5-1-2011

The effect of scheduling models for introductory algebra on 9th-grade students, test scores and grades

Angela L. O'Hanlon

University of Nebraska at Omaha

The Effect of Scheduling Models for Introductory Algebra on 9th-Grade Students, Test Scores and Grades

By

Angela L. O'Hanlon

A Dissertation

Presented to the Faculty of

The Graduate College of the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Education

In Educational Administration

Omaha, Nebraska

May 2011

Supervisory Committee

Dr. Peter J. Smith, Chair

Dr. Jeanne L. Surface

Dr. Neal F. Grandgenett

Dr. Larry L. Dlugosh

Abstract

THE EFFECT OF SCHEDULING MODELS FOR INTRODUCTORY ALGEBRA ON 9th-GRADE STUDENTS, TEST SCORES AND GRADES

Angela L. O'Hanlon

University of Nebraska 2011

Advisor: Dr. Peter J. Smith

The purpose of the study was to determine the effect of pacing and scheduling of algebra coursework on assigned 9th-grade students who traditionally would qualify for pre-algebra instruction and same course 9th-grade students who traditionally would qualify for standard algebra instruction. Students were selected based on completion of first-year algebra by the end of their 9th-grade year. This study will compare all students' math EXPLORE test scores, PLAN test scores, algebra common summative assessments (CSAs), geometry CSAs, fall grade point averages (GPAs) and spring GPAs.

Achievement was examined for three different algebra groups. The first group received algebra instruction for a period of two-years, one-period (n = 15). The second group received algebra instruction for a period of one-year, one-period (n = 30). The third group received algebra instruction for a period of one-year, two-periods (n = 19).

Among the differences observed, the students who completed the one-year, two-period algebra class were significantly lower on the EXPLORE (pretest) score, but not significantly lower on the PLAN (posttest). However their GPAs did not improve significantly.

This study suggests that the research district should continue to examine how students are placed into algebra and when students complete algebra.

Acknowledgements

The support and encouragement of many people made the completion of this dissertation possible. I want to thank my husband, Sean O'Hanlon, and our children Liam and Maureen whose unconditional love and commitment to my success provided me with motivation and confidence to complete this journey.

I want to thank my parents, Mary and Gary Marasco, who have always supported and believed in me through all of life's adventures. I can never repay you for all that you have done for me.

I would also like to thank my friend, J.J. Toczek, who convinced me to start the doctoral program and gave me hours of advice through this dissertation process.

To all of my other family members and friends too numerous to name, I thank you for the countless words of encouragement and support throughout this journey.

Finally, I want to thank my advisor, Dr. Peter Smith. His time, efforts, and enthusiasm for math education made this exploration enjoyable. I also want to thank the other members of my committee: Dr. Jeanne L. Surface, Dr. Neal F. Grandgenett, and Dr. Larry L. Dlugosh. Other University of Nebraska-Omaha faculty who helped me along this journey include: Dr. Kay Keiser, Dr. Karen Hayes and Dr. John Hill. Your demonstration of educational leadership and life-long learning has been an inspiration.

Table Of Contents

LIST OF TABLES

Tables

CHAPTER ONE

Introduction

A Nation at Risk

In 1983, The National Commission on Excellence in Education published A Nation at Risk. This report published the results of an 18-month study. The findings of the study outlined the risk faced by United States due to substandard education (1983). Achievement data of high school students showed that students were performing at low rates and gifted students were not performing to their potential. Results at the post-secondary level were not much better. There was an increase in the number of students enrolled in remedial mathematics courses and a decrease in achievement scores of graduating students.

The Commission made several recommendations to improve the educational situation. One recommendation was to raise expectations of students. Students will perform at levels expected of them. They can sense when their instructors doubt their abilities. Another recommendation was to increase the amount of time students spend on their schooling. This would include the amount of homework given, the number of school days attended and the hours of the school day.

Finally, the Commission recommended that the content of schooling be improved. The recommendation was that graduation requirements include three years of mathematics. The content that was included was: geometric and algebraic concepts; elementary probability and statistics; applications of mathematics to everyday situations; and estimation, approximation, and testing the accuracy of calculations (1983).

The response to the findings presented in A Nation at Risk: Many schools adopted "algebra for all" policies.

During the 1990's schools started increasing the expectations placed upon students. They strengthened graduation requirements, eliminated remedial courses from curricular offerings, and some started adopting algebra for all policies (Allensworth, Nomi, Montgomery, & Lee, 2009). Enrollment in algebra classes increased significantly (Loveless, 2008). Enrollment in algebra in North Carolina was 60,000 students during the 1991–1992 school-year. By the 1995-1996 school-year, that number jumped to 82,000 (Malloy & Malloy, 1998).

Prior to this, students only needed a set number of math credits for graduation. They could earn those credits through a variety of math courses. There has been a movement to specify that algebra must be a set number of those credits. Students can no longer earn a diploma by taking general math and other lower level math courses.

The state of Michigan raised the bar even higher. Students are required to complete four credits (years) of math. This includes Algebra 1, Geometry, and Algebra 2 (Geno, 2010). They must also demonstrate proficiency in these courses in order to earn a diploma.

Students have a right to a rigorous and challenging curriculum.

An introductory Algebra class, commonly referred to as Algebra 1, is often referred to as a gateway class. Success in this class leads students to upper level math classes that will provide the necessary problem solving and math skills to gain acceptance into colleges and universities. Early completion of Algebra 1 also provides students with the opportunity to take advanced placement courses, with the possibility of earning college credits before graduating from high school.

By allowing students to remain in remedial classes where the material is the same, but the name of the class is different, schools are violating the civil rights of the students. The remedial classed are often filled with minority and students of poverty.

Robert Moses, a mathematics teacher and Civil Rights activist recognized the lack of diversity in algebra classrooms and began what is known as “The Algebra Project” (Checkly, 2001; Kress, 2005). Realizing the opportunities available to those students who completed algebra in either the 8th or 9th-grade, Moses made it a goal to increase the number of minority students enrolled in algebra, preparing them for the upper level math classes that were once available to students with more advantaged backgrounds.

Hill also recognized the need for students to complete upper level mathematics courses. While not all students will become engineers and scientists, many jobs require deep problem solving skills (2010). Access to “powerful mathematics” will provide students with the opportunities to gain the skills necessary to be a part of today’s technological society.

Removing the remedial courses from a school is beneficial to all students. It has been found that achievement gains are greater and learning is more evenly distributed among the various races and socio-economic groups (Allensworth et al., 2009).

Higher level math classes that start with algebra are the pathway to college and higher paying jobs (Achieve, 2008). Students have a right to the opportunity to take these classes. By starting high school in classes lower than a first year-algebra course, students will not have the prerequisites to the upper level courses, thus limiting their futures.

Taking algebra versus learning algebra.

Simply requiring students to enroll in an algebra course will not ensure algebra achievement. Students with lower abilities have been found to be more likely to fail the class (Allensworth et al., 2009). Students with lower abilities need to have support in place in order to be successful. Teachers and schools will need to change how algebra is taught.

When students are unprepared for the courses in which they are registered, interventions need to be available. One such option is a soft-ware based learning opportunity. This can be in addition to regular classroom instruction or in place of classroom instruction when the goal is credit recovery. A public school in Ohio found success with PLATO, one such online program (Fratt, 2006). Students who earned two F's in the first semester of algebra were given the option to enroll in PLATO in addition to their algebra class. This allowed the student to learn the material they missed and potentially earn credit for the semester (2006).

One schedule fits all.

With a requirement of completion of algebra being in place, schools need to find a way to make it feasible for all students to be successful. A traditional schedule may not work for students who are unprepared for algebra. In buildings with seven or eight class periods, students could be offered a second period of math in order to enrich the experiences and lessons of the first period. One school in Virginia found that students who opted to take the second period scored higher on class assessments than those who only took the first period (Loughran Peele, 1998). The two period group also earned more A's and B's and fewer C's and D's than one period group.

Other states and districts have offered flexibility in how Algebra 1 is completed. Some have presented it in a slow-paced two year course. Others have moved to a block schedule to allow for a longer period during the day. Other districts have maintained a traditional 45–55 minute class period in order to learn the material. Students that struggle are given the opportunity to get a "double dose" of algebra, meeting during a second class period to receive additional help and instruction (1998). Are all the needs of all students being met in order to attain the goal of all students learning algebra?

Frequent assessment and interventions are necessary. By splitting the material into quarters and utilizing a modified block, failing students would not need to wait until the following semester to earn credit. At the end of a predetermined unit, students who are ready would move on, while students who have not mastered the material would be placed into a separate group for another opportunity to learn the material (Rettig & Canady, 1998).

A non-traditional Algebra for All.

Teaching algebra to all students will require a change in mindset for teachers and administrators. Traditional approaches of lecture and drill have been found to be unsuccessful with low-achieving and low-motivated students (Malloy & Malloy, 1998). Lessons will need to be more inquiry based and less teacher-driven (Slosson, 2004). Seeing math as more than just numbers on a page will make math more interesting and relevant to students who were previously unsuccessful in math courses (Hill, 2010). When students can connect with the material, they will be more engaged. They will be more likely to gain the deeper understanding necessary to retain the material and apply it when they are assessed.

Purpose of the Study

The purpose of the study was to determine the effect of pacing and scheduling of algebra coursework on assigned 9th-grade students who traditionally would qualify for pre-algebra instruction and same course 9th-grade students who traditionally would qualify for standard algebra instruction, on all students' math PLAN test scores, algebra common summative assessments (CSAs), geometry CSAs, fall grade point averages (GPAs) and spring GPAs.

Research Questions

The following research questions were used to analyze student participation in an introductory algebra class through different scheduling models measuring norm-referenced math achievement, district common summative assessment achievement, and cumulative grade point averages.

Overarching Pretest-Posttest Achievement Research Question #1. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their beginning 9th-grade pretest EXPLORE math score compared to their ending 10th-grade posttest

PLAN math score following participation in algebra class utilizing different scheduling models?

Analysis. Research Questions #1 was analyzed using repeated measure two-way ANOVA tests to examine the significance of the difference between students' beginning 9th-grade pretest EXPLORE math scores converted to standard scores compared to their ending 9th-grade posttest PLAN math scores converted to standard scores following completion of a first-year algebra class utilizing different scheduling models. Because multiple statistical tests were conducted, a one-tailed .05 alpha level was employed to help control for Type I errors. Post hoc analyses were conducted when there was a main effect significance.

Overarching Posttest-Posttest Achievement Research Question #2. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average algebra CSA scores?

Analysis. Research Question #2 was analyzed utilizing a single classification Analysis of Variance (ANOVA) to determine the main effect between algebra CSA scores for students who completed a first-year algebra course over the period two years receiving instruction one period per school day, students who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day. An *F* ratio was calculated and an alpha level of .05 was utilized to test the null hypothesis. Post hoc analyses were conducted if there was main effect significance.

Overarching Posttest-Posttest Achievement Research Question #3. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average geometry CSA scores?

Analysis. Research Question #3 was analyzed utilizing a single classification Analysis of Variance (ANOVA) to determine the main effect between geometry CSA scores for students who completed a first-year algebra course over the period two years receiving instruction one period per school day, students who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day. An *F* ratio was calculated and an alpha level of .05 was utilized to test the null hypothesis. Post hoc analyses were conducted if there was a main effect significance.

Overarching Pretest-Posttest Achievement Research Question #4. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their fall semester 9th-grade cumulative GPA compared to their spring semester 9th-grade cumulative GPA following participation in algebra class utilizing different scheduling models?

Analysis. Research Question #4 was analyzed using repeated measure two-way ANOVA tests to examine the significance of the difference between students' fall semester 9th-grade cumulative GPA compared to their spring semester 9th-grade cumulative GPA following participation in algebra class utilizing different scheduling models. Because multiple statistical tests were conducted, a one-tailed .05 alpha level was employed to help control for Type I errors. Post hoc analyses were conducted if there was main effect significance.

Assumptions

The study has several strong features. A large sample of the students in the research school who completed Algebra 1 by the end of the 2008–2009 was included. The teachers who worked with the students during the 2008–2009 school year, met regularly to plan lessons, activities, and formative assessments. All teachers were trained to use the district scoring rubric for CSAs. The district and building administrative team provided support to the students and teachers in order for students to achieve at their highest level.

Students were excluded from the study if they were missing any of the following: EXPLORE math score, PLAN math score, Algebra 1 CSA score or Geometry CSA score.

Delimitations of the Study

This study was delimited to the 10th-grade students of one high school in a suburban school district who were in attendance from the fall of 2008 to the spring of 2010. All 9th-grade students in 2008-2009 were required to take the EXPLORE test in the fall of 2008. All 10th-grade students in 2009-2010 were required to take the PLAN test in the fall of 2009. Data on grade point average during 2008-2009 were included in the study. Study findings will be limited to students who completed both tests as well as district common summative assessments.

Students who did not complete a first-year algebra course by the end of the 2008 – 2009 school year were not included in this study. This would be advanced students who completed the course during the 2007 – 2008 school year. These students completed the first-year algebra course during their 8th-grade year.

The other group of students who were not included in the study was the students who completed the first-year algebra course over a period of two years, receiving instruction one period per day, but starting during the 2008 – 2009 school year. They completed the course during their 10th-grade year.

Limitations of the Study

Several limitations of this study should be noted. Students' number sense and mathematical background may be a factor in pretest and posttest scores. The availability of mathematical support at home may also contribute to the outcome of achievement data. The total number of students available for the study may also skew the results and limit the outcomes of the study. These limitations will be taken into consideration when analyzing the results.

Definition of Terms

Common Summative Assessment (CSA). Assessments administered at the end of a unit, given by all teachers of the same course. All students, regardless of teacher, complete the same assessment. All teachers score the assessment in the same manner, with the same guidelines as described by a rubric. Students are scored on five content standards: problem solving, representation, reasoning, communications, and connections. Each standard is scored on a 4 point scale as follows: 4 = Advanced, 3 = Proficient, 2 = Progressing, 1 = Beginning. The sum of the five scores is then recorded as the student's overall score for the assessment.

EXPLORE Test. The EXPLORE Test is a norm-referenced test developed by ACT to assess academic progress at the 8th or 9th-grade level. The test is comprised of reading, English, math, and science subtests. Students at the research school take this test during the fall semester of their 9th-grade year. The results are given as both a raw score and a percentile score. In order to compare EXPLORE pretest scores to PLAN posttest scores, percentile scores will be converted to standard scores.

Grade point average (GPA). Grade point average is defined as the average on a scale of 4.0 of the grades received by a student throughout a school year based on the SIMS database.

Normal curve equivalent (NCE). Normal curve equivalent is defined as standard scores with a mean equal to 50 and a standard deviation equal to 21.06. Running from 1 to 99, the numbers on the NCE line indicate how many students out of a hundred had a lower score. NCE scores are often used to compare standardized test performance over a period of years (Salvia & Ysseldyke, 2004).

Norm-referenced test (NRT). Norm-referenced tests are defined as tests that measure and compare an individual's performance to the performance of a similar group of students who have taken the same test. The NRTs used in this study will be the EXPLORE Test and the PLAN test.

PLAN Test. The PLAN Test is a norm-referenced test developed by ACT to assess academic progress at the 10th-grade level. The test is comprised of reading, English, math, and science subtests. Students at the research school take this test during the fall semester of their 10th-grade year. The results are given as both a raw score and a percentile score. In order to compare EXPLORE pretest scores to PLAN posttest scores, percentile scores will be converted to standard scores.

Significance of the Study. This study has the potential to contribute to research, practice, and policy. It is of significant interest to educators seeking ways to give all students the skills necessary to be successful in a first-year algebra course.

Contribution to research. A large body of literature exists discussing the need for rigor in mathematical course offerings for students. There is also a substantial amount of literature stating opinions of practitioners on the policy of requiring algebra for all students. The research comparing options for offering algebra is limited. This study will provide policymakers with data to determine a scheduling method that meets the needs of their students.

Contribution to practice. Based on the outcomes of this study the school and the district may decide to change or maintain current practice for scheduling first-year algebra. Changes to elementary and/or middle school math curriculum may also be changed in order to facilitate preparation for math instruction at the 9th-grade level.

Contribution to policy. Local level policy will be impacted by this study. If results show that scheduling can negatively impact achievement in other areas, a discussion should be generated to consider the policies scheduling first-year algebra for high school students.

Organization of the Study

The literature review relevant to this study is presented in Chapter 2. This chapter reviews professional literature on algebra for all students. Chapter 3 describes the research design, methodology, and procedures that will be used to gather and analyze the data of the study. Chapter 4 reports the research results and Chapter 5 provides conclusions and discussions of the research results.

Chapter 2

Review of Literature

Algebra: A gateway to multiple opportunities

At one time, algebra was a course that only upper level students completed. Now, algebra is a requirement for admittance to most colleges and universities. By not requiring all students to take algebra, schools are limiting a student's options for postsecondary work. This is considered by some, a violation of a student's civil rights (Kress, 2005).

An introductory algebra course is a prerequisite for other upper level math classes. Some will contend that the upper level courses provide a pathway to college, which will in turn provide a pathway to good jobs and higher salaries (Fratt, 2006). Any student with an interest in engineering, physics, computer science, and medicine will need to achieve at high levels in a first year algebra course (Edwards, 2000). Without success in math, these career fields will not be possible.

Opposition to algebra for all policies

While many experts agree that algebra should be a requirement for all students, there are some who feel that it is not necessary. Bagwell states that many students can not comprehend the abstract concepts of algebra. This lack of comprehension may only lead to frustration and failure (2000). This is especially true for students who have not mastered pre-algebra skills. This failure can have dire consequences, such as the dropping out of students who have lost hope.

Bagwell also contends that forcing all students to take algebra has negative effects on the content of the course. She claims that the material tends to be taught at a more basic level (2000). This not only affects the weaker students, but can cause the brighter students to become bored and disinterested.

Noddings (2000) also argues that algebra is not necessary for all students. She argues that some students are not adequately prepared for algebra and are on a track to failure. This failure could lead to disparity and failure to earn a high school diploma. The advent of high stakes testing also increases this sense of inadequacy.

Proponents of algebra for all will state that learning algebra is necessary for the path to college. Noddings (2000) asks about the students who are not going to college. She claims that requiring them to take algebra devalues their educational experience. She stated, “Students should be able to choose either college or non-college curricula proudly and with some confidence that their choices will yield a genuine valued education.”

Morgatto (2008) expressed the same concern for students who are not interested in college. A student who chooses a path other than college should not feel shame for the choices they make. There are many successful career paths that do not require a college education.

In the push to get all students through algebra, many students are forced into the course without having the skills necessary to be successful. The teachers of the course are expected to make up for the deficiencies of the students. “In 8th-grade they [the misplaced student] are now expected to learn, in a single year, the six years of math they have not yet learned along with a full year of algebra” (Bracey, 2009b).

Algebra for all: Under supportive conditions and with proper training

A few authors expressed concern for generic algebra for all policies. While they agree with the idea, they have some doubts. Bracey states, “No matter what the relationship between NAEP and algebra, the kids with lower than 4th-grade math skills have no business in algebra class" (2009a). Like Noddings and Bagwell, he claims that this will only lead to frustration and failure. With a new audience of students in algebra classes, teachers need professional development in order to teach the content and use techniques that may be new to them (Morgatto, 2008).

Choike (2000) offers classroom strategies that he has found to be successful in his own classroom. Often, algebra curriculum is broad without a lot of depth. He contends that focusing on big ideas will help students to understand the big concepts. Along with the big ideas, he encourages teachers to emphasize multiple representations. When students are allowed to complete problems in a variety of manners instead of being stifled into just one right way, they are more likely to stay engaged in the problem.

Part of the training that teachers need would involve "unlocking the combinations to pedagogies that value the whole person in mathematics classrooms" (Kress, 2005). Teachers can no longer teach math to faceless students. They need to recognize the colors and cultures of the students in their classrooms in order to allow the connections to take place. Without these connections, math is meaningless to students.

Not only will teachers need support, but the students will need support as well. McKibben references a recommendation made by the National Mathematics Advisory Panels. Elementary schools may need to hire mathematics resource teachers (2009). Most schools have resource teachers for reading deficiencies, but lack a math resource teacher. Students would benefit from the services that could be provided by this additional teacher.

The students themselves can also be a resource. When algebra is taught in a student centered fashion, students will realize their abilities and have more success (Hill, 2010). Students need to be allowed to explore and figure things out for themselves. The classroom may become more noisy than usual. Slosson states, “Students will talk and socialize no matter what you do, so try to get them talking about math” (2004).

While the proper training implies staff development for the teachers, principals also need training. Some principals were not math teachers before leaving the classroom. For many, their math instruction was far in their past. Workshops that provide a foundational understanding of algebra and best practice for teaching it are beneficial not only to the principals, but also the students and teachers in their buildings (Carver, Steele, & Herbel-Eisenmann, 2010).

The training of principals will allow them to better observe and evaluate algebra instruction. It will give them the necessary background in order to have meaningful conversations with teachers about what was observed. It will also provide them with a better understanding of the struggling student (2010).

Algebra for all: A collaborative effort.

At one time, teachers worked autonomously in their classrooms, determining the curriculum, without much interaction with coworkers. Now that expectations have been raised and achievement is being more deeply analyzed, teachers can no longer be on their own island. They need to be more collaborative with their departments. In successful schools, it is common to see teachers collaborating on materials and discussing the best strategies to increase the levels of understanding (Flores & Roberts, 2008). When teachers are teaching the same material at the same time, they are able to discuss strategies that have been successful, as well as those that were unsuccessful (2008).

In their visits with three urban schools in California, Flores and Roberts found math department leaders serving in much different roles than traditional department leaders. They served as coaches to the teachers in their departments. They shared the responsibility of teaching all students. They not only taught the upper level classes, but also the lower level classes (2008). They were the curriculum leaders who also provided professional development to the members of the department. “There was little mention of conferences or workshops away from the school” (2008).

Algebra for all: At what grade level?

Before the movement of all students taking algebra, algebra at the 8th-grade level was only for students with a high math aptitude. This track would allow for a student to complete calculus before graduating from high school. More and more students are being placed into this track.

Is 8th-grade the right timing for learning algebra? Several authors will agree to this idea. Allen states, “I am a proponent of algebra in the middle school. If appropriately taught, algebra helps students reason, see patterns and relationships, and make predictions and generalizations (2000).

Placing a student on this fast paced route to upper level math can be successful if a few criteria are met. First, students need to have mastered basic skills. If they have not mastered the basics, they will not be able to fully comprehend the complexity present in the upper level courses. Second, the curriculum needs to be aligned properly. This needs to start with kindergarten (McKibben, 2009). Without these criteria, students will struggle.

If schools have the opportunity to offer rich upper level math courses at the high school level, offering algebra in 8th-grade is an advantageous option for students. However, if there are no options for such opportunities, then there is no reason to offer algebra early in a student's academic career (Seeley, 2004).

In her study of a large southeastern suburban school district, Spielhagen found that offering algebra in the 8th-grade to a diverse population helps to close the achievement gap often found between different socioeconomic groups (2006). She also contends that this practice encourages students to pursue math at higher levels. She found that students who took algebra in the 8th-grade were more likely to take higher level math courses and continue taking them for a longer time period.

In 2008, the state board of education in California passed a rule stating that all 8th-graders would be enrolled in algebra during their 8th-grade year (Jacobson, 2008). At the time, Minnesota was the only other state with an 8th-grade requirement. This decision was made "after last minute pressure" from the governor. The policy passed without the full support of leaders in the state. Superintendent of Public Instruction, Jack O'Connell, had concerns. While he felt that this plan was achievable, he also acknowledged that support would be needed. He felt that this would include: adequate teacher preparation, professional development, and instructional time (2008).

Technology as an integral tool for success in algebra classes

The Commission discussed the changing role of technology in the lives of students in A Nation at Risk. Technology is as important to a math classroom as a text book or pencil. Graphing calculators and computer software enhance student learning and allow for exploration through math topics. Students become active learners engaged in the theories of math instead of robots of computation (Pugalee, 2001).

Calculators are becoming more accessible to students. These calculators have a lot to offer math classrooms whether middle level or at the high school level. At one time, a calculator was only used for the four basic functions: addition, subtraction, multiplication, and division. Calculators can graph different types of functions, create a best fit function from a set of data points, run statistical tests and many other functions. While some teachers will fight the use of calculators in their classrooms, this is a tool they should embrace (Howell, 2000). Partnered with pencil and paper work, calculators allow students to make the connections necessary to truly understand math.

Credit recovery and remediation are another purpose for technology. In some school districts, students who have not been successful in a traditional classroom have the option of earning algebra credits through online algebra using programs such as NovaNet, PLATO or Apex (Fratt, 2006). While this is considered as soft credit by some, it allows student to learn at their own pace and provided remediation of the skills they are lacking. This type of program is especially successful for students at risk (Fratt, 2006).

Technology also provides a visual aid for students to understand abstract concepts such as functions and polynomials. It also helps to alleviate the deficit faced by students with learning disabilities or limited computational skills (Hodges, 2000).

Alternative approaches to traditional algebra

In most high schools, algebra and geometry are taught in different years. Teachers often feel frustrated with the lack of retention by taking a year away from algebra. In his article, Begg (2000) offers advantages to teaching algebra in an integrated approach

- All students from age five learn algebra along with mathematics from the other strands; students do not have a year in which they forget what they learned.
- Integrated courses facilitate making connections and algebra becomes involved in a range of contexts.
- The integrated curriculum provides variety, which is important because students enjoy parts of mathematics, but lack confidence with others.
- An integrated philosophy enables changes to be made at each level so that such new topics as statistics can be introduced easily.

While this approach is different from how most schools teach math, the applications become apparent to students which furthers their interest in math.

At one time, math classrooms were sterile. Teachers lectured, students wrote. They were not interactive and students found little relevance in what they were learning. While some classrooms may still remain this way, others are teaching math through the eyes of students. There have been reforms in math that have led to teachers offering insight into the cultural history behind math (Kress, 2005).

Connections are an important piece to a deeper understanding in a math classroom. Having students mindlessly solve equations does not show a teacher if a student truly understands the math. This process often only shows that a student can follow the prescribed steps of the process. There needs to be a bridge between the concrete and abstract levels of math (Matsumoto, 2000).

After watching students struggle with and fail the Washington Assessment of Student Learning (WASL), James Slosson provided solutions to problems he identified (2004). To compensate for the poor math skills that students bring into high school, he suggested a change in the curriculum. Instead of a traditional task-based course, integrate geometry, probability, graphing as well as other topics that are more relevant and interesting to students. He also suggested changes in instruction and grading. The more traditional styles of instruction and grading are not effective for lower ability students who have given up on their math abilities. By requiring students to keep working until they are successful, we not only build their confidence, but we also build their math skills (2004).

Conclusion.

The fundamental belief of educators is that all children can learn. With the implementation of more specific math standards into schools, some educators seem to want to add an exception to this rule. Some feel that not all students can learn algebra. They do not think that it is fair to place this requirement on students. By requiring all students to take algebra, we are setting some students up for failure. We are leading them down a path that will lead to dropping out of school.

Others will argue that by not requiring all students to take algebra, we are not providing students with an educational right. We are not sending them down the path that will lead to a college education and higher paying jobs.

All students can learn and they can learn algebra. They can learn algebra if they are provided relevant instruction by trained teachers. They can learn algebra if they are given the right support to repair any deficiencies that may be present in their mathematical knowledge base. They can learn algebra if they are provided with the tools necessary to succeed.

CHAPTER THREE

Methodology

Participants

Number of participants. The maximum accrual for this study was (*N* = 64) including a naturally formed group of students who completed a first-year algebra course over the period two years receiving instruction one period per school day, (*n* =19), a naturally formed group of students who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day (*n* = 30); and a naturally formed group of students who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day, (*n* = 15).

Gender of participants. Of the total number of selected subjects who completed a first-year algebra course over the period two years receiving instruction one period per school day, (*n* =15), the gender ratio was 10 boys (67%) and 5 girls (33%). Of the total number of selected subjects who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day (*n* = 30), the gender ratio was 12 boys (40%) and 18 girls (60%). Of the total number of selected subjects who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day, (*n* = 19), the gender ratio was 11 boys (58%) and 8 girls (42%).

Age range of participants. The age range for all study participants was from 16 years to 17 years. All participants were in the 11th-grade. The age range of the study participants was congruent with the research school districts age range demographics for 11th-grade students.

Racial and ethnic origin of participants. Of the total number of selected subjects who completed a first-year algebra course over the period two years receiving instruction one period per school day, (*n* =15), the racial and ethnic ratio was 13 white (86%), one black (7%) and one Hispanic (7%). Of the total number of selected subjects who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day (*n* = 30), the racial and ethnic ratio was 26 white (87%), one black (3%), one Hispanic (3%) and two Asian (7%) . Of the total number of selected subjects who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day, (*n* = 19), the racial and ethnic ratio was 16 white (84%), one black (5%), and two Hispanic (11%).

Inclusion criteria of participants. Eleventh-grade students who attended the research school for the entire 9th-grade and 10th-grade school years and completed study assessments were eligible. A sample of students who completed a first-year algebra course by the end of their 9th-grade year was included. Any students who completed a first-year algebra course during any other year were not included in the study.

Method of participant identification. Students who completed algebra coursework during their 9th-grade school year were identified. No individual identifiers were attached to the achievement data of the 64 participating students in the three naturally formed groups.

Description of Procedures

Purpose of the Study

The purpose of the study was to determine the effect of pacing and scheduling of algebra coursework on assigned 9th-grade students who traditionally would qualify for pre-algebra instruction and same course 9th-grade students who traditionally would qualify for standard algebra instruction, on all students' math PLAN test scores, algebra common summative assessments (CSAs), geometry CSAs, fall grade point averages and spring GPAs.

Research design. The pretest-posttest three-group comparative efficacy study design is displayed in the following notation.

Group 1 X_1 O_1 Y_1 O_2

Group 2 X_1 O_1 Y_2 O_2

Group 3 X_1 O_1 Y_3 O_2

Group 1 = study participants #1. Naturally formed group of 10th-grade students (n = 19) who attended the research school.

Group 2 = study participants #2. Naturally formed group of 10th-grade students (n = 30) who attended the research school.

Group 3 = study participants #3. Naturally formed group of 10th-grade students (n = 15) who attended the research school.

X_1 = study constant. All assigned students (N = 64) completed a first year algebra course covering algebra content traditionally covered in one year of a standard 9th-grade algebra course.

Y_1 = study independent variable, algebra readiness, condition #1. Tenth-grade students who completed a first-year algebra course over the period two years receiving instruction one period per school day

Y_2 = study independent variable, algebra readiness, condition #2. Tenth-grade students who completed a first-year algebra course over the period of one year receiving instruction one period per school day.

Y_3 = study independent variable, algebra readiness, condition #3. Tenth-grade students who completed a first-year algebra course over the period of one year receiving instruction two periods per school day.

O_1 = study pretest dependent measures. (1) Achievement as measured by the research school districts 9th-grade EXPLORE math normal curve equivalent (NCE) score. (2) Achievement as measured by the research school districts 9th-grade 1st-semester grade point average (GPA).

O_2 = study posttest dependent measures. (1) Achievement as measured by the research school districts 10th-grade PLAN math test NCE score. (2) Achievement as measured by the research school districts 9th-grade 2nd-semester GPA. (3) Achievement as measured by the research school districts' algebra common summative assessment (CSA) average. (4) Achievement as measured by the research school districts' geometry CSA average.

Implementation of the Independent Variables

The independent variables for this study will be the three student groups representing 10th-grade students who completed a standard first-year algebra course by the end of their 9th-grade school year. The students in the first group completed a first year algebra course over the period two years receiving instruction one period per school day, (n =15). The students in the second group completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day (n =

30). The students in the third group completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day, (n = 19). The groups of students were selected from the same student population that completed first-year algebra course at the end of their 9th-grade school year.

The first-year algebra course provides the foundation for all subsequent math courses. It is designed for students intending to pursue a vocational career as well as those who plan to attend a post-secondary school. Students will study topics such as: number theory; solving proportions, linear equations, and linear inequalities; graphing and writing equations of lines, and solving systems of linear equations using a variety of methods. Students will also study quadratics, polynomials, factoring, radicals, and exponents.

The purpose of the study will be to determine the effect of course pacing on assigned 11th-grade students.

Dependent Measures

The study’s three dependent variables were (1) Achievement as measured by the research school district’s EXPLORE and PLAN math tests NCE scores. (2) Achievement as measured by the research school district’s cumulative GPA. (3) Achievement as measured by the research school district’s algebra CSA’s. (4) Achievement as measured by the research school district’s geometry CSA’s.

All test score and classroom data will be retrieved from the research school district’s data management system. All data was archival, retrospective, and de-identified by appropriate school district research personnel.

Research Questions and Data Analysis

The following research question was used to analyze student participation in slow pace algebra course work measuring norm-referenced math outcomes.

Overarching Pretest-Posttest Achievement Research Question #1. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their beginning 9th-grade pretest EXPLORE math score compared to their ending 10th-grade posttest PLAN math score following participation in algebra class utilizing different scheduling models?

Analysis. Research Questions #1 was analyzed using repeated measure two-way ANOVA tests to examine the significance of the difference between students' beginning 9th-grade pretest EXPLORE math scores converted to standard scores compared to their ending 9th-grade posttest PLAN math scores converted to standard scores following completion of a first-year algebra class utilizing different scheduling models. Because multiple statistical tests were conducted, a one-tailed .05 alpha level was employed to help control for Type I errors. Post hoc analyses were conducted if there was a main effect significance.

The following research questions were used to analyze student participation in slow pace algebra course work measuring district common summative assessments.

Overarching Posttest-Posttest Achievement Research Question #2. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average algebra CSA scores?

Analysis. Research Question #2 was analyzed utilizing a single classification Analysis of Variance (ANOVA) to determine the main effect between algebra CSA scores for students who completed a first-year algebra course over the period two years receiving instruction one period per school day, students who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day and students who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day. An *F* ratio was calculated and an alpha level of .05 was utilized to test the null hypothesis. Post hoc analyses were conducted if there was a main effect significance.

Overarching Posttest-Posttest Achievement Research Question #3. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average geometry CSA scores?

Analysis. Research Question #3 was analyzed utilizing a single classification Analysis of Variance (ANOVA) to determine the main effect between geometry CSA scores for students who completed a first-year algebra course over the period two years receiving instruction one period per school day, students who completed a first-year algebra course over the period of one year receiving algebra instruction one period per school day and students who completed a first-year algebra course over the period of one year receiving algebra instruction two periods per school day. An *F* ratio was calculated and an alpha level of .05 was utilized to test the null hypothesis. Post hoc analyses were conducted if there was a main effect significance.

The following research question was used to analyze student participation in slow pace algebra course work measuring grade point averages.

Overarching Pretest-Posttest Achievement Research Question #4. Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their fall semester 9th-grade cumulative GPA compared to their spring semester 9th-grade cumulative GPA following participation in algebra class utilizing different scheduling models?

Analysis. Research Question #4 was analyzed using repeated measure two-way ANOVA tests to examine the significance of the difference between students' fall semester 9th-grade cumulative GPA compared to their spring semester 9th-grade cumulative GPA following participation in algebra class utilizing different scheduling models. Because multiple statistical tests were conducted, a one-tailed .05 alpha level will be employed to help control for Type I errors. Post hoc analyses were conducted if there was main effect significance.

Data Collection Procedures

All study achievement and behavioral data were retrospective, archival, and routinely collected school information. Permission from the appropriate school research personnel was obtained. Naturally formed groups of 15 students in one arm, 30 students in a second arm and 19 students in the third were obtained to include achievement data. Non-coded numbers were used to display individual de-identified achievement and behavioral data. Aggregated group data, descriptive statistics, and parametric statistical analysis were utilized and reported with means and standard deviations on tables.

Performance site. The research was conducted in the public school setting through normal educational practices. The study procedures did not interfere with the normal educational practices of the public school and did not involve coercion or discomfort of any kind. Data were stored on spreadsheets and computer flash drives for statistical analysis in the office of the primary researcher and the dissertation chair. Data and computer files were kept in locked file cabinets. No individual identifiers were attached to the data.

Institutional Review Board (IRB) for the protection of Human Subjects

Approval Category. The exemption categories for this study were provided under 45CFR.101(b) category 4. The research was conducted using routinely collected archival data. A letter of support from the district was provided for University of Nebraska Medical Center/University of Nebraska at Omaha Joint Institutional Review Board review.

Chapter 4

Results

Purpose of the Study

The purpose of the study was to determine the effect of pacing and scheduling of algebra coursework on assigned 9th-grade students who traditionally would qualify for pre-algebra instruction and same course 9th-grade students who traditionally would qualify for standard algebra instruction, on all students' math PLAN test scores, algebra common summative assessments (CSAs), geometry CSAs, fall grade point averages (GPAs) and spring GPAs.

Research Question #1

Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one-year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their beginning pretest 9th-grade EXPLORE math percentile score converted to normal curve equivalent score and ending posttest 10th-grade PLAN math percentile score converted to normal curve equivalent score following participation in algebra class utilizing different scheduling models?

The first hypothesis was tested using a repeated measures two way Analysis of Variance (ANOVA) test. Data is displayed in Table 4, Table 5 and Table 6. There was no statistically significant main effect for standardized test (9th-grade EXPLORE/10thgrade PLAN), $F(1, 61) = 2.15$, $p = .15$. There was no significant interaction between test scores and algebra $F(2, 61) = .82$, $p = .45$. There was a significant main effect for algebra group, $F(2, 61) = 3.55$, $p = .04$.

The statistically significant main effect for algebra group indicated that students in the two-year, one-period group (*M* = 53.30, *SD* = 10.14) and students in the one-year, one-period group (*M* = 51.98, *SD* = 10.86) had significantly higher EXPLORE scores than students in the one-year, two-period group (*M* = 43.05, *SD* = 11.05). There was no significant difference among groups on the PLAN scores. Means and standard deviations are displayed in Table 7 and ANOVA results are displayed in Table 8.

Research Question #2

Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average algebra CSA scores?

The second hypothesis was tested using a single classification Analysis of Variance (ANOVA) to determine the main effect between average Algebra 1 Common Summative Assessment (CSA) averages and scheduling model. Data is displayed in Table 9. There was a significant effect of algebra scheduling on Algebra 1 CSA scores at the $p < .05$ level for the three groups ($F(2, 61) = 10.31$, $p < .001$). Post hoc comparisons indicate that the mean score for students in the two-year, one period group (*M* = 16.95, *SD* = 1.28) was significantly lower than the mean score for students in the one-year, one period group (*M* = 18.53, *SD* = .98) and students in the one-year, two periods (*M* = 18.26, *SD* = 1.18). Means and standard deviations are listed in Table 10. ANOVA results are displayed in Table 11.

Research Question #3

Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day have ending congruent or different average geometry CSA scores?

The third hypothesis was tested using a single classification Analysis of Variance (ANOVA) to determine the main effect between average Geometry Common Summative Assessment (CSA) averages and scheduling model. Data is displayed in Table 12. There was a significant effect of algebra scheduling on Geometry CSA scores at the $p < .05$ level for the three groups, $F(2, 61) = 7.74$, $p = .001$. Post hoc comparisons indicate that the mean score for students in the one-year, two period group (*M* = 15.57, *SD* = 2.44) was significantly lower than the mean score for students in the one-year, one period group (*M* = 17.60, *SD* = 1.29). Means and standard deviations are listed in Table 13. ANOVA results are displayed in Table 14.

Research Question #4

Did students who completed a first-year algebra course by the end of the 9th-grade over the period two years receiving instruction one period per school day, students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction one period per school day, and students who completed a first-year algebra course by the end of the 9th-grade over the period of one year receiving algebra instruction two periods per school day lose, maintain, or improve their fall semester 9th-grade cumulative GPA compared to their spring semester 9th-grade cumulative GPA following participation in algebra class utilizing different scheduling models?

The pretest-posttest hypothesis was tested using a repeated measures two way Analysis of Variance (ANOVA) test. Data is displayed in Table 15, Table 16 and Table 17. There was no statistically significant main effect for time (Fall GPA/Spring GPA), $F(1, 61) = 0.18$, $p = .68$. There was no significant interaction between time (Fall GPA/Spring GPA) and algebra group, $F(1, 61) = 2.62$, $p = .08$. There was a significant main effect for algebra group $F(1, 61) = 4.63$, $p = .01$. Means and standard deviations are displayed in Table 18. ANOVA results are displayed in Table 19.

The statistically significant main effect for algebra group indicated that students in the one-year, one period group ($M = 3.16$, $SD = .49$) had significantly higher fall GPAs than students in the one-year, two periods group ($M = 2.72$, $SD = .58$). Students in the one-year, one period group ($M = 3.25$, $SD = .40$) also had significantly higher spring GPAs than students in the one-year, two periods group ($M = 2.73$, $SD = .62$).

Table 1

Demographic Information of 9th-Grade Students Who Completed a First-Year Algebra Course Over the Period Two Years Receiving Instruction One Period per School Day

	Race	Gender
1.	Hispanic	Male
2.	Caucasian	Male
3.	Caucasian	Male
4.	Caucasian	Male
5.	African American	Male
6.	Caucasian	Male
7.	Caucasian	Male
8.	Caucasian	Female
9.	Caucasian	Male
10.	Caucasian	Male
11.	Caucasian	Male
12.	Caucasian	Female
13.	Caucasian	Female
14.	Caucasian	Female
15.	Caucasian	Female

Table 2

Demographic Information of Individual 9th-Grade Students Who Completed a First-Year Algebra Course Over the Period of One Year Receiving Instruction One Period per School Day

	Race	Gender
1.	Caucasian	Male
2.	Caucasian	Female
3.	Caucasian	Male
4.	Caucasian	Female
5.	Caucasian	Male
6.	Caucasian	Female
7.	Hispanic	Male
8.	African American	Female
9.	Caucasian	Female
10.	Caucasian	Female
11.	Caucasian	Female
12.	Caucasian	Male
13.	Caucasian	Male
14.	Caucasian	Female
15.	Caucasian	Male
16.	Caucasian	Female
17.	Caucasian	Female
18.	Caucasian	Male
19.	Caucasian	Male
20.	Caucasian	Female
21.	Caucasian	Female
22.	Asian	Male
23.	Caucasian	Female
24.	Caucasian	Female
25.	Caucasian	Female
26.	Caucasian	Female
27.	Caucasian	Female
28.	Asian	Female
29.	Caucasian	Male
30.	Caucasian	Male

Table 3

Demographic Information of 9th-Grade Students Who Completed a First-Year Algebra Course Over the Period of One Year Receiving Instruction Two Periods per School Day

	Race	Gender
1.	Caucasian	Male
2.	Caucasian	Male
3.	Caucasian	Male
4.	Caucasian	Female
5.	Caucasian	Female
6.	Caucasian	Female
7.	Caucasian	Male
8.	Caucasian	Male
9.	Hispanic	Male
10.	Caucasian	Female
11.	Hispanic	Male
12.	African American	Female
13.	Caucasian	Female
14.	Caucasian	Male
15.	Caucasian	Male
16.	Caucasian	Female
17.	Caucasian	Male
18.	Caucasian	Female
19.	Caucasian	Male

Table 4

EXPLORE Pretest and PLAN Posttest Math Percentile Scores Converted to Normal Curve Equivalent Scores for Individual 9th-Grade Students in the Two-Year, One-Period Group

	EXPLORE Pretest Math		PLAN Posttest Math	
	Explore Percentile Score	Explore NCE Score	PLAN Percentile Score	PLAN NCE Score
1.	63	56.99	48	48.94
2.	81	68.49	86	72.75
3.	74	63.55	37	43.01
4.	63	56.99	48	48.94
5.	29	38.35	3	10.39
6.	74	63.55	91	78.24
7.	74	63.55	66	58.69
8.	40	44.66	57	53.71
9.	63	56.99	57	53.71
10.	52	51.06	57	53.71
11.	63	56.99	73	62.91
12.	63	56.99	79	66.98
13.	29	38.35	57	53.71
14.	29	38.35	57	53.71
15.	40	44.66	73	62.91

Table 5

EXPLORE Pretest and PLAN Posttest Math Percentile Scores Converted to Normal Curve Equivalent Scores for Individual 9th-Grade Students in the One-Year, One-Period Group

	EXPLORE Pretest Math		PLAN Posttest Math	
	Explore Percentile Score	Explore NCE Score	PLAN Percentile Score	PLAN NCE Score
1.	52	51.06	57	53.71
2.	63	56.99	79	66.98
3.	74	63.55	73	62.91
4.	63	56.99	48	48.94
5.	52	51.06	18	30.72
6.	74	63.55	37	43.01
7.	97	89.61	73	62.91
8.	29	38.35	48	48.94
9.	63	56.99	89	75.83
10.	63	56.99	48	48.94
11.	63	56.99	79	66.98
12.	52	51.06	48	48.94
13.	29	38.35	48	48.94
14.	40	44.66	48	48.94
15.	29	38.35	37	43.01
16.	52	51.06	3	10.39
17.	52	51.06	48	48.94
18.	52	51.06	57	53.71
19.	52	51.06	86	72.75
20.	52	51.06	57	53.71
21.	74	63.55	48	48.94
22.	40	44.66	48	48.94
23.	29	38.35	66	58.69
24.	40	44.66	37	43.01
25.	81	68.49	73	62.91
26.	29	38.35	37	43.01
27.	52	51.06	57	53.71
28.	40	44.66	73	62.91
29.	52	51.06	57	53.71
30.	40	44.66	73	62.91

Table 6

EXPLORE Pretest and PLAN Posttest Math Percentile Scores Converted to Normal Curve Equivalent Scores for Individual 9th-Grade Students in the One-Year, Two-Periods Group

	EXPLORE Pretest Math		PLAN Posttest Math	
	Explore Percentile Score	Explore NCE Score	PLAN Percentile Score	PLAN NCE Score
1.	15	28.17	27	37.09
2.	40	44.66	48	48.94
3.	63	56.99	66	58.69
4.	52	51.06	48	48.94
5.	52	51.06	48	48.94
6.	40	44.66	66	58.69
7.	11	24.17	11	24.17
8.	29	38.35	27	37.09
9.	40	44.66	66	58.69
10.	40	44.66	48	48.94
11.	21	33.02	83	70.09
12.	21	33.02	48	48.94
13.	40	44.66	27	37.09
14.	11	24.17	37	43.01
15.	63	56.99	83	70.09
16.	29	38.35	27	37.09
17.	40	44.66	48	48.94
18.	74	63.55	48	48.94
19.	52	51.06	48	48.94

Table 7

Descriptive Statistics for EXPLORE AND PLAN NCE Scores

	EXPLORE Pretest Math		PLAN Posttest Math	
	M	*SD*	*M*	*SD*
Two-year, one period (n = 15)	53.30	10.14	54.82	15.47
One-year, one period (n = 30)	51.98	10.86	52.60	12.71
One-year, two periods (n = 19)	43.05	11.05	48.60	11.52
Total (N = 64)	49.64	11.44	51.93	13.08

Table 8

Consistency of NCE Scores for Algebra Students in Different Scheduling Groups

Source of Variation	*df*	*MS*	*F*	*p*	*d*
Between Subjects					
Algebra Group	2	348.40	3.59	.04	.19
Error	61	98.17			
Within Subjects					
Test Scores	1	387.03	2.145	.15	ns
Test Scores *Algebra Group	2	147.07	.82	.45	ns
Error	61	180.15			

Table 9

Algebra 1 Common Summative Assessment Score Averages

	Two-Year, One-Period	One-Year, One-Period	One-Year, Two-Periods
1.	17.00	18.75	18.50
2.	16.50	19.75	18.75
3.	15.50	17.50	18.50
4.	18.25	16.75	19.00
5.	16.00	18.00	18.25
6.	14.25	19.50	19.25
7.	15.50	18.75	19.00
8.	19.00	19.50	17.25
9.	16.75	19.25	17.50
10.	18.25	18.50	17.50
11.	17.00	19.50	19.00
12.	16.75	18.25	17.25
13.	18.25	18.00	19.75
14.	17.50	18.75	19.00
15.	17.75	18.50	18.00
16.		17.75	15.00
17.		18.25	18.75
18.		20.00	20.00
19.		19.00	16.75
20.		17.00	
21.		18.75	
22.		15.50	
23.		18.75	
24.		18.75	
25.		19.00	
26.		19.50	
27.		19.50	
28.		18.25	
29.		17.50	
30.		19.00	

Table 10

Descriptive Statistics for Algebra 1 Common Summative Assessment Averages

	Sum	*M*	*SD*
Two-year, one period (N = 15)	254.25	16.95	1.28
One-year, one period (N = 30)	555.75	18.53	0.98
One-year, two periods (N = 19)	347	18.26	1.18
Total (N = 64)	1157	18.08	1.27

Table 11

ANOVA for Consistency of Algebra 1 Common Summative Assessment Averages

Source of variation	*SS*	*df*	*MS*	*F*	*p*
Between Groups	25.731	2	12.87	10.31	< .001
Within Groups	76.128	61	1.248		
Total	101.859	63			

Table 12

Geometry Common Summative Assessment Score Averages

	Two-year, one-period	One-year, one-period	One-year, two-periods
1.	12.25	17.25	15.50
2.	18.00	17.75	15.50
3.	17.00	18.00	16.00
4.	18.00	19.25	17.50
5.	16.50	15.50	16.50
6.	18.00	17.75	16.75
7.	15.50	17.50	14.25
8.	18.25	14.25	8.75
9.	16.50	17.25	19.50
10.	18.50	17.00	17.25
11.	15.75	19.50	14.25
12.	18.00	18.00	17.00
13.	16.75	19.25	15.00
14.	16.75	15.75	12.25
15.	16.50	18.50	13.75
16.		18.25	14.00
17.		16.00	17.75
18.		16.50	18.50
19.		18.50	15.75
20.		18.75	
21.		18.25	
22.		16.00	
23.		17.25	
24.		18.00	
25.		20.00	
26.		16.75	
27.		19.00	
28.		17.50	
29.		17.25	
30.		17.50	

Table 13

Descriptive Statistics for Geometry Common Summative Assessment Averages

	Sum	*M*	*SD*
Two-year, one-period (N = 15)	252.25	16.82	1.57
One-year, one-period (N = 30)	528.00	17.60	1.29
One-year, two-periods (N = 19)	295.75	15.57	2.44
Total (N = 64)	1076.00	15.57	1.94

Table 14

ANOVA for Consistency of Geometry Common Summative Assessment Averages

Source of variation	*SS*	*df*	*MS*	*F*	*p*
Between Groups	48.14	2	24.07	7.74	.001
Within Groups	189.61	61	3.11		
Total	237.75	63			

Table 15

Semester Grade Point Averages for Individual 9th-Grade Students in the Two-Year, One-Period Group

	Fall GPA	Spring GPA
1.	2.33	1.83
2.	3.67	3.43
3.	2.57	2.86
4.	3.33	3.57
5.	4.00	3.67
6.	1.86	1.86
7.	2.00	2.50
8.	3.43	3.50
9.	3.50	2.86
10.	3.71	3.14
11.	3.33	3.33
12.	2.00	1.83
13.	3.60	2.86
14.	3.86	3.67
15.	3.29	3.43

Table 16

Semester Grade Point Averages for Individual 9th-Grade Students in the One-Year, One-Period Group

	Fall GPA	Spring GPA
1.	3.14	3.33
2.	3.33	3.50
3.	1.71	2.33
4.	3.00	3.29
5.	3.50	3.50
6.	3.57	3.43
7.	2.57	2.57
8.	2.67	3.00
9.	3.29	3.86
10.	2.57	2.43
11.	3.33	3.29
12.	3.33	3.67
13.	3.50	3.71
14.	3.14	2.86
15.	3.17	3.43
16.	2.29	2.57
17.	3.86	3.57
18.	3.71	3.50
19.	2.86	3.00
20.	3.33	3.33
21.	3.50	3.29
22.	2.86	3.14
23.	3.29	3.33
24.	3.86	3.83
25.	3.86	3.43
26.	3.00	3.57
27.	3.67	3.57
28.	3.29	3.17
29.	3.00	2.86
30.	2.67	3.00

Table 17

Semester Grade Point Averages for Individual 9th-Grade Students in the One-Year, Two-Periods Group

	Fall GPA	Spring GPA
1.	2.00	2.50
2.	2.29	2.17
3.	2.43	1.86
4.	2.83	2.86
5.	3.33	3.17
6.	3.71	3.86
7.	2.83	2.14
8.	1.50	1.50
9.	3.00	3.17
10.	2.57	3.14
11.	2.57	3.00
12.	3.00	3.00
13.	3.14	3.14
14.	2.71	2.71
15.	2.71	2.57
16.	1.67	2.00
17.	3.00	3.00
18.	3.67	3.71
19.	2.67	2.29

Table 18

Descriptive Statistics for Grade Point Averages

	Fall GPA		Spring GPA	
	M	*SD*	*M*	*SD*
Two-year, one-period (n = 15)	3.10	.74	2.96	.67
One-year, one-period (n = 30)	3.16	.49	3.25	.40
One-year, two-periods (n = 19)	2.71	.58	2.73	.62
Total (N = 64)	3.02	.61	3.02	.58

Table 19

Consistency of GPAs for Algebra Students in Different Scheduling Groups

Source of Variation	*df*	*MS*	*F*	*p*	*d*
Between Subjects					
Algebra Group	2	2.71	4.63	.01	.01
Error	61	.58			
Within Subjects					
GPA	1	.01	.18	.68	ns
GPA *Algebra Group	2	.13	2.62	.08	ns
Error	61	.05			

Chapter 5

Conclusions and Discussions

Purpose of the Study

The purpose of the study was to determine the effect of pacing and scheduling of algebra coursework on assigned 9th-grade students who traditionally would qualify for pre-algebra instruction and same course 9th-grade students who traditionally would qualify for standard algebra instruction, on all students' math PLAN test scores, algebra common summative assessments (CSAs), geometry CSAs, fall grade point averages (GPAs) and spring GPAs.

Conclusions

The following conclusions were drawn from the study for each of the four research questions.

Research Question #1

Research question #1 was used to analyze student achievement as measure by the EXPLORE and PLAN tests during the students' 9th and 10th-grade years. The EXPLORE test was administered during the fall of their 9th-grade year. The PLAN test was administered during the fall of their 10th-grade year. Both tests are norm referenced test written by ACT in order to measure student progress in math, science, reading, and English.

Students in the two-year, one-period group and the one-year, one-period group had similar EXPLORE test scores. The students in the one-year, two-periods group had significantly lower scores than the other two groups.

While all groups experienced an increase in NCE scores from their 9th-grade EXPLORE test to their 10th-grade PLAN test, the difference was not statistically significant. The one-year, two-period group showed the greatest improvement.

Posttest PLAN test math scores were not significantly different among the three groups. The two-year, one period group has the highest scores of the three groups, followed by the one-year, one-period group. The lowest scores were earned by the one-year, two-periods group. The overall average of the three groups also showed a slight, but not statistically significant, improvement.

Research Question #2

Research question #2 was used to analyze algebra achievement as measured by district common summative assessments (CSAs). Students completed four algebra CSAs. The mean of the four CSAs were analyzed for differences among the three groups.

Students in the two-year, one period group scored significantly lower than the mean score for students in the one-year, one period group and students in the one-year, two periods. Although, they had an earlier start with algebra instruction, they did not have higher algebra CSA scores.

Students in the one-year, one period group had slightly higher scores than students in the one-year, two-periods group. The difference was not statistically significant.

Research Question #3

Research question #3 was used to measure growth in mathematics as measured by geometry district CSAs. Students completed four CSAs. The mean of the four were analyzed for differences among the three groups. It should be noted that all students received one period of geometry instruction, over a period of one year. While some of the students in all three groups were in an honors level class, the assessments were the same.

Students in the one-year, one-period group had the highest average, followed by students in the two-year, one-period group. The lowest average was earned by the students in the one-year, two-periods group. The only difference that was statistically significant was the difference between the one-year, one-period group and the one-year, two-periods group.

Research Question #4

Research question #4 was used to measure student growth in grade point average (GPA) from the fall semester to the spring semester. All classes on a student's transcript were included into the GPA. Honors classes were given the same weight as non-honors classes.

Statistical analysis showed that students in the one-year, one-period group had statistically significant higher GPAs than students in the one-year, two-periods group during both the fall and spring semesters of the students' 9th-grade year.

While none of the groups made a statistically significant change from the fall semester to the spring semester, the students in the one-year, one-period group and the students in the one-year, two-periods group had higher spring GPAs than fall GPAs. The students in the two-year, one-period group had lower spring GPA than fall GPA.

Discussion

This study was conducted to determine the effects of scheduling models for a first year algebra course on academic achievement. This exploratory study focused on students who completed a first-year algebra course by the end of their 9th-grade year. The students of the study completed 9th-grade during the 2008 – 2009 school year.

Two-Year, One-Period. The students in this group were identified by teachers, through a placement exam and course grades during their 6th-grade grade year, to take a pre-algebra course during 7th-grade. At the end of 7th-grade, they were identified, in a similar manner, to be unready for a one-year, one-period first-year algebra course during 8th-grade. As a result, they were placed into the two-year, one-period course.

The first year of the two-year, one-period course was taught in a middle-school during the students' 8th-grade year. The second year was taught in a high school during the students' 9th-grade year. The students in this group received instruction from two different teachers using the same district curriculum for the Algebra 1 course.

While they did outscore the other two groups on the norm referenced tests, they did not have the highest scores on the district CSAs. They also did not have the highest GPAs. From this group, 79% (15 of 19), completed honors geometry. It was also found that 56% (10 of 18), completed an honors level of the second year algebra course.

One-Year, One-Period. The students in this group completed a two-year pre-algebra course during their 7th and 8th-grade years. At the end of 8th-grade, they were recommended to take a traditional one-year, one period Algebra 1 course in 9th-grade. While this track would not put them in a position to complete calculus in high school, it would allow them to complete a math course after a second-year algebra course.

These students outperformed the other two groups on district CSAs and had higher GPAs. It should also be noted that 67% (20 of 30) completed Honors Geometry and 59% (17 of 29) completed Honors Algebra 2.

One-Year, Two-Periods. The students in this group were identified by their 8th-grade teacher as needing additional support, but able to complete a first-year algebra course over the period of one year. It was concluded that they did not need to take a slower-paced two-year course.

The students in this group received instruction during two consecutive class periods. There were two teachers, both certified in mathematics, co-teaching the class. One of the teachers was also the instructor of the one-year, one period group.

This group scored lower than both groups on norm referenced standardized tests, geometry CSAs and had lower GPAs than the other two groups. They did have higher algebra CSA averages than the two-year, one period group. From this group, 32% (6 of 19) completed Honors Geometry, while 26% (5 of 19) completed Honors Algebra 2. This is lower than the other two groups.

Had this option not been available, the students would have either been placed in a traditional one-year, one period first year algebra course or a two-year, one period slow paced first year algebra course. The first option would give them an opportunity to take an upper level math course that would help prepare them for college. The second choice would have placed them on a track that would leave them unprepared for college entrance exams as well as the ACT or SAT college preparatory exams.

Implications for Practice.

High schools have stopped offering courses that would serve as a prerequisite to a first-year algebra course.   It is more common to see math offerings starting with Algebra 1. As a result of this, math teachers are going to encounter more and more students who are unprepared for algebra. Many students will be entering high school with math skills that are far below grade level (Bracey, 2008). Classroom practices will need to change to accommodate the needs of these students. Teachers will need to focus more on the main concepts of algebra and less on finishing an entire text book (Choike, 2000). By teaching material at a deeper level, students will be able to make the connections from prior lessons to current lessons. They will also be able to retain information, even after the test.

Another hint from Choike in order to improve algebra understanding is to use numbers that are more easily understandable for students. While teaching algebra with integers may not be as real world as the decimals seen on price tags, this practice will help keep students from focusing on just the decimal. They will be able to focus on the concept and not the fact that their computational skills are weak (2000).

Online programs such as Apex and PLATO offer a non-traditional route to algebra credit, but these options do not have to be stand-alone instruction. When used a supplement to traditional classroom instruction, students will be given an opportunity to master concepts (Fratt, 2006). This can be done as part of a teacher's classroom plans, or this could be available to students during a study hall or unscheduled period of the school day.

A traditional lecture classroom often does not provide the differentiation necessary for all students. Integrating more technology into an algebra classroom may also help struggling students. Technology can help students make the conjectures often given to them by the teachers. It can help students discover the rationale behind theorems and formulas they were once only memorizing (Pugalee, 2001).

Starting conversations about algebra in upper elementary grades and middle school grades would also be helpful in preparing students for Algebra 1. In order to fully prepare students for the course, algebraic concepts need to be introduced in the lower grades. These concepts can be introduced as early as third or fourth grade (Vogel, 2008). Algebraic concepts can be introduced while also teaching students basic computational skills. Elementary and middle school curriculum will need to change in order to fully prepare students to be successful.

Collaboration between teachers is critical in helping struggling students. Teachers should share strategies, assessments, and lessons. They should discuss the results of their practices and brainstorm together (Flores & Roberts, 2008). They should be familiar with standards and use those to drive their lessons. The textbook will become a tool, not a driving force for their lessons.

Implications for Policy

More and more states and schools are moving to a requirement of completion of algebra for graduation. Supports will need to be in place for struggling students. There are many options available. The results of this study indicate that making changes to the master schedule of a traditional seven or eight-period day in order to offer a two-period block class is not necessary. Other policies can be implemented in schools in order to help students achieve success in a first-year algebra course.

Credit recovery programs such as PLATO and Apex offer an online format for students. Bay-Arenac Career Center, in Bay City, Michigan, found success in a non-traditional summer-school, credit recovery program that utilized both teacher-led instruction and technology (Geno, 2010). Students were presented with material from the teacher. From there, they rotated to different stations. Some stations had students practice the material in a traditional paper-pencil fashion. Other stations had students practicing lessons utilizing web-sites identified by the teachers to help students master the skills (2010).

Students who feel an affiliation to other students have been found to have higher algebra achievement than those who feel invisible and/or alone (Nichols & White, 2001). Schools are no longer only responsible for building students' knowledge foundations. Peer groups can strongly influence academic achievement. Schools need to be proactive and well aware of the different groups present in a school. They need to be aware of students with little to no peer affiliations and find programs to meet the needs of these students.

It should be noted that the research school is no longer offering a one-year, two periods course for students. This change was made for personnel and master scheduling reasons. The research district continues to offer the two-year one period course that starts in 8th-grade, along with the one-year, one period course for 9th-grade students. A two-year, one period course starting in 9th-grade is also available to students.

Implications for Research

The results of this study indicate the need for further research. It is evident that students are entering 9th-grade unprepared for algebra. Further research could focus on curriculum development and instructional practices at the lower grade levels to ensure that more students are ready for algebra by the time they enter 9th-grade.

Other research could focus on the students who completed a first-year algebra course over the period of two years receiving algebra instruction one period per school day during their 9th-grade and 10th-grade years. In order to open the doors of upper level math courses, students need to complete Algebra 1 by the end of 9th-grade. There are a large number of students in the research school who are in this slower track. Further research investigating strategies to help these students get back on track would be helpful in giving these students the opportunity to take upper level math courses.

Finally, the results of this study indicated that scheduling and time were not major factors in algebra achievement. Further research focusing on curriculum development and instructional practices for a traditional one-period, one year algebra course would be helpful. This would provide the research school and the teachers in that school with methods and strategies to help all students achieve algebra success within the constraints of a traditional seven or eight period day.

References

A Nation at Risk. (April 1983). Retrieved from The United States Department of Education website: http://www.ed.gov/pubs/NatAtRis/index.html

Achieve. (2008). The building blocks of success. Retrieved from http://www.achieve.org/files/BuildingBlocksofSuccess.pdf

Allen, A. (2000). Algebra in the middles school? Yes, and here's how to start! *Mathematics Education Dialoges*, 3(2), 6.

Allensworth, E., Nomi, T., Montgomery, N., & Lee, V. (2009). College preparatory curriculum for all: Academic consequences of requiring algebra and English I for ninth graders in Chicago. *Educational Evaluation and Policy Analysis*, 31 (4), 367 – 391.

Bagwell, S. (2000). No! Not algebra. *Mathematics Education Dialoges*, 3(2), 9.

Begg, A. (2000). Algebra in an integrated approach to mathematics. *Mathematics Education Dialoges*, 3(2), 11.

Bracey, G. (2009a). Algebra redux. *Principal Leadership (High School Ed.)*, 9(6), 60.

Bracey, G. (2009b). Over their heads, out of their league. *Principal Leadership (High School Ed.)*, *9*(5), 56-8.

Bracey, G. (2008). The algebra hoax. *Phi Delta Kappan*, 90(4), 306-07.

Carver, C., Steele, M., & Herbel-Eisenmann, B. (2010). Principal + algebra (-fear) = Instructional leadership. *Journal of Staff Development*, 31(5), 30 – 33.

Checkley, K. (2001). Algebra and activism: Removing the shackles of low expectations. A conversation with Robert P. Moses. *Educational Leadership*, 59(2), 6 – 11.

Choike, J. (2000). Teaching strategies for "Algebra for all". *Mathematics Teacher*, *93*(7), 556-60.

Edwards, T. (2000). Some "big ideas" of algebra in the middle grades. *Mathematics Teaching in the Middle School*, *6*(1), 26-31.

Flores, S, & Roberts, W. (2008). Productive strategies for raising student achievement in algebra. A personal view from two high school principals. *NASSP Bulletin*, 92(4), 305 – 315.

Fratt, L. (2006). Algebra's at-risk solution. (Cover story). *District Administration*, *42*(10), 58-63.

Geno, J. (2010). Achieving Academic Success in Algebra. *Academic Leadership*, 8(4). Retrieved from OmniFile Full Text Select database

Hill, C. (2010). When traditional won't do: Experiences from a "lower-level' mathematics classroom. *The Clearing House*, 83(10), 239 – 243.

Hodges, K. (2000). Making high school algebra accessible to all. *Mathematics Education Dialoges*, 3(2), 8.

Howell, M. (2000). Rising to the CAS challenge. *Mathematics Education Dialoges*, 3(2), 10.

Jacobson, L. (2008). California board mandates algebra 1 for all 8th graders. *Education Week*, *27*(43), 19.

Kress, H. (2005). Math as a civil right: Social and cultural perspectives on teaching and teacher education. *American Secondary Education*, *34*(1), 48-56.

Loughran Peele, L. (1998). Double dose: A viable instructional alternative. *NASSP Bulletin*, 82(2), 111-114.

Loveless, T. (2008). *The 2008 Brown Center report on American eduation: The misplaced math student: Lost in eighth-grade algebra*. Retrieved August 15, 2010, from http://www.brookings.edu/reports/2008/0922_education_loveless.aspx

Malloy, C., & Malloy, W. (1998). Resiliency and algebra 1: A promising non-traditional approach to teaching low-achieving students. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas,* 71 (5), 314 – 317.

Matsumoto, T. (2000). Demanding more from middle-level mathematics? *Mathematics Education Dialoges*, 3(2), 7.

McKibben, S. (2009). Should all 8th graders take algebra? *The Education Digest*, *74*(7), 62-4.

Morgatto, S. (2008). Should all students be required to take algebra? Are any two snowflakes alike? *The Clearing House*, *81*(5), 215-17.

Nichols, J., & White, J. (2001). Impact of peer networks on achievement of high school algebra students. *The Journal of Educational Research* 94(5), 267 – 273.

Noddings, N. (2000). Algebra for all? Why? *Mathematics Education Dialoges*, 3(2), 2.

Pugalee, D. (2001). Algebra for all: the role of technology and constructivism in an algebra course for at-risk students. *Preventing School Failure*, *45*(4), 171-6.

Rettig, M., & Canady, R. (1998). High failure rates in required mathematics courses: Can a modified block schedule be part of cure? *NASSP Bulletin*, 82, 56 – 65.

Salvia, J., & Ysseldyke, J. E. (2004). *Assessment* (9th Ed.) Boston: Houghton Mifflin Company.

Seeley, C. (2004). 21st Century mathematics. *Principal Leadership (High School Ed.)*, *5*(2), 22-6

Slosson, J. (2004). When 2 + 2 doesn't equal four. *Principal Leadership (High School Ed.)*. 5(2), 45 – 48.

Spielhagen, F. (2006). Closing the achievement gap in math: Considering eighth grade algebra for all students. *American Secondary Education*, 34(3), 29-42.

Vogel, C. (2008). Algebra: Changing the equation. *District Administration*, 44(6), 34 – 38, 40.