 4x4 HS, and 4x4 JH & 4x4 HS). Gender and socioeconomic status are dichotomous, nominal attribute variables. Socioeconomic

status is measured by voluntary participation in the school district's federally subsidized FRL program.

Reliability and Validity

American College Test (ACT). ACT reports the reliability of the reading test as $R = .86$ and the reliability of the mathematics test as $R = .91$ using a methodology outlined by Kolen, Hanson, and Brennan (cited in ACT Assessment, 1997). This measurement of reliability uses the scale score average standard errors of measurement and the observed scale score variance for the test. The following equation was used ($R = 1 - SEM^2/S^2$) where R is the reliability, SEM is the estimated scale score average standard error of measurement and S is the observed scale score variance for the test. Although not stated in the technical manual, it appears this reliability measured internal consistency.

The content validity of the ACT tests is ongoing through the test development process. Before an item is incorporated into a test, it has been critically examined at least 20 times (ACT Assessment, 1997, p. 37). Detailed specifications have been developed to ensure the test content is representative of current high school and university curricula. All test forms are reviewed to ensure that they match these specifications. ACT reports one type of criterion-related validity, predictive evidence for mathematics at .82 and reading at .71 (ACT Assessment, 1997). They conclude that a student who takes advanced courses in mathematics is more likely to score higher on the achievement test than students who takes advanced classes in language arts.

Achievement Level Tests (ALT). Northwest Evaluation Association (2003) reported two measures of reliability for their ALT exams—marginal reliability and test-retest reliability. Marginal reliability is NWEA's measure of internal consistency—reliability across test items. According to Kingsbury (2003), "marginal reliability is one

of the best methods of calculating the reliability for adaptive tests because it uses the test information function to determine the expected correlation between the scores of two hypothetical tests taken by the same student" (p. 54). Another advantage is it allows calculation of reliability across multiple test forms. The marginal reliability for 6th grade students is reported as .94 for reading and .94 for math (Kingsbury, 2003). A correlation coefficient between .7 and 1.0 indicates a measurement is reliable (Gliner & Morgan, 2000).

Test-retest reliability is the correlation between scores of two different tests over the same content by the same student. A strong positive correlation is expected if two scores were either the same or very close to one another (Gliner & Morgan, 2000). NWEA (2003) reports the test-retest reliability of 6th grade students in reading and mathematics as .91.

The rigorous process of test item development controls content validity of the ALTs. Classroom teachers have developed items and item banks over a 22-year period. This process involves the writing and checking of items by teachers. Once an item is deemed appropriate, an independent panel of teachers reviews it for racial/ethnic and gender bias. If bias exists, the item is discarded. Approved items are field-tested and calibrated using Item Response Theory by Lord and Novick (cited in Kingsbury, 1997). Items that do not perform well are either revised or discarded. This process is closely aligned with Gliner and Morgan's (2000) description of content validity. NWEA reports that taken together, the item development process, test content definition process, and test construction process provide strong evidence the content of the ALT assessment is valid for its intended use (Kingsbury, 2003, p. 52).

In addition to content validity, NWEA reports concurrent validity which correlates scores from a variety of assessments to the ALT assessment. NWEA compared the ALT test with five states' standardized tests and found correlation

coefficients ranging from .76 to .91 (Kingsbury, 2003). The state in this study has correlations of .86 in reading and .91 in math (Kingsbury, 2003).

Data Collection

Data were collected from the district's student information system using a data extraction application (Student Data Miner). Specifically, data extracted for 2003-2004 juniors included the following elements: gender, free/reduced lunch status, 1999 reading and mathematics ALT scores, 2004 reading and mathematics ACT scores, and the school enrolled in at the end of each school year from 1999-2004. Additionally, demographic data collected from a variety of sources included the state's department of education web site, the district's web site, and the district's published accountability report.

This district generates an alias identification number for each student for research purposes. Student names were never associated with data collection; thus, student anonymity was ensured at all times. Once extracted, the database was kept on a secure computer hard drive, a flash drive, and a compact disk ensuring ample back-ups were available. At the completion of this study, data will be stored in a locked file cabinet at the university.

Statistical analysis. The mean ACT scores in mathematics and reading of traditional, AB block, and 4x4 block schedule format of 11^{th} grade students are compared by gender and socioeconomic status and controlled by achievement in mathematics and reading on the 6^{th} grade ALTs. The statistical analysis of choice is analysis of covariance (ANCOVA). Although ANCOVA is a very useful and powerful statistical analysis for experimental studies where subjects can be randomly assigned to groups, it may also be used to reduce bias when intact or self-selected groups are compared (Stevens, 1999). In this *ex post facto,* post-test only design, random assignment of subjects to treatment groups is not possible. Therefore, the covariate scores are used to match treatment

groups on achievement. According to Mertler and Vannatta (2002), when random assignment is not possible, using covariate scores to match subjects improves the research design.

Using ANCOVA is the statistical analysis of choice providing assumptions of such testing are not violated. In addition to three primary assumptions for analysis of variance: (a) observations within each sample must be randomly assigned and independent of one another, (b) distribution of scores on the dependent variable must be normal, and (c) distributions of scores on the dependent variable must have equal variances, there are three additional assumptions; a linear relationship existing between the dependent variable and the covariate, regression slopes for the covariate are homogeneous, and the covariate is reliable and measured without error (Mertler & Vannatta, 2002, p.97). Often times, the test for homogeneity of regression slopes is violated with intact group samples such as this study. If this assumption is violated, then a forward multiple regression analysis is conducted.

The alpha level for all main effect comparisons is set at .025 instead of the standard .05. The reason for the more stringent alpha is to reduce the probability of committing a Type I error (rejecting the null hypothesis when it is true) that is often common when conducting multiple analyses with the same group of participants (Stevens, 1999). The method for Bonferonni adjustments, such as this, is to divide the *p*-value by the number of dependent variables (Gliner and Morgan, 2001). In this study, math and reading are the dependent variables and thus is why the alpha level is set at .025 instead of .05.

The effect size *(d)* is calculated for any statistically significant differences found in this study. There are three primary reasons for reporting the effect size. Effect size measures the magnitude of a statistical difference in standard deviation units allowing comparison of findings of multiple studies (Gliner & Morgan, 2000). Second, effect size

is an alternative to null hypothesis testing and provides additional information on the strength or extent of significant results (Gliner & Morgan, 2000). Third, the 5th edition of the Publication Manual of the American Psychological Association (APA) recommends that effect sizes should always be reported with primary results to allow readers to assess the magnitude of the observed effect or relationship (APA, 2001).

The Statistical Packages for the Social Sciences (SPSS) software, version 12.0, is used to analyze the data using ANCOVA. As necessary, SPSS is used to analyze data using a forward multiple regression analysis.

CHAPTER 4: RESULTS

This chapter presents the results of this study. The first section includes a description of the final sample. This section is followed by an analysis of the assumptions of normality, independence of measurement, and linearity. The assumption of homogeneity of variance as well as those associated specifically with analysis of covariance is discussed within the section on the analysis of each research question. The last section reports the results from supplementary analyses that were conducted.

This study adds a longitudinal study to the empirical literature on student achievement and schedule format combination used in secondary schools (7 levels) in a Mountain West school district. The study uses ACT subtest scores in mathematics and reading as criterion variables and explores effects of gender and socioeconomic status on schedule formats. An ANCOVA is used to answer questions only after the assumptions for using this statistic were tested. Two questions in the supplementary analyses are answered using a forward multiple regression analysis as a result of the assumption of the homogeneity of regression slopes being violated for ANCOVA.

Description of Sample

The final sample consisted of 1100 students enrolled in one of three high schools of interest in this study at the end of the 2003-2004 school year. Using ACT's High School Profile reporting procedures as a guide, combinations with less than 30 participants were eliminated (Ziomek, 2000). As a result, two schedule combinations were eliminated from the final sample due to small sample sizes. Students who attended a 4x4 JH and AB HS (n = 18) as well as students who attended a 4x4 JH and Trad HS (n = 2) were eliminated.

Table 5 shows gender and FRL descriptive data from the final sample. These data were slightly different than district demographic data reported in Table 2. This difference existed because the final sample consisted of a reduced set of 11th graders; whereas, district data included all students grades K - 12. The most notable difference was in the percentage of FRL students. The district had 20.9%; whereas, the final sample had 12.1%. Also, the percentage of males in the district was 51.5% compared to 49.4% in the final sample and females of 48.5% and 50.6% respectively.

Table 5

Final Sample Characteristics (N = 1,100)

Characteristic	*n*	%
Gender		
Male	543	49.4
Female	557	50.6
FRL Status		
Eligible	133	12.1
Not Eligible	967	87.9

Table 6 shows characteristics of the active independent variable (schedule format combination in secondary schools) with the attribute independent variables (gender and FRL status). The final sample had a range of 46% males and 54% females in the Trad JH and AB HS combination to 54.5% males and 45.5% females in the AB JH and AB HS combination. The final sample had an average of 49.4% males and 50.6% females. The range of students eligible for FRL varies from a low of 6.7 % in the AB JH and traditional HS combination to a high of 22.7% in the Trad JH and AB HS combination. An average of 12.1% of the students in the final sample were eligible for FRL, and 87.9% of the students were not eligible.

Table 6

Final Sample Data for Schedule Format Combination, Gender, and FRL Status

Junior High and High School Schedule Format	Gender				FRL Status[a]			
	Male		Female		Eligible		Not Eligible	
	n	%	*n*	%	*n*	%	*n*	%
Trad JH & Trad HS	99	46.5	114	53.5	25	11.7	188	88.3
Trad JH & AB HS	69	46.0	81	54.0	34	22.7	116	77.3
Trad JH & 4x4 HS	31	51.7	29	48.3	10	16.7	50	83.3
AB JH & Trad HS	78	47.9	85	52.1	11	6.7	152	93.3
AB JH & AB HS	85	54.5	71	45.5	20	12.8	136	87.2
AB JH & 4x4 HS	118	50.9	114	49.1	16	6.9	216	93.1
4x4 JH & 4x4 HS	63	50.0	63	50.0	17	13.5	109	86.5
Total	543	49.4	557	50.6	133	12.1	967	87.9

[a] FRL represents students who voluntarily participated in the district's FRL plan and was used as a measure of socioeconomic status.

Table 7 shows descriptive statistics for the dependent variables (ACT mathematics scores and ACT reading scores) and the covariates (ALT mathematics scores and ALT reading scores). These results show the minimum and maximum score, the unadjusted means of the dependent variables, the means of the covariates, and the standard deviation for data from the final sample.

Table 7

Descriptive Statistics for ACT Math, ACT Reading, ALT Math, and ALT Reading Test Scores (N = 1100)

Variable	Min	Max	*M*	*SD*
ACT Math	10	35	21.9	5.19
ACT Reading	7	36	22.4	6.37
ALT Math	172	285	233.0	14.67
ALT Reading	169	257	222.8	12.19

The descriptive statistics for the active independent variable (schedule format combination) and the dependent variables (ACT mathematics scores and ACT reading scores) are shown in Table 8. The combination with a Trad JH and Trad HS had the highest mean in math ($M = 22.31$) and reading ($M = 23.65$) while the AB JH and AB HS combination had the lowest mean in math ($M = 20.79$) and reading ($M = 20.57$).

Table 8

Descriptive Statistics for Schedule Format Combination and ACT Subtest Scores

Schedule Format Combination	ACT Math		ACT Reading	
	M^a	*SD*	M^a	*SD*
Trad JH & Trad HS	22.31	5.29	23.65	6.51
Trad JH & AB HS	22.05	5.75	23.37	6.89
Trad JH & 4x4 HS	21.07	5.17	21.73	5.64
AB JH & Trad HS	21.98	5.20	21.94	6.22
AB JH & AB HS	20.79	5.25	20.57	6.86
AB JH & 4x4 HS	22.25	4.99	22.26	5.75
4x4 JH & 4x4 HS	21.61	4.41	22.32	5.95

[a] *M* represents the unadjusted mean.

Analysis of Assumptions

This section shows results of three analyses necessary to test assumptions of an ANCOVA. The normality assumption was analyzed with skewness indices as the measure. If skewness is less than plus or minus one (± 1), then the variable is approximately normal (Leech, Barrett, & Morgan; 2005). The assumption of independent observations assumes no relationship exists between scores for one person and those of another (p. 28). This assumption is accounted for in sampling design. Linearity assumes two variables are related in a linear fashion (Mertler & Vannatta; 2002). According to Mertler and Vannatta (2002), "the assumption of linearity is roughly assessed by inspecting the bivariate scatterplots between the covariate and the dependent variable" (p. 97).

Both dependent variables were analyzed for multivariate normality and none of the skewness indices exceeded plus or minus one (± 1). Therefore, the assumption of normality was maintained for the dependent variables. The sampling process ensured students were assigned to only one level of the active independent variable (schedule format combination). This task was achieved during data collection. After the final sample was selected, a new data field, schedule format combination, was created in Microsoft Excel. Students could only be assigned to one of nine possible combinations. As a result, the assumption of independent measurement was satisfied. Figure 2 shows the bivariate plot of ACT mathematics scores with ALT mathematics scores. A strong linear relationship is suggested between the ACT mathematics dependent variable and the ALT mathematics covariate. Likewise, Figure 3 suggests a strong linear relationship between the ACT reading dependent variable and the ALT reading covariate.

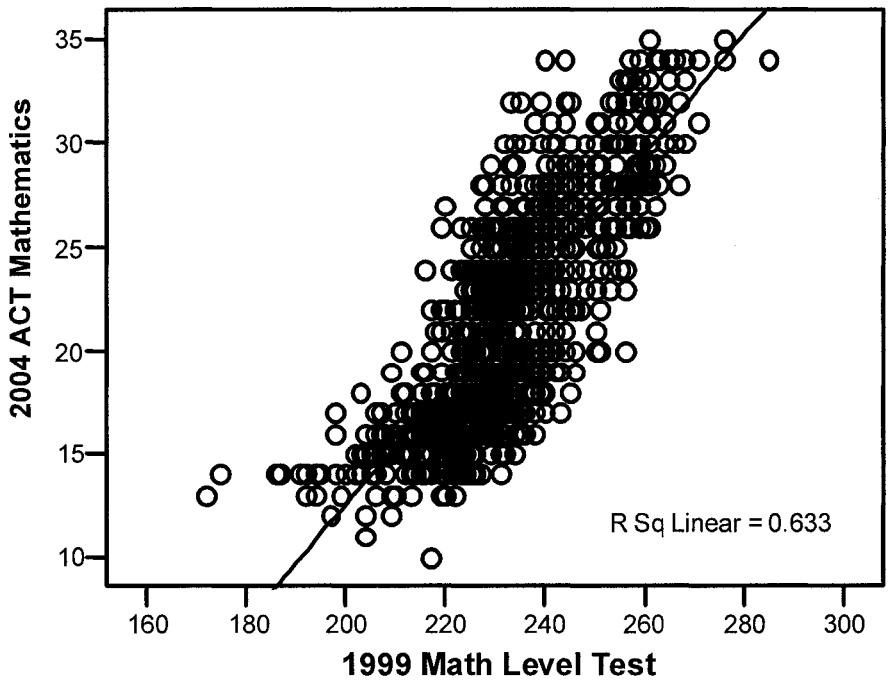

Figure 2. Scatterplot of 1999 ALT and 2004 ACT mathematics scores.

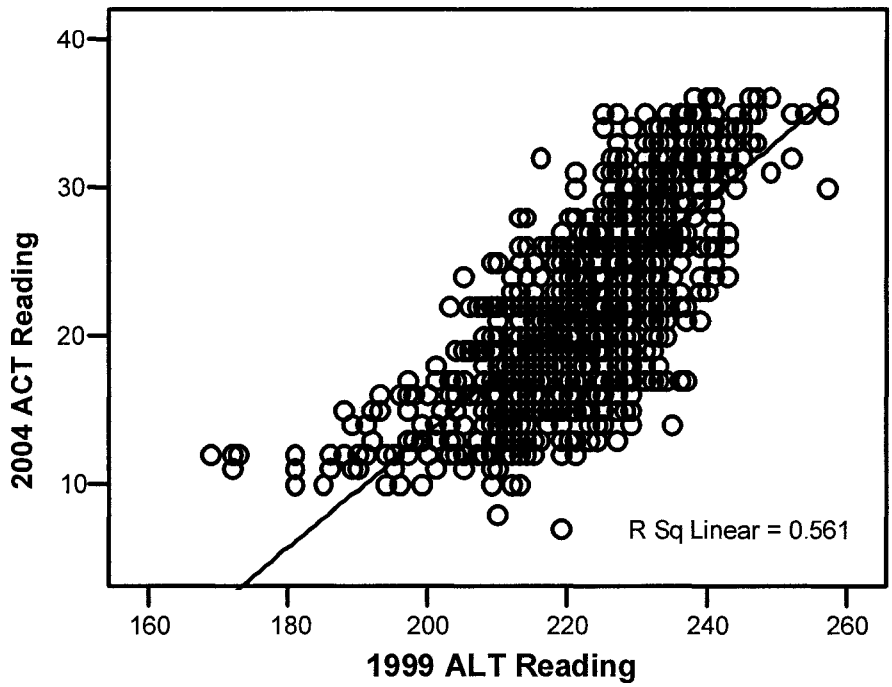

Figure 3. Scatterplot of 1999 ALT and 2004 ACT reading scores.

To further show the strength of relationship between dependent variables and covariates, a Pearson product-moment correlation was conducted and is shown in Table 9. These results show a strong positive correlation between ACT math and ALT math scores ($r = .80$, $df = 1096$, $p < .01$). In addition, a strong positive correlation is shown between ACT reading and ALT reading ($r = .75$, $df = 1096$, $p < .01$).

Table 9

Intercorrelations for ACT Subtest Scores and ALT Test Scores

Variable	2004 ACT Math	2004 ACT Reading	1999 ALT Math	1999 ALT Reading
2004 ACT Math	--			
2004 ACT Reading	.68**	--		
1999 ALT Math	.80**	.61**	--	
1999 ALT Reading	.67**	.75**	.75**	--

**Correlations significant at $p < .01$ level (2-tailed) for all cells $N = 1100$.

Analysis of Research Questions

Research Question 1: What is the effect on student achievement as measured by the average score on the ACT mathematics subtest and the combination of junior high and high school scheduling format? After testing for the assumption of homogeneity of regression slopes and also for homogeneity of variance on the dependent variable, a one-way analysis of covariance was used to determine the effect on student achievement in mathematics and schedule format combination. Table 10 shows the test for assumption of homogeneity of regression slopes was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 10

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination and ALT Math Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x ALT Math	6	15.02	2.50	.26	.957
Error	1086	10607.43	9.77		

The results for the ANCOVA for schedule format combination in secondary schools and ACT mathematics outcome variable are shown in Table 11. These results indicate a significant effect on schedule format combination in regard to average scores on the ACT mathematics subtest $F(6,1092) = 3.87$; $p < .002$.

A subsequent post hoc analysis revealed one pairwise contrast as the primary contributor of the significant effect. This comparison was the AB JH & Trad HS combination with the 4x4 JH & 4x4 HS combination. The effect size ($d = .31$) of this pairwise comparison was calculated using covariate adjusted means and non-adjusted, pooled standard deviations (Cohen, 2001). According to Cohen (2001), this effect size is small. As shown in Table 12, and graphically in Figure 4, it is with 95% certainty that students in the first combination (AB JH & Trad HS) have higher mean scores ($M =$ 22.46) on the ACT mathematics subtest than students in the latter combination (4x4 JH & 4x4 HS) [$M = 20.97$]. The overall covariate adjusted mean difference was 1.49.

Table 11

ANCOVA of ACT Math Scores as a Function of Schedule Format Combination with ALT Math Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	225.98	37.66	3.87	.001
Error	1092	10622.44	9.73		

Table 12

Adjusted and Unadjusted Means for ACT Math with Schedule Format Combination

Junior High and High School Schedule Format	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Trad JH & Trad HS	21.96	.21	22.31	5.29
Trad JH & AB HS	22.09	.26	22.05	5.75
Trad JH & 4x4 HS	21.47	.40	21.07	5.17
AB JH & Trad HS	22.46	.25	21.98	5.20
AB JH & AB HS	21.37	.25	20.79	5.25
AB JH & 4x4 HS	22.07	.21	22.25	4.99
4x4 JH & 4x4 HS	20.97	.28	21.61	4.41

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

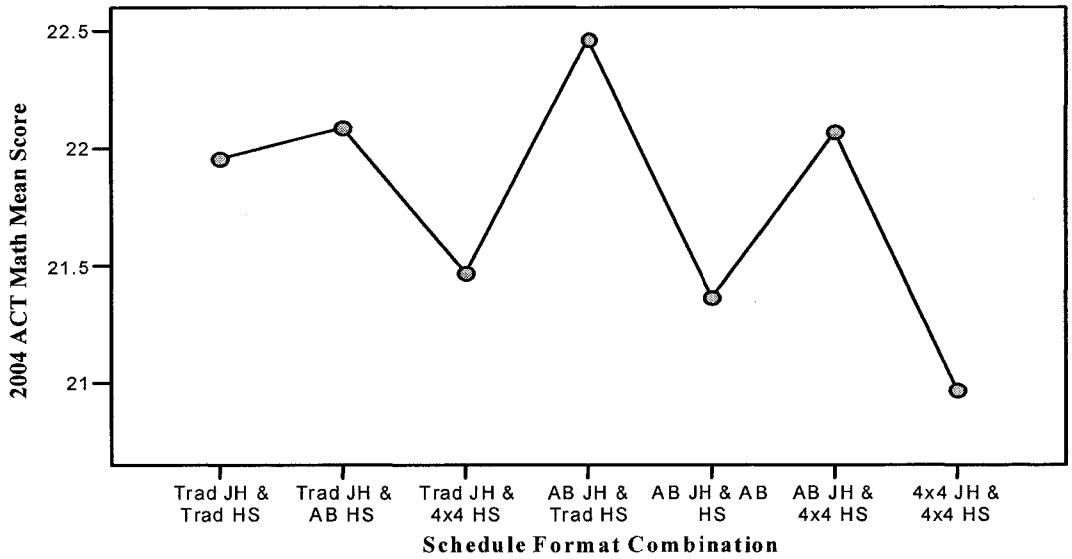

Figure 4. Adjusted means of ACT math and schedule format combination.

Research Question 2: What is the effect on student achievement as measured by the average score on the ACT reading subtest, and the combination of junior high and high school scheduling format? A one-way ANCOVA was used to determine the effect on student achievement in reading and schedule format combination in secondary schools. Table 13 shows the test for assumption of homogeneity of regression slopes was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

The results for the ANCOVA for schedule format combination and the ACT reading outcome variable are shown in Table 14. These results indicated a significant effect on schedule format combination in regard to the average score on the ACT reading subtest $F(6,1092) = 3.34$; $p < .004$.

A subsequent post hoc analysis was conducted and two pairwise contrasts had statistically significant results. These results showed students in the Trad JH & Trad HS

combination compared with students in either the AB JH & AB HS or the AB JH & 4x4 HS combinations contributed to the significant effect. The effect sizes were calculated using covariate adjusted means and non-adjusted, pooled standard deviations (Cohen, 2001). The effect size (d = .21) for the Trad JH & Trad HS combination with the AB JH & AB HS combination is small according to Cohen (2001). Additionally, the effect size (d = .22) is small for the Trad JH & Trad HS combination with the AB JH & 4x4 HS combination (Cohen, 2001).

Table 13

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination and ALT Reading Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x ALT Reading	6	159.49	26.58	1.51	.170
Error	1086	19074.66	17.56		

Table 14

ANCOVA of ACT Reading Scores as a Function of Schedule Format Combination with ALT Reading Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	353.28	58.88	3.34	.003
Error	1092	19234.15	17.61		

Table 15 and Figure 5, show with 95% certainty that students attending junior high school and high school with traditional format schedules have higher covariate adjusted mean ACT reading scores (M = 23.14) than students attending junior high school and high school with AB block format schedules (M = 21.72). The overall covariate adjusted mean difference was 1.42. Furthermore, students who attended junior

high school and high school with the traditional format had higher covariate adjusted mean ACT reading scores ($M = 23.14$) than students who attended an AB block schedule junior high school and 4x4 block schedule high school ($M = 21.81$). The covariate adjusted mean difference for this result was 1.33.

Table 15

Adjusted and Unadjusted Means for ACT Reading with Schedule Format Combination

Junior High and High School Schedule Format	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Trad JH & Trad HS	23.14	.29	23.65	6.51
Trad JH & AB HS	23.05	.34	23.37	6.89
Trad JH & 4x4 HS	22.11	.54	21.73	5.64
AB JH & Trad HS	22.52	.33	21.94	6.22
AB JH & AB HS	21.72	.34	20.57	6.86
AB JH & 4x4 HS	21.81	.28	22.26	5.75
4x4 JH & 4x4 HS	22.04	.37	22.32	5.95

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

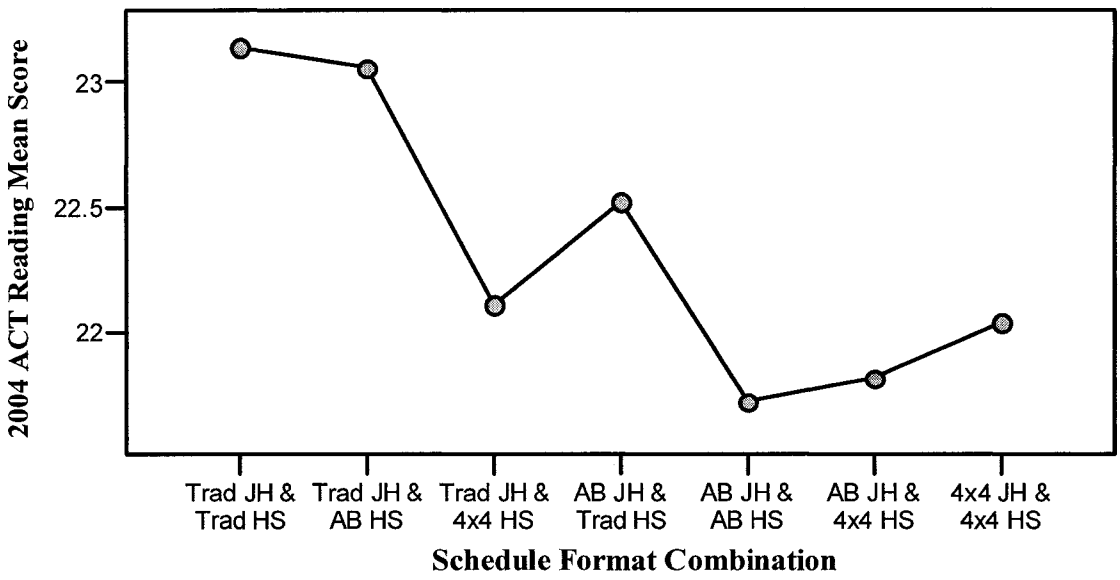

Figure 5. Adjusted means of ACT reading and schedule format combination.

Research Question 3: How do these effects vary by gender? After testing for the assumption of homogeneity of regression slopes and also for the homogeneity of variance on the dependent variable, a factorial ANCOVA was used to determine the effect on student achievement in mathematics and schedule format combination by gender. Table 16 shows the test for assumption of homogeneity of regression slopes for ACT mathematics was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

An ANCOVA was conducted to explore the efficacy of schedule format combination in secondary schools by gender, yielding a 7 x 2 factorial between groups design. Neither the gender main effect nor the interaction was statistically significant using the ACT mathematics outcome variable. However, there was a significant main effect for schedule format combination $F(6,1085) = 3.83$; $p < .002$ (Table 17). The results of this significant main effect for schedule format combination and student achievement on the ACT mathematics subtest were discussed in the analysis of research

question one. Figure 6 shows a graphic representation of covariate adjusted mean ACT math scores and schedule format combination by gender.

Table 16

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination, Gender, and ALT Math Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x Gender x ALT Math	13	142.43	10.96	1.13	.33
Error	1078	10479.90	9.72		

Table 17

ANCOVA of ACT Math Scores as a Function of Schedule Format Combination by Gender with ALT Math Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	222.45	37.08	3.83	.001
Gender	1	2.36	2.36	.24	.622
SFC x Gender	6	118.45	19.74	2.04	.058
Error	1085	10503.87	9.68		

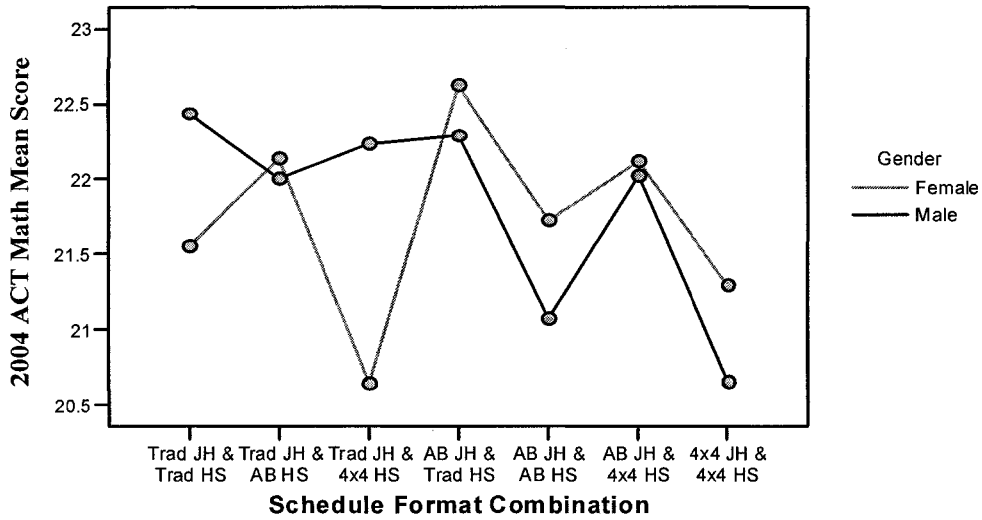

Figure 6. Adjusted means of ACT math and schedule format combination by gender.

After testing for assumption of homogeneity of regression slopes and for homogeneity of variance on the dependent variable, a factorial ANCOVA was used to determine the effect on student achievement in reading and schedule format combination in secondary schools by gender. Table 18 shows the test for assumption of homogeneity of regression slopes for ACT reading was not violated. A significant Levene's Test indicated the homogeneity of variance on the ACT reading outcome variable was violated $F(13,1086) = 2.10; p < .02$. However, utilizing an ANCOVA is robust to the violation of the normality assumption when the sample size is large (Mertler and Vannatta, 2002). The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 18

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination, Gender, and ALT Reading Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x Gender x ALT Reading	13	297.54	22.89	1.32	.195
Error	1078	18702.53	17.35		

The results for the ANCOVA for schedule format combination by gender and the ACT reading outcome variable are shown in Table 19. These results indicated a significant main effect on schedule format combination $F(6,1085) = 3.10$; $p < .006$. In addition, a significant main effect was found for gender $F(1,1085) = 10.40$; $p < .002$. The interaction between schedule format combination and gender was not statistically significant. Analysis of the significant main effect for schedule format combination was presented in analysis of research question two. The effect size ($d = .14$) of the significant main effect for gender is considered small and was calculated using the adjusted means and the unadjusted, pooled standard deviations (Cohen, 2001)

The significant main effect for gender, shown in Table 20, revealed with 95% confidence female students have a higher adjusted mean score ($M = 22.77$) on the ACT reading subtest than males ($M = 21.89$). The adjusted mean difference on the ACT reading subtest was .88. Figure 7 shows adjusted mean ACT reading scores for females were higher than males in all schedule format combinations except where students attended a Trad JH and a 4x4 HS. In this case, males had higher mean scores than females.

Table 19

ANCOVA of ACT Reading Scores as a Function of Schedule Format Combination by Gender with ALT Reading Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	323.71	53.95	3.10	.005
Gender	1	180.91	180.91	10.40	.001
SFC[a] x Gender	6	124.14	20.69	1.19	.309
Error	1085	18875.94	17.40		

[a] SFC = schedule format combination.

Table 20

Adjusted and Unadjusted Means for ACT Reading Scores by Gender

Gender	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Female	22.77	.19	23.16	6.05
Male	21.89	.19	21.57	6.59

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

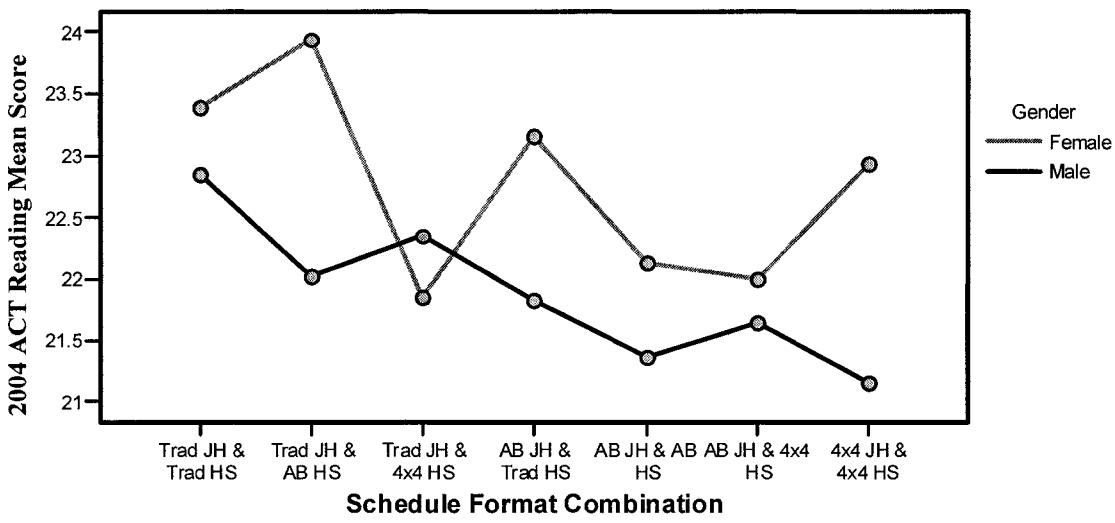

Figure 7. Adjusted means of ACT reading and schedule format combination format by gender.

Research Question 4: How do these results vary by socioeconomic status as measured by participation in the federally subsidized FRL program? After testing for the assumption of homogeneity of regression slopes and also for the homogeneity of variance on the dependent variable, a factorial ANCOVA was used to determine the effect on student achievement in mathematics and schedule format combination in secondary schools with the FRL status of students. Table 21 shows the test for the assumption of homogeneity of regression slopes for the ACT mathematics subtest was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 21

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination, FRL Status, and ALT Math Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x FRL status x ALT Math	13	199.30	15.33	1.60	.08
Error	1078	10357.27	9.61		

The results for the ANCOVA for schedule format combination with FRL status and the ACT math outcome variable are shown in Table 22. Neither the schedule format combination main effect nor the interaction was statistically significant using the ACT mathematics outcome variable. However, there was a significant main effect for FRL status $F(1,1085) = 5.46$; $p < .03$.

The effect size ($d = .14$) was calculated using adjusted means and unadjusted, pooled standard deviations. The effect size for the significant main effect for FRL status is small (Cohen, 2001). The significant main effect for FRL status, shown in Table 23, revealed with 95% confidence that students who were not eligible for FRL had a higher adjusted mean score ($M = 21.86$) on the ACT math subtest than did students who were eligible ($M = 21.11$). The adjusted mean difference on the ACT reading subtest was .75. Figure 8 shows for all possible schedule format combinations, the adjusted mean ACT math scores were higher for students who were *not* eligible for FRL than students who were eligible.

Table 22

ANCOVA of ACT Math Scores as a Function of Schedule Format Combination and FRL Status with ALT Math Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	113.82	18.97	1.96	.069
FRL	1	52.85	52.85	5.46	.020
SFC x FRL	6	48.20	8.03	.83	.547
Error	1085	10508.37	9.69		

Table 23

Adjusted and Unadjusted Means for ACT Math Scores by FRL Status

FRL Status	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Not Eligible	21.86	.11	22.29	5.12
Eligible	21.11	.30	18.65	4.57

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

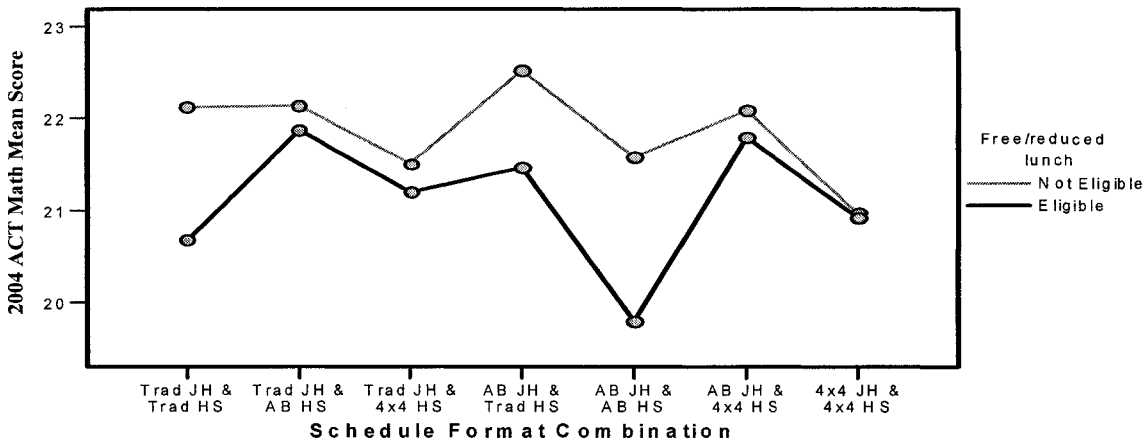

Figure 8. Adjusted means of ACT math and schedule format combination by FRL.

After testing for the assumption of homogeneity of regression slopes, and also for homogeneity of variance on the dependent variable, a factorial ANCOVA was used to determine the effect on student achievement in reading and schedule format combination in secondary schools with FRL status. Table 24 shows the test for assumption of homogeneity of regression slopes for ACT reading was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 24

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Combination, FRL Status, and ALT Reading Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination x FRL status x ALT Reading	13	409.27	31.48	1.81	.07
Error	1078	18780.14	17.42		

Table 25 shows there were no main effects for schedule format combination or FRL status. In addition, there was no interaction effect. In Table 26, and shown graphically in Figure 9, the adjusted mean ACT reading score was higher for students who were eligible for FRL (AB JH & 4x4 HS). In all other combinations, the adjusted mean ACT reading scores were higher for students who were not eligible for FRL.

Table 25

ANCOVA of ACT Reading Scores as a Function of Schedule Format Combination and FRL Status with ALT Reading Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Combination	6	124.82	20.80	1.18	.313
FRL	1	46.16	46.16	2.62	.106
SFCa x FRL	6	103.58	17.26	.98	.436
Error	1085	19085.83	17.59		

[a] SFC represents schedule format combination.

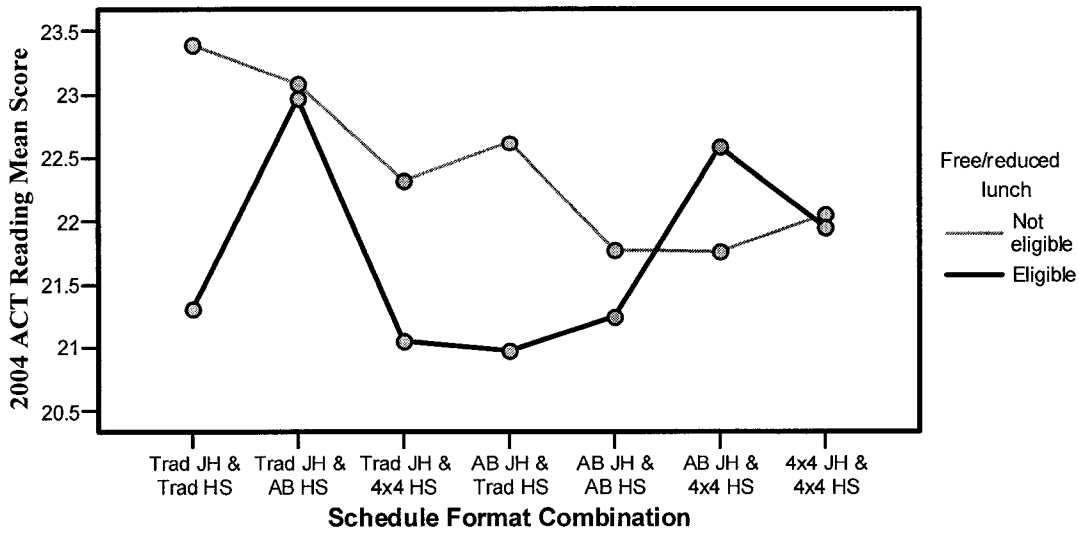

Figure 9. Adjusted means of ACT reading and schedule format combination by FRL.

Supplementary Analyses

Lewis et al. (2004a) found that students attending block schedule format high schools (both AB block and 4x4 block) had higher achievement on the ACT in mathematics and reading compared to students who attended a traditional schedule format high school. In their study, students were matched on ninth grade ALT tests. In order to be included in the study, a student must have attended schools with the same schedule format in the last year of junior high school as well as the first two years of high school (Lewis et al., 2004a). More specifically, students were only included with the following schedule format combinations: Trad JH and Trad HS, AB JH and AB HS, and 4x4 JH and 4x4 HS. Students who switched formats from junior high school to high school were excluded. For example, a student attending a Trad JH and AB HS would have been eliminated.

The Lewis et al. (2004a) study combined with the longitudinal nature of this dissertation spawned additional research analyses. Specifically, what would the effects

of the analyses be if the data were recoded to compare students who were in the same schedule format for the duration of the study versus students who had changed schedule formats? As a result, the following four supplemental research questions emerged.

1. What is the effect on student achievement as measured by the average score on the ACT mathematic subtest if students change schedule formats?
2. What is the effect on student achievement as measured by the average score on the ACT subtest in reading if students change schedule formats?
3. How do these effects vary by gender?
4. How do these results vary by socioeconomic status as measured by participation in the federally subsidized FRL program?

These supplemental research questions were analyzed using ANCOVA except when the assumptions for conducting the analysis were violated. In these cases, a forward multiple regression analysis was used.

The only condition changed in the supplemental analyses was the active independent variable. The new active independent variable, schedule format stability (SFS) was nominal with two levels (stable or changed). To create data for the supplemental analyses, a new data field (SFS) was created in SPSS. During this phase, data was included from all nine possible schedule format combinations and resulted in a final sample of 1120 participants. The assumptions of normality, independence, and linearity were not violated. Additional assumptions necessary to conduct ANCOVA were conducted during the analysis of each new research question and are presented.

Supplemental Question 1: What is the effect on student achievement as measured by the average score on the ACT mathematic subtest if students change schedule formats? After testing for the assumption of homogeneity of regression slopes, and also for homogeneity of variance on the dependent variable, a one-way analysis of covariance was used to determine the effect on student achievement in mathematics if students

changed schedule formats. Table 26 shows the test for assumption of homogeneity of regression slopes was not violated. Additionally, a non-significant Levene's Test confirmed the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 26

Test for the Assumption of Homogeneity of Regression Slopes for Schedule Format Stability and ALT Math Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability x ALT Math	1	.79	.79	.08	.778
Error	1116	11041.07	9.89		

The results for the ANCOVA for schedule format stability and ACT mathematics outcome variable are shown in Table 27. These results indicated a significant effect on schedule format stability in regard to the average score on the ACT mathematics subtest $F(1,1117) = 9.25$; $p < .003$. The effect size ($d = .11$) was calculated using covariate adjusted means and pooled, unadjusted standard deviations. This effect size is small (Cohen, 2001). As shown in Table 28, it is with 95% certainty that students who changed schedule formats from junior high to high school have higher mean scores ($M = 22.14$) on the ACT mathematics subtest than students who have the same schedule format ($M = 21.57$). The overall covariate adjusted mean difference was .57.

Table 27

ANCOVA of ACT Math Scores as a Function of Schedule Format Stability with ALT Math Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability	1	91.46	91.46	9.25	.002
Error	1117	11041.85	9.89		

Table 28

Adjusted and Unadjusted Means for ACT Math and Schedule Format Stability

Schedule Format Stability	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Stable Format	21.57	.14	21.65	5.10
Change in Format	22.14	.13	22.07	5.28

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

Supplemental Question 2: What is the effect on student achievement as measured by the average score on the ACT subtest in reading if students changed schedule formats? After testing for the assumption of homogeneity of regression slopes and also for homogeneity of variance on the dependent variable, a one-way analysis of covariance was used to determine the effect on student achievement in reading if students had changed schedule formats. Table 29 shows the test for the assumption of homogeneity of regression slopes was not violated. A significant Levene's Test indicated the homogeneity of variance on the ACT reading outcome variable was violated $F(1,1118) = 8.64$; $p < .004$. However, utilizing an ANCOVA is robust to the violation of the normality assumption when the sample size is large (Mertler and Vannatta, 2002). The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 29

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Stability and ALT Reading Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability x ALT Reading	1	29.86	29.86	1.66	.199
Error	1116	20129.20	18.04		

The results for the ANCOVA for schedule format stability and the ACT reading outcome variable is shown in Table 30. These results indicated a non-significant effect on schedule format stability in regard to the average score on the ACT reading subtest. Consequently, schedule format stability does not affect student achievement results in reading as measured by the mean score on the ACT reading subtest.

Table 30

ANCOVA of ACT Reading Scores as a Function of Schedule Format Stability with ALT Reading Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability	1	2.95	2.95	.16	.686
Error	1117	20159.06	18.05		

Supplemental Question 3: How do these effects vary by gender? After testing for the assumption of homogeneity of regression slopes and also for the homogeneity of variance on the dependent variable, a factorial ANCOVA was used to determine the effect on student achievement in mathematics and schedule format stability by gender. Table 31 shows the test for assumption of homogeneity of regression slopes for ACT mathematics was not violated. Additionally, a non-significant Levene's Test confirmed

the homogeneity of variance assumption was not violated. The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

An ANCOVA was conducted to explore the efficacy of schedule format stability by gender, yielding a 2 x 2 factorial between groups design. Neither the gender main effect nor the interaction was statistically significant for the ACT mathematics outcome variable. However, as shown in Table 32, there was a significant main effect for schedule format stability $F(1,1115) = 9.26$; $p < .003$. The results of this significant main effect for schedule format stability and student achievement on the ACT mathematics subtest were discussed in the analysis of supplemental question one. Figure 10 shows a graphic representation of covariate adjusted mean ACT math scores and schedule format stability by gender.

Table 31

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Stability, Gender, and ALT Math Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability x Gender x ALT Math	3	15.48	5.16	.52	.668
Error	1113	11025.82	9.91		

Table 32

ANCOVA of ACT Math Scores as a Function of Schedule Format Stability by Gender with ALT Math Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability	1	91.69	91.69	9.26	.002
Gender	1	.40	.40	.04	.841
SFS x Gender	1	.96	.96	.10	.756
Error	1115	11040.33	9.90		

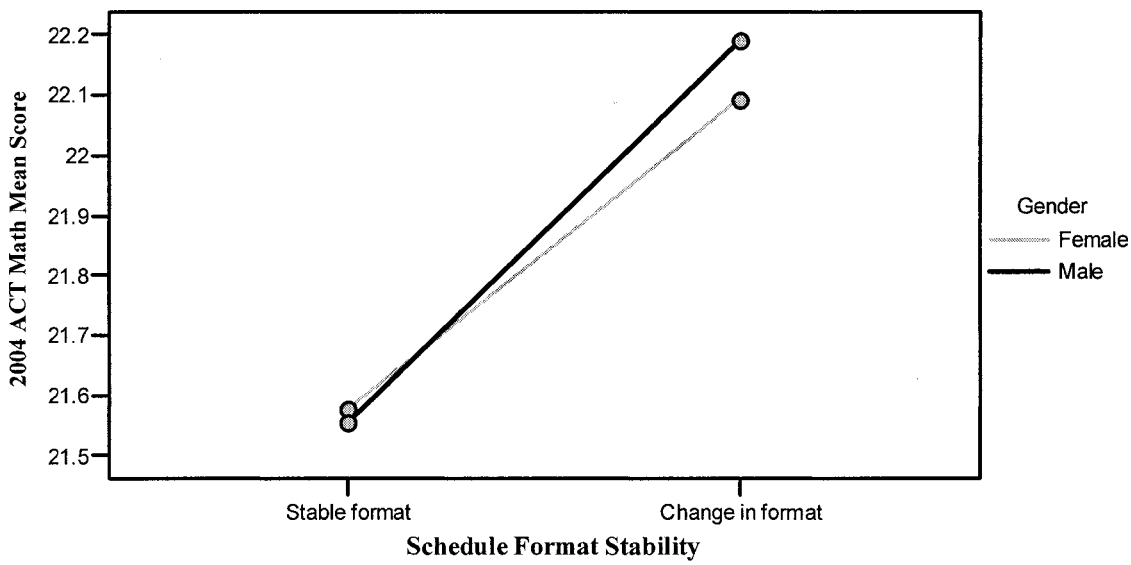

Figure 10. Adjusted ACT math mean scores with schedule format stability by gender.

After testing for the assumption of homogeneity of regression slopes and also for the homogeneity of variance on the dependent variable, a factorial analysis of covariance was used to determine the effect on student achievement in reading and schedule format stability by gender. Table 33 shows the test for assumption of homogeneity of regression

slopes for ACT reading was not violated. A significant Levene's Test indicated the homogeneity of variance on the ACT reading outcome variable was violated $F(3,1116) = 6.063; p < .001$. However, utilizing an ANCOVA is robust to the violation of the normality assumption when the sample size is large (Mertler and Vannatta, 2002). The criterion for rejecting the null hypothesis was set at $\alpha = .025$.

Table 33

Test for Assumption of Homogeneity of Regression Slopes for Schedule Format Stability, Gender, and ALT Reading Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability x Gender x ALT Reading	3	60.48	20.16	1.13	.335
Error	1113	19826.40	17.81		

The results for the ANCOVA for schedule format stability by gender and the ACT reading outcome variable are shown in Table 34. Neither the schedule format stability main effect nor the interaction was statistically significant using ACT reading as the outcome variable. However, there was a significant main effect for gender $F(1,1115) = 15.118; p < .001$. The effect size ($d = .16$) was calculated using covariate adjusted means and pooled unadjusted standard deviations. This effect size is small (Cohen, 2001). As shown in Table 35 and graphically in Figure 11, it is with 95% certainty that female students have higher mean scores ($M = 22.86$) on the ACT reading subtest than males ($M = 21.87$). The overall covariate adjusted mean difference was .99.

Table 34

ANCOVA of ACT Reading Scores as a Function of Schedule Format Stability by Gender with ALT Reading Scores as the Covariate

Source	*df*	*SS*	*MS*	*F*	*p*
Schedule Format Stability	1	3.35	3.35	.19	.665
Gender	1	269.63	269.63	15.19	.000
Schedule Format Stability x Gender	1	.09	.09	.01	.945
Error	1115	19886.79	17.84		

Table 35

Adjusted and Unadjusted Means for ACT Reading by Gender

Gender	Adjusted *M*	Std. Error[a]	Unadjusted *M*	*SD*
Female	22.86	.179	23.12	6.06
Male	21.87	.181	21.59	6.60

[a] The standard error of the mean is equal to the standard deviation of the sample (Hinkle, Wiersma, & Jurs; 1998).

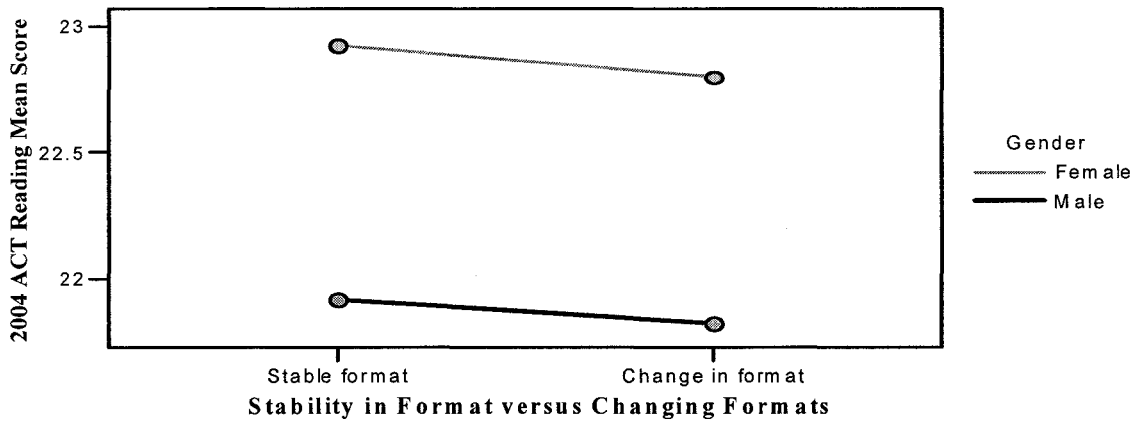

Figure 11. Adjusted ACT reading scores with schedule format stability by gender.

Supplemental Question 4: How do results vary by a student's socioeconomic status as measured by participation in federally subsidized free and the reduced lunch program? The assumption for homogeneity of slopes was violated for both dependent variables (ACT subtest scores) for this supplemental question, and subsequent forward multiple regression analyses were conducted.

The first analysis explored a prediction model of math achievement for high school students using three independent variables in a forward multiple regression analysis. These independent variables were ALT mathematics scores, schedule format stability, and FRL status. The means, standard deviations, and intercorrelations for ACT math scores and the predictor variables are shown in Table 36. The overall prediction model was statistically significant $F(3,1116) = 655.87$; $p < .001$. As shown in Table 37, all three of the predictors were statistically significant—ALT math scores ($\beta = .79$; $p < .001$), schedule format stability ($\beta = .05$; $p < .004$), and FRL status ($\beta = -.05$; $p < .007$). The resulting prediction equation from this forward multiple regression was:

$\hat{Y} = .28X_1 + .57X_2 - .82X_3 - 43.71$, where X_1 = ALT mathematic score, X_2 = schedule format stability, and X_3 = FRL status. As shown in Table 37, the adjusted R^2 was .64. This result indicates 64% of the variance in math achievement as measured by the ACT subtest score was explained by the model. The ALT mathematics scores accounted for 63.2% of this variance with the SFS and FRL status minimally contributing (Table 37). According to Cohen (2001), this result represents a large effect.

Table 36

Means, Standard Deviations, and Intercorrelations for ACT Math Scores and Predictor Variables (N = 1120)

Variable	*M*	*SD*	ALT Math	SFS	FRL
ACT Math	21.89	5.20	.80**	.04	.23**
Predictor Variable					
ALT Math	233.18	14.57	--	-.02*	-.22*
SFS	.56	.50		--	-.01*
FRL Status	.12	.326			--

*$p < .05$; **$p < .01$

Table 37

Model Summary—Prediction by Predictor Variables of ACT Math Scores (N = 1120)

Step	Variable	*B*	*SEB*	*β*	*p*	$R^2adj.$	$\Delta R^2adj.$
1	ALT Math	.28	.01	.79**	.000	.632	
2	SFS	.57	.19	.05*	.003	.635	.003
3	FRL Status	-.82	.30	-.05*	.006	.637	.002
	Constant	-43.71	1.56				

Note. R^2adj. = .64; $F(3,1116) = 655.87$, $p < .01$

*$p < .05$; **$p < .01$

The second analysis explored a prediction model of reading achievement for high school students using three independent variables in a forward multiple regression analysis. These independent variables were ALT reading scores, schedule format stability, and FRL status. The means, standard deviations, and intercorrelations for ACT

reading scores and the predictor variables are shown in Table 38. The overall prediction model was statistically significant $F(1,1118) = 1406.43$; $p < .001$. As shown in Table 39, one of the predictors was statistically significant—ALT reading scores ($\beta = .75$; $p < .001$). Schedule format stability and FRL status were not statistically significant and were removed from the prediction equation. Thus, the resulting prediction equation from this forward multiple regression was: $\hat{Y} = .39X_1 - 64.99$, where X_1 = ALT reading scores. The adjusted R^2 was .56 (Table 39). This result indicates that 56% of the variance in reading achievement as measured by the ACT subtest score was explained by the model. According to Cohen (2001), this result represents a large effect.

Table 38

Means, Standard Deviations, and Intercorrelations for ACT Reading Scores and Predictor Variables (N = 1120)

Variable	*M*	*SD*	ALT Reading	SFS	FRL
ACT Reading	22.37	6.38	.75**	-.21**	.00
Predictor Variable					
ALT Reading	222.82	12.14	--	-.25*	.02
SFS	.56	.50		--	-.01
FRL Status	.12	.33			--

*$p < .05$; **$p < .01$

Table 39

Model Summary—Prediction by Predictor Variable of ACT Reading Scores (N = 1120)

Step	Variable	*B*	*SEB*	*β*	*p*	$R^2adj.$	$\Delta R^2adj.$
1	ALT Reading	.39	.01	.75**	.000	.56	-
	Constant	-64.99	2.33				

Note. R^2adj. = .56; F(1,1118) = 1404.43, $p < .01$

**$p < .01$.

Summary

School of choice in this Mountain West district afforded a unique opportunity to investigate the efficacy of school scheduling formats on student achievement in high schools using ACT subtests in mathematics and reading as outcome measures. Furthermore, schools in the study had the same scheduling format in place from 1999-2004. As a result, a longitudinal analysis ensued exploring student achievement and schedule format combinations in secondary schools. In addition, students in this district took the ALT tests in reading and mathematics in 6th grade, allowing a control measure for achievement before entering the scheduling format combination intervention in secondary schools. Analysis of covariance was used to answer most research questions. However, when assumption of regression slopes was violated, a forward multiple regression analysis was conducted.

Before using ANCOVA, the final sample of 1100 students was selected from 1705 possible students. Data reduction occurred in multiple stages. The first stage eliminated students attending alternative high schools in the district. In the second stage, students were eliminated who exclusively changed schedule formats in junior high school or high school. The final stage eliminated students with incomplete data sets. Two

schedule format combinations were eliminated due to small sample sizes resulting in the final sample of 1100 students.

Once the final sample was selected, ANCOVA was used to answer the primary and supplemental research questions. Tests for assumptions of using ANCOVA were tenable in all but two of the supplementary analyses questions. In these two cases, a forward multiple regression analysis was conducted. A more stringent alpha level of .025 was chosen to reduce the possibility of rejecting a null hypothesis that may be true (Type I error). Post hoc analyses used an alpha level of .05. The effect size (*d*) was calculated for statistically significant results using covariate adjusted means and non-adjusted, pooled standard deviations. The statistical analyses produced results for each research question. The four primary research questions were: (1) What is the effect on student achievement as measured by the average score on the ACT mathematic subtest and the combination of junior high and high school scheduling format? (2) What is the effect on student achievement as measured by the average score on the ACT subtest in reading and the combination of junior high and high school scheduling format? (3) How do these effects vary depending on student gender? (4) How do these results vary by a student's socioeconomic status?

Table 40 summarizes findings of the research questions using ACT mathematics scores as the outcome measure. Post hoc analysis showed students with the AB JH & Trad HS combination compared to students with the 4x4 JH & 4x4 HS combination contributed to most of the statistically significant effect of scheduling format combination on student achievement in mathematics. There was not a significant main effect on student gender. There was a significant main effect on FRL status. Students who were *not* eligible for FRL had a higher mean average on the ACT mathematics subtest than did students who were eligible. There were no interaction effects for gender or FRL status.

In reading, there was also a significant main effect in regard to scheduling format combination (see Table 41). Post hoc analyses revealed the significant effect was a result of two comparisons of scheduling format combinations. The first had Trad JH & Trad HS with higher mean scores in reading compared to AB JH & AB HS. The second had Trad JH & Trad HS with higher mean scores than AB JH & 4x4 HS. In both cases, remaining in a stable traditional schedule format appeared to have an impact on student achievement. An analysis of gender revealed females had a higher mean reading scores than males. There was no interaction between gender and schedule format combination. There were no significant effects for schedule format combination and FRL status using reading as the outcome variable.

Table 40

Summary of Results with Effect Sizes using the ACT Mathematics Subtest

Research Question	Main Effect 1	Main Effect 2	Post Hoc Results	*d*
SFC[a]	$p = .001$	NA	AB JH & Trad HS > 4x4 JH & 4x4 HS	.31
SFC, Gender	$p = .001$	No	NA	
SFC, FRL[b]	No	$p = .02$	Not Eligible FRL > Eligible FRL	.14
SFS[c]	$p = .002$	NA	Change Format > Stable Format	.11
SFS, Gender	$p = .002$	No	Change Format > Stable Format	.11
SFS, FRL	MRA[d] conducted; 64% of variance explained by the model			

[a] SFC represents schedule format combination in secondary schools.

[b] FRL represents voluntary participation in free and reduced lunch status.

[c] SFS represents schedule format stability in secondary schools.

[d] MRA represents multiple regression analysis.

Table 41

Summary of Results with Effect Sizes using the ACT Reading Subtest

Research Question	Main Effect 1	Main Effect 2	Post Hoc Results	*d*
SFC[a]	$p = .003$	NA	Trad JH & Trad HS > AB JH & AB HS; Trad JH & Trad HS > AB JH & 4x4 HS	.21 .22
SFC, Gender	$p = .005$	$p = .001$	Female > Male	.14
SFC, FRL[b]	No	No	NA	NA
SFS[c]	No	NA	NA	NA
SFS, Gender	No	$p = .000$	Female > Male	.16
SFS, FRL	MRA[d] conducted; 56% of variance explained by the model			

[a] SFC represents schedule format combination in secondary schools.

[b] FRL represents voluntary participation in free and reduced lunch status.

[c] SFS represents schedule format stability in secondary schools.

[d] MRA represents multiple regression analysis.

The significant result in reading coupled with the design of a recent study by Lewis et al. (2004a) prompted supplementary analyses. In these secondary analyses, data were recoded to include students who had the same schedule format in junior high and high school in one group and students who changed schedule formats in the other group. This new active independent variable was identified as schedule format stability (SFS). In mathematics (see Table 40), the results for SFS and gender paralleled findings of the original research questions. There was a statistically significant result for SFS for students who changed formats; they had higher mean scores than students with stable formats. Gender did not have an effect. The assumption of regression slopes was violated for SFS and FRL status prompting a subsequent multiple regression analysis.

The prediction model explained 64% of the variance with SFS, FRL status, and ALT math scores significantly contributing. Most of the variance in the model was attributed to the ALT math scores.

In reading scores, SFS was not statistically significant (Table 41). Females had higher mean reading scores on the ACT than males. The assumption of regression slopes was also violated in reading for SFS and FRL status. The prediction model explained 56% of the variance with only the ALT reading score statistically significant.

CHAPTER 5: DISCUSSION

The key findings of this study are discussed in this chapter. Data from the primary and supplemental analyses are used to frame the following sections: conclusions, interpretations, limitations, and recommendations.

Conclusions

The purpose of this study was to determine if scheduling format combination in secondary schools had an effect on student achievement as measured by scores on ACT subtests in mathematics and reading, and if these effects vary by gender and socioeconomic status. Subsequent supplemental analyses were also conducted to determine if the schedule format stability in secondary schools had an effect on student achievement in reading and mathematics using the same outcome measures. Gender and socioeconomic status were also variables of interest in these supplemental analyses.

An ANCOVA was conducted and there were statistically significant differences for some of the main effects (see Table 40 and Table 41). Post hoc analyses revealed specific schedule format combinations and schedule format stability contributed most to the findings. Even though design of this study was robust with respect to statistical analyses, definitive conclusions are difficult to make. In order to have confidence in the findings, trends or patterns should exist for either certain schedule format combinations or schedule format stability. Instead, no definitive patterns or trends existed, and as a result, the following conclusions are presented with caution.

In mathematics, the AB JH and Trad HS combination was superior to all other scheduling format combinations. This result lends credibility to the findings of Cobb et al. (1999) and Dunnan (2001) who also showed students in traditional schedule format

schools outperforming students in block scheduled high schools. As for reading scores, the Trad JH and Trad HS combination was superior to all other combinations, suggesting that students in traditional schedule formats may have higher achievement in reading than students in block scheduling.

When these effects were examined by gender and socioeconomic status, the results varied. There were main effect significance found for FRL status in mathematics and gender in reading. However, because there was neither an interaction effect between schedule format combination and gender, nor schedule format combination and FRL status, results merely reflect means for disaggregated groups. As a result, no conclusions can be drawn regarding the relationship between scheduling format combination, gender, and FRL and student achievement in reading and mathematics.

Supplemental analyses were conducted and these results were also inconsistent. There was a significant effect for schedule format stability in regard to student achievement in mathematics. Surprisingly, results showed students who changed formats had higher mean scores than students with stable formats. This result seemed contradictory to expectations. Therefore, additional analysis may be necessary to imply that changing schedule formats from junior high to senior high is advantageous to staying in the same format. As for reading scores, there were no statistically significant main effects for schedule format stability. As a result, student achievement in reading appears to be held harmless in regard to schedule format stability.

The schedule format stability effects examined by gender and FRL status were similar to schedule format combinations indicating a significant main effect for gender in reading. The results show females had higher mean scores than males when using the ACT reading subtest as the outcome measure. Because there was no interaction between schedule format stability and gender, there are no conclusions made regarding these variables. For FRL status, the assumption of homogeneity of regression slopes was

violated and forward multiple regression analyses were conducted in mathematics and reading. Although both prediction models explain high percentages of the variance (see Table 40 and Table 41), the results are misleading. Most of the explained variances were due to the covariates, ALT mathematics scores and ALT reading scores, with very little variance explained by the FRL status. Consequently, no definitive conclusions can be made regarding the schedule format stability and FRL status in either mathematics or reading achievement.

The lack of commonality of findings in this study parallels the findings of many other studies—they are inconsistent. Unfortunately, no trends or common patterns were shown for the primary or supplementary analyses. As a result, the significant findings presented were done so without confidence. For practitioners, it appears schedule format combination and schedule format stability have little effect on student achievement in reading and mathematics. Therefore, when choosing a schedule format, careful consideration should be given to meeting the needs of the entire educational community.

Interpretations

Math achievement and schedule format combination. The analysis showed a statistically significant mathematics result for schedule format combination. A post hoc analysis revealed most of this significant result was attributed to the AB JH & Trad HS compared to the 4x4 JH & 4x4 HS. In one pairwise contrast, students in a traditional format high school outperformed students in a 4x4 block schedule format high school using ACT mathematics scores as the outcome variable and controlled for with the ALT scores. When compared to other studies using ACT as the outcome measure, this finding supports Dunnan (2001) and Terrazas (2001) and contradicts Carter (2003) and Lewis et al. (2004).

A definitive conclusion regarding this result is difficult to make. In the AB JH & Trad HS combination, students may have *higher* achievement as a result of schedule formats. Yet, in the 4x4 JH & 4x4 HS combination, students may have *lower* achievement as a result of the schedule format. Since no pattern exists for both Trad HS combinations or for all three 4x4 HS combinations, this significant result cannot be over generalized (Figure 4).

In this study, there was no effect for schedule format combination by gender on student achievement in mathematics. Similarly, Schreiber et al. (2002) and Lewis et al. (2004a) showed no significant difference for gender. The results of this study showed males and females had similar mean scores on the ACT mathematics subtest. Even though the intent of this analysis was to explore interaction effects of schedule format combination by gender, males were expected to have higher mean scores than females on the ACT mathematics subtest (Sadker & Sadker, 1994). Further analysis is recommended to examine possible causes for this unexpected result.

Students who were *not* eligible for FRL had higher mean averages on the ACT mathematics subtest than students who were eligible. SES was shown by Marzano (2000) to have the greatest influence on student achievement. In his study, income was correlated with achievement—higher income resulted in higher achievement. Carter (2003) also found a relationship between income and achievement—students with low SES had lower ACT scores than students with high SES. Although not enough data existed in the literature to conduct a one-tailed statistical analysis, the results found in this study were expected.

Reading achievement and schedule format combination. A statistically significant result was shown for schedule format combination in regard to mean scores on the ACT reading subtest. Post hoc analyses showed two schedule format combinations contributed to this significant result, suggesting high school students in traditional schedule formats

have higher mean scores on the ACT reading subtest than do students in both the AB and 4x4 block schedule format schools. These results support earlier studies by Lewis et al. (2004b) and Terrazas (2001) and contradict other studies (Dunnan, 2001; Lewis et al., 2004a; Stewart, 2003).

Figure 5 shows students in 4x4 HS, regardless of the feeder junior high school, have lower mean reading scores than students in both Trad HS combinations. Students attended traditional schedule format junior high schools in both combinations with the highest mean reading scores. Students appear to have higher reading achievement in traditional schedule format schools and lower reading achievement in the 4x4 block schedule format school. Replicating this study in future years would determine if these reading findings remain consistent over time.

Results for the effects of gender indicated a statistically significant main effect and no interaction effect. Females had higher mean scores on the ACT reading subtest than males. This result was expected as females have a history of higher reading achievement than males on standardized tests. Similar findings are common in the literature (e.g., Coley, 1989). Gender difference research has focused on socialization, self-esteem, parent and teacher expectations, and genetic make-up as possible factors for this difference in reading (Benbow & Stanley, 1983; Eccles & Jacobs, 1996; Entwisle & Baker, 1983).

FRL status and schedule format combination did not have a statistically significant effect on reading scores. As shown, family income impacts student achievement—higher income correlates to higher achievement (e.g., Marzano, 2000). This study showed that FRL status did not have a significant effect. Although not statistically significant, students who were not eligible for FRL had higher mean ACT reading subtest scores than students who were eligible in six of the seven schedule format combinations (Figure 9). An interesting result showed FRL eligible students at the 4x4

block schedule high school with higher mean scores, or nearly the same mean scores as students who were not eligible. Perhaps 4x4 block scheduling had a positive impact on this subset of students. Although this impact is possible, further analyses are needed because of small sample sizes of FRL eligible students.

Math achievement and schedule format stability. The supplemental analyses conducted to explore effects of schedule format stability, gender, and FRL status in regard to student achievement suggest results in mathematics paralleled the findings for schedule format combination. There was a statistically significant effect showing students who changed formats had higher mean scores on the ACT mathematics subtest than students who were in a stable format. It can be inferred that being in a stable format for five years is advantageous to changing schedule formats. However, the opposite was found in this study, suggesting a need for further analysis.

As the design of the supplemental analysis was unique, there were not literature-supported expectations for ACT mathematics scores and schedule format stability by gender. As mentioned, it can be inferred that remaining in the same schedule format would be advantageous to changing formats. In addition, the literature shows males outperform females on ACT math by about one point (Sadker & Sadker, 1994). Therefore, results showing males outperforming females are expected.

Although there was not a statistically significant difference for gender, Figure 10 shows males with higher mean math scores than females where students changed schedule formats. For stable schedule format, means were about the same. There was no interaction effect between schedule format stability and gender. The results reflect the significant main effect for schedule format stability; students who changed formats had higher mean scores than those who remained in the same schedule format. As a result, no definitive conclusions can be made regarding these variables.

The homogeneity of regression slopes was violated for using an ANCOVA to explore the effects of FRL status and schedule format stability. Consequently, a forward multiple regression analysis was conducted. The resulting prediction model explained 64% of the variance. Even though the model showed that FRL status was a good predictor of student achievement on the ACT math subtest, the results were misleading. Most of the predicted variance was attributed to the ALT math scores (the covariate) and nearly negligible variance was predicted by the FRL status. As a result, in this study, FRL status was not a good predictor of ACT mathematics scores. This result was consistent with the findings of Baker (2002) who found no statistically significant differences with ACT math scores and SES.

Reading achievement and schedule format stability. There was not a statistically significant result for reading achievement and schedule format stability. This result showed mean scores for stable schedule formats and changing schedule formats were nearly the same. Consequently, reading achievement does not seem affected by the stability of the schedule format.

Analysis of these effects by gender revealed similar results to the primary analysis. Females had statistically significant higher mean reading scores on the ACT subtest than males (Figure 11). In this school district, these results would be likely across any gender analysis, and schedule format stability by gender findings were not surprising.

The homogeneity of regression slopes was violated for using an ANCOVA to explore the effects of FRL status, schedule format stability, and reading achievement. Consequently, a forward multiple regression analysis was conducted. The resulting prediction model explained 56% of the variance. As shown in mathematics, the predicted variance by FRL status was also negligible in reading. Most of the predicted variance was attributed to the ALT reading variable. Although the model implies FRL status was

a good predictor of student achievement on the ACT reading subtest, the result was misleading.

Limitations

Many factors contribute to the achievement of students and this study attempted to show effects of scheduling format in regard to student achievement in reading and mathematics. Although this study used a covariate to control for prior achievement in mathematics and reading before entering either the scheduling format combination or scheduling format stability intervention, no attempts were made to control for teacher effects, school effects, or building leadership effects. A thorough review of quantitative research conducted by Waters, Marzano, and McNulty (2004) revealed the factors for schools, teachers, and students that have the greatest impact on student achievement. Clearly, schedule format is only one of many factors that contribute to student achievement.

Teacher quality has been shown to positively impact student achievement (Marzano, 2000). Even though Table 4 shows teaching experience and teachers with advanced degrees across the schools of interest to be similar, these factors do not necessarily correlate to the quality or effectiveness of the teachers. The results of this study showed students in the traditional schedule format high school with significant results in mathematics and reading, and one explanation of this result, could be the quality of teachers at this high school. Another possibility could be the quality of leadership. Perhaps these statistically significant results reflect better building leadership at the traditional schedule format high school. Without the added benefit of observation during this study, these suggestions are merely speculative.

Although analysis of covariance was used to improve the quality of the statistical analysis, using ANCOVA with intact groups, such as those used in this study, should be done with caution. Even though a covariate was used to equate the samples on student

achievement before entering the schedule format intervention, the samples may differ on other unknown variables. According to Stevens (1999), differential growth of subjects can confound the interpretation of results. For example, one group may naturally grow (learn) more than another group and ANCOVA would find a significant difference. Stevens states, "after adjusting for pretest differences, then it isn't clear whether the difference is due to the treatment, differential growth, or part of each" (p. 323). Another limitation of ANCOVA was measurement error. Stevens (1999) points out that "measurement error can seriously bias the treatment effect" (p. 323). Even though limitations exist, using ANCOVA is appropriate provided the researcher: pays careful attention to the design, ensures none of the assumptions were violated, and interprets causal effects with caution.

In addition to the statistical limitations associated with using an ANCOVA, there are also limitations to any *ex post facto* design. Because data were examined "after the fact," it was not possible to observe the fidelity of the implementation of block scheduling at either of the two high schools in this study. For example, if a teacher quit in the middle of the year or a new principal was hired, it likely would confound achievement results for students.

Successful implementation of block scheduling requires adequate staff development and ongoing support. When comparing scheduling formats in studies like this one, achievement results coupled with observation during the implementation would strengthen the design. In addition, conclusions about the achievement effects would be more definitive. In this study, it appears students in the traditional schedule format high school outperform students in block schedule format schools. However, these results may reflect real differences in student achievement; they may reflect a poor job of implementation of the block schedule format; they may reflect higher quality teaching at

the traditional format high school; or most likely, they reflect a complex combination of factors.

Another limitation of this study was use of ACT subtests in mathematics and reading as outcome measures. Even though these tests are commonly used in research literature as achievement measures in mathematics and reading, they were designed primarily to predict success in college. As a result, ACTs may not be a valid measure of student achievement in relation to schedule format combination or schedule format stability. The nature of these tests may not measure some of the reported advantages of block scheduling such as improvement in problem solving, creativity, and critical thinking skills (Rettig & Canaday, 1996). Currently, this limitation is difficult to overcome due to lack of standardized assessments designed to measure student achievement in not only reading and mathematics, but other subjects as well.

As shown, the results of this study were delimited to reading and mathematics because of available archived data. However, other subjects may be better measures of student achievement in relation to the type of schedule format or schedule format stability. Robust and standardized measures of student achievement in performing arts, foreign language, and visual arts need to be developed to improve reported achievement in regard to the type of schedule format. Until then, using measures such as ACT, AP test scores, and SAT results are the best available standardized measures to allow for comparisons across the United States.

Recommendations

This study analyzed student achievement in mathematics and reading and the effects of scheduling format combination, scheduling format stability, gender, and FRL status. Because of school of choice in the district of interest, a unique longitudinal analysis was conducted. It appears students who remain in the same scheduling format would perform better on standardized measures than students who change formats.

However, the results of this study were inconsistent. A post hoc analysis for a significant reading result and schedule format combination showed students who were in a traditional schedule format junior high school and traditional schedule format high school had higher mean scores on the ACT reading subtest than students in both AB and 4x4 block schedule high schools. A subsequent supplementary analysis showed no statistically significant results in reading in regard to schedule format stability. Further analysis showed students who changed schedule formats had higher mean scores than students who had stable ones.

Therefore, it is difficult to make definitive recommendations to school practitioners regarding the most effective combination of scheduling formats or the schedule format stability. Instead, these results suggest the combination of scheduling formats does not negatively impact student achievement as measured by the outcomes on the ACT reading and mathematics subtests. As a result, schools should choose their scheduling format to best meet the needs of their entire educational community. Student achievement may improve, but in most cases it likely will remain about the same. This recommendation should be taken with caution because results of this study were from three high schools in one school district in a Mountain West city. Studies with more schools, and ones in different regions of the United States, will make results more generalizable. In this case, it is difficult to make broad generalizations.

Future research should attempt to control for teacher quality, school quality, and leadership quality. This can be accomplished by adding a qualitative component during the implementation phase of the block scheduling format. By observing teacher, school, and leadership factors, more definitive conclusions can be made regarding factors contributing most to student achievement—either positively or negatively. Given the wide variety of possible factors, it is recommended that findings of Waters et al. (2004) meta-analyses on achievement be utilized as a framework.

Although not statistically significant, the results in this study imply that students in 4x4 HS eligible for FRL perform better compared to students who are not eligible for FRL. The achievement gap often existing between these groups may be positively impacted by the 4x4 block scheduling format. Further analysis is recommended in this area.

This study explored student achievement in three high schools using 2004 ACT subtests scores in mathematics and reading. The sample size was relatively large at each site because all students in the school district were required to take the ACT assessment. This study reduced the sample size to students who were enrolled in the district from 1999 – 2004 and eliminated students new to the district during this time period. As a result, effects of the combination of school scheduling formats were investigated longitudinally. Even though this analysis yielded a longitudinal approach, performance on the outcome variables over time is of interest for future research.

More specifically, looking at trends in subject matter performance over time may glean additional information about the effects of the type of schedule format used in schools. Nearly 50% of all public high schools use some form of block scheduling (Canday & Rettig, 1999). In many of these schools, block scheduling has been implemented for numerous years. As a result, longitudinal achievement research using within subjects design should be conducted exploring the long-term effects of this school scheduling strategy. When possible, studies should be conducted similar to the presented research where students have been enrolled in the schedule format for longer periods of time. As a result, patterns may emerge adding significantly to the knowledge base.

If possible, experimental design studies with random assignment of participants to groups before the scheduling format interventions should be conducted. Realizing this type of design is unlikely in educational settings, efforts should be made to control for achievement before entering the scheduling format intervention. Controlling for student

achievement before the intervention, coupled with robust statistical analyses such as ANCOVA, gain score analysis of variance, or hierarchical linear modeling should be used to improve both the quality and confidence of statistically significant findings. Effect sizes should be reported for all significant findings to easily allow for future meta analyses of student achievement, and the type of schedule format used in schools. Moreover, planning of observational processes for the fidelity of the block schedule format implementation will increase the quality of the research by attempting to account for possible threats to internal validity.

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APPENDIX A-LETTER OF COOPERATION

Research & Development Center for the Advancement of Student Learning
Colorado State University •
222 West Laurel Street, Fort Collins, CO 80521
TEL. 970/491-3179 · FAX 970/491-3180 · www.colostate.edu/depts/r-dcenter

March 11, 2005

Mr. Jed Bowman
2413 Laporte Avenue
Fort Collins, CO 80521

Dear Mr. Bowman:

I have reviewed your application to conduct research in School District related to the study entitled: The Efficacy of Scheduling Formats on Student Achievement of High School Students.

I approve this study with stipulation that you mask the identity of the school district and schools utilized in the study.

Sincerely,

Ellyn M. Dickmann, Ph.D.
Director of Research, Development, and Planning

APPENDIX B-HUMAN SUBJECTS APPROVAL

Colorado State University

Office of Regulatory Compliance
Office of Vice President for Research
and Information Technology
Fort Collins, CO 80523-2011
(970) 491-1553
FAX: (970) 491-2293

CORRECTED LETTER

M E M O R A N D U M

TO: Brian Cobb, School of Education, 1588

FROM: Janell A. Meldrem, Administrator
Human Research Committee

SUBJECT: **PROJECT APPROVAL**
Title: The Efficacy of Scheduling Formats on Student Achievement of High School Students
Protocol No.: 05-076H
Funding Agency: N/A

DATE: April 4, 2005

The above-referenced project was approved by the Human Research Committee on March 21, 2005 for the period March 21, 2005 to March 21, 2006. Because of the nature of this research, it will not be necessary to obtain a signed consent form. However, all subjects must receive a copy of the approved cover letter printed on department letterhead. The requirement of documentation of a consent form is waived under § _ _.117(c)(2) as data is anonymous. **Approval is to analyze approximately 1700 anonymous records.**

A status report of this project will be required within a 12-month period from the date of approval. Renewal is the Principal Investigator's responsibility, but as a courtesy, you will be sent a reminder approximately two months before the protocol expires. The Principal Investigator will report on the numbers of subjects who have participated this year and project-to-date, about problems encountered, and provide a verifying copy of the consent form or cover letter used. The necessary form (H-101) is available from the Regulatory Compliance web page (see below). Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

It is the responsibility of the investigator to immediately inform the Committee of any serious complications, unexpected risks, or injuries resulting from this research. It is also the investigator's responsibility to notify the Committee of any changes in experimental design, participant population, or consent procedures or documents. This can be done with a memo which completely describes the changes and their consequences (new consent form or cover letter, or altered survey instrument, for example). Students serving as Co-Principal Investigators may not alter projects without first obtaining PI approval. The PI is ultimately responsible for the conduct of the project.

This approval is issued under Colorado State University's OHRP Federal Wide Assurance 00000647. If approval did not accompany a proposal when it was submitted to a sponsor, it is the researcher's responsibility to provide the sponsor with the approval notice.

Please direct any questions about the Committee's action on this project to me for routing to the Committee. Additional information is available from the Regulatory Compliance web site at http://www.research.colostate.edu/rcoweb/.

cc: Jed Bowman

APPENDIX C – SPSS CODEBOOK

SPSS Codebook

Variable Name		Position
ID	Student identification number Measurement Level: Scale	1
Sex	Gender Measurement Level: Nominal Value Label 0 Female 1 Male	2
IB	Enrolled in the International Baccalaureate (IB) Program Measurement Level: Nominal Value Label 0 Not enrolled in IB 1 Enrolled in IB	3
FRL	Free/reduced lunch status Measurement Level: Nominal Value Label 0 Not eligible for free/reduced lunch 1 Eligible for free/reduced lunch	4
04_ACT_M	2004 grade 11 ACT subtest score in mathematics Measurement Level: Scale	5
04_ACT_R	2004 grade 11 ACT subtest score in reading Measurement Level: Scale	6
99_RIT_M	Spring 1999 grade 6 Level test score in mathematics Measurement Level: Scale	7
99_RIT_R	Spring 1999 grade 6 Level test score in reading Measurement Level: Scale	8

Variable Name		Position
HS_fmt	High school scheduling format at the end of 2003-04 Measurement Level: Nominal Value Label 0 Traditional schedule format 1 AB block schedule format 2 4x4 block schedule format	9
JH_fmt	Junior high school scheduling format at the end of 2001-02 Measurement Level: Nominal Value Label 0 Traditional schedule format 1 AB block schedule format 2 4x4 block schedule format	10
JHxHSfmt	Combination of junior high and high school scheduling Format Measurement: Nominal Value Label 0 Traditional schedule format junior high school and traditional schedule format high school 1 Traditional schedule format junior high school and AB block schedule format high school 2 Traditional schedule format junior high school and 4x4 block schedule format high school 3 AB block schedule format junior high school and traditional schedule format high school 4 AB block schedule format junior high school and AB block schedule format high school 5 AB block schedule format junior high school and 4x4 block schedule format high school 6 4x4 block schedule format junior high school and traditional schedule format high school 7 4x4 block schedule format junior high school and AB block schedule format high school 8 4x4 block schedule format junior high school and 4x4 block schedule format high school	11

Variable Name		Position
04_HS	High school enrolled in at the end of 2003-2004 Measurement Level: Nominal	12

Value	Label
0	High school 3
1	High school 2
2	High school 4

02_JH	Junior high school enrolled in at the end of 2001-2002 Measurement Level: Nominal	13

Value	Label
0	Junior high school 5
1	Junior high school 6
2	Junior high school 7
3	Junior high school 8
4	Junior high school 9
5	Junior high school 10
6	Junior high school 11
7	Junior high school 12

Sch_Stab	Schedule Format Stability Measurement Level: Nominal	14

Value	Label
0	Stable Format
1	Change Format