A STUDY OF BLOCK SCHEDULING AND INSTRUCTIONAL STRATEGIES AND THEIR INFLUENCE ON ALGEBRA ACHIEVEMENT IN CLASSROOMS THROUGHOUT NORTH CENTRAL TEXAS

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The purpose of this study was to evaluate the influence of block scheduling and instructional strategies on student achievement in Algebra I. The study was conducted during the 1997-98 school year. This study was comprised of two components, a quantitative study and a qualitative study. The quantitative study focused on block and traditional scheduling and the influence identified through scores on the Texas End-of-Course exam for Algebra I. The sample for this study consisted of 59 school districts from five counties in the north Texas area. The qualitative portion of this study focused on 10 classrooms, 5 block and 5 traditional, taken from the sample of 59 districts. Data for the qualitative study included questionnaires, interviews, and observations. The End-of-Course scores were analyzed using an ANOVA at the .05 level of significance, no significant difference was identified in the achievement levels of the two groups. The qualitative data was

organized by categories derived from the NCTM teaching standards. Data from this portion of the study indicated that teachers in both block and traditionally scheduled classes spend their class time in a similar manner, using similar materials, and using more traditional strategies. Additional analyses of data based upon usage of the graphing calculator and manipulatives also resulted in no significant difference. Although all comparisons between block and traditional scheduling and usage or non-usage of technology and/or manipulatives resulted in no significant difference, the block groups and those using technology and/or manipulatives had higher mean scores. This indicates that allowing teachers more time to use alternative instructional strategies would benefit the student, but this will not take place without the teacher receiving training and support.

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CHAPTER 1

INTRODUCTION

In Everybody Counts: A Report to the Nation on the future of Mathematics Education, the National Research Council stated, "current mathematical achievement of United States students is nowhere near what is required to sustain our nations leadership in a global technological society, and to participate fully in the world of the future, America must tap the power of mathematics" (1989, p. 1). Over the past two decades, Americans have become increasingly concerned with science and mathematics education. In 1983, A Nation at Risk was published leading to an outcry for a change in the way math and science are taught. Since this publication, more than 300 reports have advocated change in mathematics education (Robin & Fraser, 1991). In an effort to lend direction to the reform effort in mathematics education, the National Council of Teachers of Mathematics (NCTM) published The Curriculum and Evaluation Standards for School Mathematics (1989). The Standards document calls for mathematics educators to develop students' mathematical power, use calculators throughout, and foster active student involvement (NCTM, 1989).

"Our nation is failing to provide a technology infrastructure in education that will enable graduates to compete in the information based economy of the 21st century" (Mills, 1995). The 1994 report of the National Education Commission on Time and Learning states, "Schools will have a design flaw as long as their organization is based on the assumption that all students can learn on the same schedule".

In recent years, dozens of individual reform efforts involving instructional strategies, technology and alternative scheduling, have been initiated (Edwards, 1994). Thus, the purpose of this study was to examine the effect of varied instructional strategies (i.e. manipulatives, graphing calculators, etc.) in traditional and block scheduling formats on student achievement in Algebra I.

<u>Change in Perspective of Mathematics Education</u>

Changing mathematics education in some ways reflects a different view of reform from the perspective held by those interested in restructuring the institution of school (e.g., Apple, 1992; Giroux & McLaren 1989). One way in which the current reform effort in mathematics education differs from the others is that the changes currently being proposed are derived from a philosophical vision that can be considered epistemic in nature. This perspective advocates a change in the nature of the mathematics taught in schools and a different view of what it means to do mathematics - that is, a constructivist view of learning (Wood & Sellers, 1997).

Constructivism is concerned with learning theory and finds its roots in Piaget's development theories (Lerman, 1989). Dewey advocated that learning experiences are best facilitated when the learner is allowed to interact with the environment and, as a result of this interaction, create their own meaning (Glatthorn, 1987). Constructivism is an alternative perspective on learning that informs the principles guiding the current movement for mathematics education reform (Schifter, 1996).

From a psychological point of view, the contention is that students learn mathematics most effectively if they construct meanings for themselves, rather than simply being told (Wood & Sellers, 1997). From a constructivist perspective, leaning mathematics is viewed as a process in which students reorganize their activity to resolve situations found to be personally problematic (von Glaserfeld, 1987). In other words, knowledge is seen as constructive when learning occurs through active participation with the teacher as the guide through the process (Romberg, 1992). In support of this view, a great deal of evidence has shown that children develop an intuitive and informal sense of mathematical concepts and procedures long before they enter school (Groen & Resnick, 1977; Hughes, 1981; Starkey & Gelman, 1982).

Dewey recommends that educators take care to structure experiences in such a way as to heighten the chances that they will be educationally worthwhile (Prawat, 1997). "The idea after it is formed is tested by acting upon it, overtly if possible, otherwise in imagination. The consequences of this action confirm, modify or refute the idea. Without ideas, experiences are undergone but not understood; they become matters of happenstance or chance" (Dewey, 1933). Educators agree that there is a need to capitalize on these ideas and find ways to help students relate them to the formal mathematics taught in school (Wood & Sellars, 1997).

This constructivist philosophy is encouraged by the NCTM through their publications. Learners are free to construct their own understandings by connecting what they already know to new information, building hierarchies of understanding (NCTM, 1989). The National Research Council's report Everybody Counts: A Report to the Nation on the Future of Mathematics Education, documented that students learn mathematics well only when they are allowed to construct their own mathematical understanding (1989). This philosophy is apparent in the NCTM Standards as follows:

> The 9-12 Standards call for a shift in emphasis from a curriculum dominated by memorization of isolated facts and procedures and by proficiency with paper-pencil skills to one that emphasizes conceptual understandings, multiple representations and connections, mathematical modeling and mathematical problem solving.

Change in Instructional Format

Teaching mathematics has been reconceived as the provision of activities designed to encourage and facilitate the constructive process. The mathematics classroom was to become a community of inquiry, a problem-posing and problem-solving environment in which developing an approach to thinking about mathematical issues would be valued more highly than memorizing algorithms and using them to get right answers (Schifter, 1996).

The NCTM published The Professional Standards for Teaching Mathematics in 1991. This document identified four components of teaching mathematics: tasks, discourse, environment and analysis (NCTM, 1991).

A central responsibility of teachers is to develop worthwhile tasks and materials that create opportunities for students to develop these kinds of mathematical understandings, competence, interests, and dispositions

(Lowenberg-Ball & Schroeder, 1992). Task refers to whatever activities in which students are engaged, including the questions they pursue and the ways in which they pursue them - with what tools, in what contexts, and with what goals (NCTM 1991, 25):

> Good tasks are ones that do not separate mathematical thinking from mathematical concepts or skills, that capture student's curiosity, and that invite them to speculate and then pursue their hunches. Many such tasks can be approached in more than one interesting and legitimate way; some have more than one reasonable solution. These tasks, consequently, facilitate significant classroom discourse, for they require that students reason about different strategies and outcomes, weigh the pros and cons of alternatives and pursue particular paths.

Change in Algebra Instruction

Changes in the way students are taught introductory concepts in algebra are part of the mathematics reform movement. Instruction should persistently emphasize doing rather than knowing, and curriculum for all students must provide opportunities to develop an understanding of mathematical models. Structures and simulations should be applicable to many disciplines, and the use of graphing technology should be expanded within the classroom to include both investigations and calculations. Students should have a balanced approach to calculation, be able to choose appropriate procedures, find solutions, and validate those answers (NCTM, 1989).

In the teaching of algebra, one focus for reform is a change from a "generalized arithmetic" approach to one in which knowledge emerges from experience with problems (NCTM, 1989). Research findings from psychology indicate that learning does not occur by passive absorption alone (Resnick, 1987). Instruction should vary and include opportunities for students to apply a particular concept or procedure and have a strong conceptual basis for reconstructing their knowledge at a later time (NCTM, 1989).

With increased emphasis on varied instructional strategies, many educators are researching alternative scheduling formats as a way to provide opportunities for such discourse. One form of alternative scheduling is block scheduling. Block scheduling is not a new phenomenon having been widely used in Canada since the 1970s. In the United States, block schedules have become increasingly popular since the beginning of the mathematics reform efforts. In longer blocks of classroom time, the literature indicated that teaching by lecture alone works less well (King et.

at., 1978; Meadows, 1995; O'Neil, 1995; Reid, 1995; Sturgis, 1995). Researchers suggest including a number of participatory activities during each block period to increase student performance and retention (Kramer, 1996).

Block Scheduling. Surveys of teachers using block schedules present evidence that in general, teachers perceive the longer time blocks as affording an opportunity to teach concepts more in depth. Overall, Kramer found an underlying belief of teachers that under a block schedule, they were able to teach less breadth of content during a given amount of instructional time but were able to investigate topics in more depth (Kramer, 1996). These beliefs have been validated through few empirical research studies.

Many studies have analyzed the academic impact of block scheduling by comparing student's grades under block scheduling with grades under a traditional schedule. Most have reported that grades under a block schedule are higher (King et. al.., 1978; Reid, 1994). Averett (1994) compared geometry and second-year-algebra achievement for students on statewide end-of-course exams. Averett found only an increase of 1.3 % in achievement scores for students on block schedules. Specific studies for first year algebra have not been documented.

Technology. There has been a dramatic shift in the mathematics that students need in this increasingly technological society (National Research Council, 1989). According to *America 2000*, student achievement can be significantly impacted if schools are equipped with up-to-date technology and this technology is utilized to improve student learning (1991). Graphing calculators allow opportunities for hands-on experiences by transforming a math classroom into a lab with students investigating, making conjectures, and verifying findings (NCTM, 1989). Through the use of graphing technology, students are provided opportunities to create their own knowledge through exploration and experimentation as advocated by the NCTM.

The changes proposed by the NCTM are a substantial departure from conventional practice, and considerable evidence suggests that reform of this nature is difficult to translate into action and hard to sustain (Cohen, McLaughlin, and Talbert, 1993; Cuban 1992). Research on the effects of reform efforts in the areas of block scheduling, graphing technology, and *Standards* implementation have been sparse (Garet & Mills, 1995). If block scheduling were implemented with adequate planning time and staff development and with administrative policies that maintained the number of classroom hours allocated to mathematics over a student's high school career, it is possible that achievement would be higher than under a traditional schedule. To date, such an implementation has not been studied (Kramer, 1996). Therefore, it may be that mathematics educators are waiting for solid empirical data determining which instructional strategies coupled with which schedule format is most effective for their mathematics students before implementing these processes within their classrooms. Thus, there is a definite need for research in effective instructional strategies and scheduling alternatives for Algebra I.

Statement of the Problem

The problem of this study was to determine the effect of varied instructional strategies (i.e. manipulatives, graphing calculators, and concrete examples) in traditional and block scheduling formats on student achievement in Algebra I.

Research Questions

1. How are the EOC exam for Algebra I scores from students in Algebra I classes related to block or traditional scheduling?

a. The mean score on the Texas Algebra I End-of-Course exam of the group of all Algebra I students from five counties who have been instructed in a block scheduling format will be significantly higher than the mean score of a group of Algebra I students who were instructed in a traditional scheduling format.

b. The mean score on the Texas Algebra I End-of-Course exam of the group of Algebra I students from the nine campuses who have been instructed in block scheduling format will be significantly higher than the mean score of a group of Algebra I students who were instructed in traditional scheduling format.

2. What are the instructional practices used in the ten sample Algebra I classes? Are there patterns of instructional practices with regard to problem solving, reasoning, connections, and communications? Are the practices the same or different for those using block or traditional scheduling?

3. How are the EOC exam for Algebra I scores from students in the ten Algebra I classes related to differing instructional practices?

a. The mean score on the Texas Algebra I End-of-Course exam of a group of Algebra I students who have utilized the graphing calculator during instruction will be significantly higher than the mean score of a group of Algebra I students who did not utilize the graphing calculator during instruction.

b. The mean score on the Texas Algebra I End-of-Course exam of a group of Algebra I students who utilized models and manipulatives during instruction will be significantly higher than the mean score of a group of Algebra I students who did not utilize models or manipulatives during instruction.

This multi-level study looks at the larger picture of two different forms of scheduling within a selected geographical area, and the smaller picture of what instructional practices are being used in the classrooms of ten teachers within this geographical area. The larger sample includes quantitative analysis of Algebra EOC scores for all students within the five county area in north central Texas. The smaller sample includes qualitative analysis through observations, interviews, and surveys of ten classrooms selected at random from the five county region.

Definitions

1. A block scheduled class is defined as any extended period class (70-90 minutes).

2. A traditional scheduled class is defined as any non-extended period class (45-60 minuets).

Limitations

This study was limited to the five counties in the north central Texas region including Dallas, Denton, Parker, Johnson, and Tarrant counties. Within this larger sample, a smaller sample of ten campuses was selected for classroom observations, interviews, and surveys. The sample of ten classrooms was limited to the five counties selected for the larger sample. The study was also limited to the results from the state administered Algebra I End-of-Course Exam. This exam covers specific objectives from Algebra I and does not specifically address instructional methodologies.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Although some school districts are experiencing increased student outcomes in mathematics, still others are struggling to maintain their current achievement levels. Mathematics achievement is not at an acceptable level due in part to ineffective teaching practices in the mathematics classroom.

"One of the fundamental elements of the improvement of mathematics education is that mathematics teachers find it very difficult to change their teaching strategies" (Steffe, 1990). Researchers in the Second International Study of Mathematics found that mathematics teaching can be characterized by formal, symbolic presentations of mathematical rules or procedures in lecture formats (McKnight, 1987). And, it is this form of instruction that lessens student achievement (Alsup, 1996; Kanai, 1995; Huntington, 1995).

Educators are looking for alternatives to traditional instructional strategies and to traditional scheduling formats. The NCTM suggests mathematical modeling, technology, and constructing one's own knowledge as avenues to the improvement of mathematics education (1989).

According to the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989), one way in which mathematics achievement can be improved is for students to be actively engaged in the creation of their own knowledge. This philosophy is in alignment with Piaget's constructivist view that knowledge is actively created not passively received from the environment (Piaget, 1989). Learners need to be provided opportunities to approach new tasks with prior knowledge, assimilate new information, and construct their own meanings (NCTM, 1989). This construction of knowledge may be attained through problem solving, reasoning, and connections illustrated through the usage of models or manipulatives.

Research also indicates that knowledge can be created through the use of the graphing calculator (Demana & Waits, 1990). The use of the graphing calculator allows students to explore and discover mathematics concepts, to learn advanced concepts earlier in the curriculum, and to observe and discover relationships between functions in graphic representations (Wilkins, 1995). According to the National Council of Teachers of Mathematics, the graphing calculator is a powerful tool to enhance understanding of algebraic concepts and in turn possibly raise achievement scores in mathematics (1989).

Seeking better instruction and improved student outcomes, a number of educators are exploring alternatives to the traditional schedule. With longer periods of time devoted to each subject, block schedules can be a catalyst for classroom innovation. Under an alternative scheduling format, a wider variation of activities can be used, such as cooperative learning, hands-on projects, and other strategies aimed at encouraging student involvement (O'Neil, 1995).

Since this study investigates the use of instructional strategies which enhance student's understanding in Algebra I, the review of literature will be divided into three sections: teaching mathematics with the graphing calculator, teaching mathematics with other alternative instructional strategies and materials, and use of alternative scheduling to support instructional and curricular change.

Teaching Mathematics with the Graphing Calculator

Use of the graphing calculator in the mathematics curriculum is thought to develop problem solving and exploration of concepts. "All recent national reports on school mathematics have recommended the incorporation of calculators and computer technology into the study of mathematics" (Usiskin, 1993, p. 18). At the national level, the National Council of Teachers of Mathematics has emphasized the usage of technology within the mathematics classroom. According to the NCTM standards (1989, p. 126), three topics should receive increased attention:

- The use of real world problems to motivate and apply theory.
- The use of computer utilities to develop conceptual understanding.
- Computer-based methods and graphing utilities for solving equations and inequalities.

The Standards foster conceptual mathematical learning and relate it to multiple representations of the graphing calculator:

> The 9-12 standards call for a shift in emphasis from a curriculum dominated by memorization of isolated facts and procedures and by proficiency with paper-and-pencil skills to one that emphasizes conceptual understanding, multiple representations and connections, mathematical modeling, and mathematical problem solving. The

integration of ideas from algebra to geometry is particularly strong, with graphical representation playing a connecting role. Thus, frequent reference to graphing utilities will be found throughout these standards (1989, p. 125).

One of the five main competencies presented in the Secretaries Commission on Achieving Necessary Skills (SCANS) is working with various technologies. "Technology today is everywhere, demanding high levels of competence in selecting and using appropriate technology, visualizing operations, using technology to monitor tasks, and maintaining and troubleshooting complex equipment" (Dept. of Education, 1991, p. 13).

At the state level, the Texas State Board of Education is in the process of implementing new essential knowledge and skills for mathematics. The 1998 adoption of the Texas Essential Knowledge and Skills (TEKS) for Algebra I state:

> "Techniques for working with functions and equations are essential in understanding underlying relationships. Students use a variety of representations (concrete, numerical, algorithmic, graphical), tools and technology, including but not limited to powerful and accessible hand-held calculators with graphing capabilities and model

mathematical situations to solve meaningful problems" TEA,1996).

Research has generally found little or no significant differences in overall performance for algebra students using graphing calculators compared to traditional or non-calculator classes (Scott, 1994; Tolias, 1993). However, when performance is divided into levels of procedural and conceptual learning, significant differences occur at the conceptual level (Tolias, 1993). Procedural knowledge refers to the "familiarity with the symbolic representation system and rules, algorithms, and procedures" (p. 9), while conceptual knowledge is "a connected web of knowledge, a network in which the linking relationships are prominent as the discrete pieces of information" (Hiebert and LeFevre, 1986, pp. 3-4)

The graphing calculator shows promise in recent research as a tool to assist the learner in constructing conceptual knowledge in mathematics in the areas of functions and algebra (Shoaf-Grubbs, 1992; Tolias, 1993). Because graphing calculators are more portable and less expensive, they have gained widespread acceptance as a powerful tool for mathematics classrooms (Wilson & Krapfl, 1994).

Curricular specialists agree that the use of technology must permeate teaching and learning. It is important that graphing technology become an integral part of the learning process (Frye, 1990). In support of Wilson's and Krapfl's findings the Garet and Mills (1995) study explored technology usage in four areas: curriculum content, teaching methods, technology, and assessment methods. In 1991 shortly after the document was published, Garet and Mills surveyed all mathematics department chairs within a one-hundred mile radius of Chicago, Illinois by mail questionnaire. From this survey a response rate of approximately seventy-two percent was attained from 550 schools.

Data from this study indicate that the use of calculators in the mathematics classroom has grown dramatically since 1986. The study asked questions relating to the use of technology in first-year Algebra classes. Fifty percent of teachers reported an increase in the use of graphing calculators to support problem solving. Teachers also reported increased usage of calculators for graphing skills and concepts. The results from the Garet and Mills study are roughly consistent with the 1986 national survey of teachers (Weiss, 1987). In 1991, the Garet and Mills data indicated that surveyed teachers used graphing calculators for graphing concepts and assessment occasionally. Garet and

Mills expect teachers to frequently use the graphing calculator for graphing concepts and assessment in the future (1995).

<u>Skills Development.</u> Research has also shown one of the major benefits of using graphing calculators to be the empowerment they provide students in solving difficult problems. Oster (1995) studied aspects of constructivism as applied to the instructional use of a graphing calculator. Three teachers involved in the project attended a workshop to learn how to use a graphing calculator as an instructional tool for graphics strategies in precalculus mathematics.

Each of the three teachers in the study taught both a control and experimental group using the same instructional materials developed prior to implementation. Students in the experimental group were taught precalculus graphic strategies with a graphing calculator, and the control group was taught using traditional teaching methods; this study showed a significant increase in students' conceptual knowledge with graphing calculators. The effect size of 0.54 translated to the 71st percentile for the treatment group as compared to the 50th percentile rank for the control group. This indicated that teachers should involve students in an interactive problem-solving situation for significant increases in conceptual knowledge and positive attitudes towards using the graphing calculator for learning (Oster, 1994).

Shoaf-Grubbs (1993) investigated the effect of the graphing calculator on students' general spatial ability (visual thinking) and the general cognitive processes (level of understanding) required of 37 students in an elementary algebra course. The experimental group used the graphing calculator as an aid in the learning of the algebra concepts, and the control group was taught using traditional teaching methods. Students were pre- and post-tested for general spatial skills and level of understanding in each of three algebraic topics taught within the classes. Results indicated that the graphing calculator had a positive learning effect upon both the general and spatial skills and level of understanding in elementary algebra concepts. Post-test results showed the experimental group at a higher mean in 13 of the 19 tests; of these 13 means, the test gains were significant in favor of the experimental group in ten cases (Shoaf-Grubbs, 1993).

According to the <u>Standards</u>, not only has new technology made calculations and graphing easier, it has also changed the nature of the problems that are important and the way mathematicians choose to deal with such problems (NCTM, 1989). A multi representational view of algebra possible with a graphing calculator provides students with numerical, graphical, and symbolic representations of algebraic concepts, and this process has positive effects on student achievement (Lynch, et. al., 1989). Slavit supported these findings in 1994 when he examined student learning associated with instruction supplemented by the graphing calculator. Data included student and instructor interviews, classroom observations, and written tests.

Results indicated that the level of classroom discourse increased during lessons utilizing the graphing calculator, as the instructor posed higher-order questions and the students took a more active role in the instructional process. The graphing calculator also aided in presenting algebra in a multi-representational framework. An investigation of student translation strategies of three case study participants revealed that the graphic representation allowed the students to think about function in terms of an object possessing certain properties more than when working with the symbolic or numeric representations (Slavit, 1995). Once again, an important consideration is how graphing calculators change the mathematics that is taught. More research needs to be done investigating how instantaneous hand-held access to graphs and solutions to equations would affect the content of school mathematics (Heid & Baylor, 1993).

One dramatic effect of technology on the algebra curriculum has been to facilitate the manipulation of graphs, raising the possibility of graphical representations taking a more equal footing with the more traditional algebraic-symbolic representations (Dugdale, et. al., 1995, p. 327). The use of the graphing calculator is expected to elevate graphing to a primary position in the algebra curriculum (McConnell, 1988). According to the National Council of Supervisors of Mathematics graphing technology is a powerful teaching device to demonstrate several graphs to a group which can generate a discussion on the differences or similarities of the graphs (1989). Numerous sources in the literature note that graphing calculators provide the power of visualization to give meaning to many important algebraic techniques (Dick & Shaughnessy, 1992; Schultz & Rowan, 1991; Waits & Demana, 1992; West, 1991).

Performance. Ruthven (1990) compared the mathematical performance of upper secondary school mathematics students using graphing calculators with students of similar background lacking regular access to graphing calculators. The sample included 80 students from four different schools. The findings illustrate that, under appropriate conditions, access to information technology can have an important influence both on the mathematical approaches employed by the students and on their mathematical attainment. The use of a graphing calculator was associated with markedly superior attainment on symbolism concepts (Ruthven, 1990).

Caldwell (1995) investigated the effect of the graphing calculator as a learning tool on algebra students' understanding of concepts and performance of procedures involving functions and graphs. Caldwell's study was a posttest-only design involving four classes of college algebra. Two instructors each taught one treatment section and one control section. At the conclusion of the treatment a concepts test, a procedures test, and an attitude survey were administered to both treatment and control classes. A significant difference ($p \le 0.05$) was found between the treatment group and the control group on the procedures test. The conclusion of the study was that the use of the graphing calculator in algebra had a significant effect on the performance of procedures involving functions and graphs (Caldwell, 1995).

In a study conducted on advanced high school mathematics students, Devantier (1993) found that students with experience using the graphing calculator had significantly higher scores on an instrument testing understanding of functions and their graphs than students with no graphing calculator experience. Gathering information on the mathematics achievement of high school students who use the graphing calculator, Chandler (1993) used a pretest-posttest design with a sample of three teachers and 173 students. The treatment group received two weeks of specialized graphing calculator instruction, while the control group received traditional instruction over the same topics. The adjusted mean of the experimental group (106.78) was statistically significantly higher than the control group (102.90) with an effect size of 0.25. This study supports research findings that students who use the graphing calculator to explore, propose, and build connections among the numeric, graphic, and algebraic representations of functions have a better understanding of the relationship between a function and its graphical representation.

Learning Environment. Technology has facilitated a departure from the traditional algebraic skills practice in favor of a more active student role in applying algebraic ideas, planning strategies, and reasoning with and about mathematics (Dugdale, et. al., 1995, p. 331). The success of any moves toward attaining the goals of the Standards is predicated on a philosophy that students learn through active engagement in the creation of their own knowledge (NCTM, 1989, p. 7).

Educational research conducted between 1990 and 1992 reveals that technology has had positive effects on the learning environment. A few recent research efforts suggest that introducing technology into the learning environment may make it more student-centered and stimulate increased student-teacher interaction (Sivin-Kachala, 1993).

Quesada and Maxwell (1994) studied 710 students over three semesters in a precalculus course in which the use of the graphing calculator allowed for more exploration, experimentation, and interactive presentation of topics. The control group was taught the same concepts through more traditional methods. Statistical results indicated that test scores of the experimental groups were significantly higher than those of the control groups. However, whether the improvement in scores was due to graphing calculator use was not clear. Several other factors should be considered: more interactive presentation, immediate feedback, the ability to check the answers the calculator provides, the development of visualization skills, or the students' constructing of knowledge (Quesada & Maxwell, 1995).

Using a graphing calculator may foster mathematics learning opportunities by generating mathematical problem situations in the eyes of students (Wheatley, 1991). From a constructivist perspective (von Glassersfeld, 1987), a calculator can aid mathematics learning when it permits meaning to be the focus of attention, facilitates problem solving, allows the learner to consider more complex tasks, and lends motivation and boosts confidence.

Used appropriately and effectively, new instructional technologies can change both what students learn and how they are taught. However, the mere existence of calculators in a classroom does not accomplish these ends (Cuoco, 1995). In all situations, technology tightly interwoven into the educational experience should be used both as a tool and as a means for creating new teaching strategies and not just as an add-on for its own sake. Technology in the classroom should support the totality of the NCTM's Standards as well as local and state curriculum frameworks (Cuoco, 1995). Based on mathematics instruction research, Dugdale and others (1995) believe that introducing technological innovations into even the most traditional curriculum can have a dramatic effect on what is taught, what is learned, and the very fabric of classroom discussions.

Hembree and Dessart (1986) identified general trends from seventy-nine calculator studies. The researchers were able to draw several conclusions related to secondary mathematics:

(1) students who use calculators in concert with traditional instruction maintain their paper-and-pencil skills without apparent harm, and (2) the use of calculators in testing produces much higher achievement scores than paper-and-pencil efforts, both in basic operations and in problem solving. The most sweeping recommendations arising from the meta-analysis is that calculators should be used in all mathematics classes. Hembree and Dessart believe that it is no longer a question of whether calculators should be used, but how (1986).

The graphing calculator provides students with the power of visualizing the relationship between a function and its graphical representation and has shown to have positive effects on students' spatial skills. Classrooms become more student centered and provide students with opportunities to construct their own knowledge. Many researchers believe that graphing calculators have an effect on the mathematical approaches and performance procedures students choose in the construction of their mathematical knowledge.

Although the research appears to heavily support graphing calculator usage in the mathematics classroom, the findings are mostly for higher level math courses and do not address the Algebra I level. Research still needs to be conducted in the area of graphing calculator usage in the Algebra I classroom.

Teaching Mathematics With Alternative Instructional Strategies

According to the NCTM's Professional Teaching Standards, teaching mathematics must shift from an authoritarian model based on the transmission of knowledge to a student-centered practice in which teachers act as co-learners with students (NCTM, 1991). If algebra is, as Cunningham (1987) states, "a symbolic language that provides a powerful and precise way of recording patterns and relationships that exist in our world," then it becomes necessary to provide students with opportunities to ground the formal symbols of mathematics in a wealth of meaningful experiences before any manipulation procedures are elaborated and guidance towards conventions given (Pope, 1994).

Active Involvement. Piaget (1980) noted that knowledge can only develop if a child is actively involved, both physically and mentally. From a constructivist perspective, knowledge originates in the learner's activity performed on objects. Activity becomes transformed into an object when a student can perceive an activity in thought, produce results, and take the result as a given (Wheatley, 1991).

Piaget emphasized that:

> children must perceive, talk about, and manipulate objects to develop intellectual abilities. First hand experience, however time consuming, is the key to stable and enduring learning. What matters more than verbalizing rules and committing facts to memory, is engagement in practical activities that call for problem solving (Strom & Bernard, 1982, p. 127).

Wade (1995) researched a problem-solving instructional program based on the constructivist theory. The instructional program emphasized the use of reading and writing strategies in a social context that allowed peer collaboration to solve problems. The sample included 17 participants experiencing the instructional program for three and a half hours daily for six weeks. Results showed a significant ($p \leq .05$) gain in problem solving ability in posttest over pretest achievement test scores. Children create new mathematical knowledge by reflecting on their physical and mental actions (Piaget, 1970). In addition, children's actions are viewed as rational to them and reflect their current understanding (Labinowicz, 1985). Thomas (1994) examined the impact of a constructivist approach to teaching and learning mathematics on African-American students' confidence in their mathematical abilities. The study was conducted within the constructivist paradigm and the methods of a constructivist inquiry. Participants included ninth and tenth grade African-American geometry students. Data included video, audio, student interviews, student journals, and attitude tests. Ninety seven percent of African-American students reported feeling more confident in mathematics due to mathematics instruction from a constructivist perspective.

In contrast to Thomas' findings, Strait (1993) examined the effectiveness of deductive and inductive teaching strategies. The deductive teaching strategy was in the sequence of rule, examples, and practice. The inductive teaching strategy was in the sequence of examples, rule, and practice. The sample included fifty college algebra students. Results from the study suggest no significant difference in procedural skill or conceptual understanding, but higher factual knowledge with the deductive teaching strategy.

Discovery Learning. Similar results were found by Emese (1993). Emese examined guided discovery style teaching in differential calculus. Three groups of introductory calculus classes with one class using graphing calculators and a discovery approach, a second class using traditional instructional practices with graphing calculators, and the third class using traditional instruction only. No statistically significant differences were found on the computational, conceptual, or transfer skills parts of the pretest and placement tests. No instructional method proved superior to the others in comparison.

Stewart (1993) conducted a combination qualitative and quantitative study involving four Algebra I classes in Tennessee. Qualitative data were obtained from student and teacher journals, and quantitative data included students' pretest and posttest mathematics scale scores on the Tennessee Comprehensive Assessment Program achievement test. The results of the study indicated students felt a need to be actively involved in the learning process, and achievement scores for the treatment group (journal writers) showed gains to be significantly higher than the control group (non-journal writers). The process of writing during instruction aids students in their own learning process (Stewart, 1993).

Learning Environment. For constructivism to be fostered within a mathematics classroom, the teacher must provide an appropriate environment and opportunities for students to explore. Owen (1994) examined a second-grade constructivist teacher for methods of promoting students' construction of mathematical knowledge. The study was descriptive in nature and included observation of six mathematics lessons. Results from the study suggest that a teacher must develop a safe, secure environment if constructivism is to be fostered. With the environment in place, the teacher can provide various problem situations that promote students' active reflection.

Another constructivist study done by Hadaway (1993) examined how geometry students use writing to facilitate their thinking, make mathematical connections, and construct knowledge. The sample included 29 students who responded through writings and interviews. Data was also collected through teacher notes. The writings provided frequent evidence of student construction of knowledge by comparing original responses to revised responses. This study supports Stewart's (1993) findings in that writing promotes understanding and the construction of knowledge (Hadaway, 1993).

Graphing calculators may provide teachers with opportunities to adopt new and more effective instructional strategies. Clark (1994) conducted an action-research study involving four teachers. The aim of the teachers was to provide more active learning opportunities for their students in mathematics. Over the period of the school year, the group met thirty times, was observed forty-two times, and was interviewed three times. The data collected included audiotapes of the meetings and interviews, and classroom observational notes. The teachers made a remarkable improvement in their practices demonstrating transition from a transmission to constructivist approach which affected not only their teaching of mathematics but also other subjects. In making the transition, however, the teachers and their students experienced a number of difficulties in changing patterns of communication and new roles for the teacher and the student.

Changing the Learning Environment

Changing the instructional environment within the mathematics classroom is a long and arduous process. Teachers will be seeking alternatives to traditional instructional strategies in an effort to implement the constructivist philosophy of the NCTM. These alternative instructional strategies require a transformation in the role of the classroom teacher.

> Alternative methods of instruction will require the teacher's role to shift from dispensing information to facilitating learning, from that of director to that of catalyst and coach. Such an instructional setting enables
> students to approach the learning of mathematics both

creatively and independently and thereby strengthen their confidence and skill doing mathematics (NCTM, 1989,128).

Kanai (1995) designed a quasi-experimental study to examine instructional strategies in the Algebra I classroom. The control group was taught in a traditional teacher-centered classroom, using a textbook. The experimental group was taught in a non-traditional manner, implementing a variety of manipulatives, and using the textbook infrequently. No significant differences due to the teaching methods were found. Both groups of students exhibited significant learning gains. Results from an instrument designed to determine student perceived quality of instruction indicated that the students in the experimental group enjoyed their algebra class more than the control group.

Alsup (1996) examined the effectiveness of problem-centered learning, an instructional approach based on constructivism. Both quantitative and qualitative research methods were employed for this study. The researcher evaluated the effectiveness of the instruction by interviewing six students. Data indicated that the instruction was effective in improving students' conceptual understanding of basic concepts, in helping them overcome mathematics anxiety, and in strengthening their confidence in mathematics. This research represents a start at recognizing powerful alternatives to traditional mathematics instruction (Alsup, 1996).

Huntington (1995) investigated the effect of concrete, semi-concrete, and abstract teaching sequences on the algebraic word problem solving performance of three students with learning disabilities. During concrete instruction, students learned to represent problems with Algebra Lab Gear. Next, students represented problems with manipulatives and drew pictures of the representations during semi-concrete instruction. In the third phase, students represented problems with Algebra Lab Gear, drew pictures of the representations, wrote algebraic equations, and solved algebraic equations. Visual analysis of the data indicated that this teaching sequence was an effective intervention for this sample of adolescents with learning disabilities; all three students reached the criterion of 100% accuracy over the three consecutive sessions.

Manipulatives. Many forms of manipulatives are available for use in the algebra classroom. One of the most popular algebra manipulatives is algebra tiles. Dyer (1996) studied the usage of algebra tiles at the community college level. The sample included 90 students with two classes receiving instruction with the algebra tiles and two receiving traditional symbolic instruction. Results revealed significant differences in the mean performances between the students in the manipulative instruction classroom and the students in the traditional symbolic instruction classroom. Content learning of polynomial multiplication increased significantly for community college students who received manipulative instruction.

Goldsby (1997) supported Dyer's findings concerning the usage of algebra tiles. Goldsby investigated the effect of algebra tiles with teacher explanation on the polynomial factoring ability of Algebra I students and the traditional method of teacher explanation alone. The sample included 247 students in six schools in a suburban public school system. The data, using a multivariate analysis of covariance, yielded a significant difference in the posttest, total facets competency, and proficiency in factoring scores when considered together. The use of manipulatives resulted in higher scores than teacher explanation alone across grades nine and ten and achievement levels (Goldsby, 1997).

Hands-on Learning. Although a constructivist view of learning mathematics has been commonly accepted by researchers and mathematics educators alike (NCTM, 1989), learning mathematics in school still continues to be dominated by the traditional transmission view of knowledge (Wood, Cobb & Yackel, 1991). Several studies demonstrated that constructing meaning through experiences develops students' problem solving skills. Hands-on learning experiences promote confidence in mathematics for African American students, and discovery teaching has proven to be a viable alternative to traditional teaching strategies.

Although all the research pertaining to constructivist teaching and manipulative usage in the mathematics classroom has not been positive, the research has shown that the teacher's role is significant and an appropriate environment must be provided. A large portion of the research relates to higher level mathematics courses, leaving research in the area of algebra I for future studies.

Addressing Curricular Changes Through Alternative Scheduling

Teachers are the key to changing the way in which mathematics is taught and learned. If teachers are to create learning environments that empower students, teachers need additional classroom time and resources for proper implementation. Education Week identified time as one of seven key areas where change must occur for school reform to succeed (Price, 1993). Many schools are exploring alternatives to the traditional schedule; block scheduling is one alternative.

Block schedules are typically of two types: alternating day and semestered. Alternating day represents school schedules where students have eight courses meeting 80 to 90 minutes every other day for about ninety days. Semestered schedules have four courses meeting 80 to 90 minutes daily for about ninety days.

The present interest in block scheduling is not the first time educators have considered dumping the traditional high school schedule. During the 1960s and '70s, as many as fifteen percent of junior and senior high schools experimented with some form of flexible scheduling. However, scheduling is not enough to improve education. O'Neil believes that "the success of today's experiments with alternative schedules depends on the teacher's ability to use different instructional strategies effectively" (1995).

Research going back to the 1970s confirmed most of the non-academic benefits attributed to block scheduling. Academic effects on the other hand were mixed. Although lecturing appeared to be less effective in a block or extended class period, the assumption that this would cause teachers to rely more on participatory modes of instruction instead of lecture was not supported - unless teachers were given adequate planning time and considerable staff development (Kramer, 1997a).

Lyon (1996) explored the perceptions of students as they experienced the transition from a traditional seven-period schedule to that of semestered block schedule. The study was a qualitative, multiple case study involving six high school seniors. Data was collected through interviews, examination of journal entries, and observations within the classroom. The researcher found that students appreciate the opportunities provided by the 90-minute class periods as long as the time is well spent; physical movement within the 90-minute period is crucial as educators plan activities; longer class periods allow for a greater availability of help to students by teachers; and focus on learning is more easily achieved when students only have four classes per day (Lyon, 1996).

Another study conducted by Skrobarcek, et. al. (1997) supports Lyon's findings. In the study, student perceptions of an Algebra I block class were obtained through a telephone survey. Students reported more individual attention by the teacher and more time for homework. Students also felt they learned more because it was easier to concentrate, they understood the lessons better, and they felt less stressed or rushed. Seventy-five percent of the students agreed the block class had a wide variety of learning activities(Skrobarcek, et. al., 1997).

Impact on Achievement. Mathematics teachers often wonder about the impact of alternative scheduling on what and how they teach and on their students' achievements. Canady and Rettig (1993) reported on the advantages of scheduling classes in longer blocks of time. Teachers have fewer students and increased planning time, students can earn more credits, quality instructional time is increased, and a greater variety of instructional models are made possible.

King et al. (1978) conducted a detailed survey in 26 Ontario schools related to block scheduling. The following conclusions were drawn from the data.

> Some teachers have made very little adjustments in their teaching methods in the longer period while others have made major curricular and methodological changes. Those that have made adjustments appear to be far more successful in making the learning experience more rewarding for students. It appears necessary to exchange some of the content normally covered in the past for a more in-depth study of major themes and skills to extract the greatest benefit from full-credit semestering (King et al., p. 45).

Impact on Instruction. There is a clear consensus that maintaining a pure direct teaching/lecture mode of instruction does not work as well in longer classes or blocks of class time(King, et al., 1975; Canady and Rettig, 1994; Meadows, 1995; O'Neil, 1995; Reid, 1995). Unfortunately, as King et al. (1978) noted, creating a new situation in which old instructional methodologies do not work as well does not necessitate that new methods will be adopted. In general, research into school restructuring indicates that structural change alone, without additional support, does not lead to changes in instruction (Newman & Wehlage, 1995).

King (1997) examined ways in which block scheduling affected the academic achievement, learning environment, and instructional strategies used in classrooms. The study focused on the ways teachers were teaching under block scheduling to determine if they had supplemented their presentation format. The research design was a longitudinal, descriptive, non-experimental case study involving three high schools.

From the data, King concluded that block scheduling was beneficial but not in all areas regarding academic achievement. Overall, school wide academic achievement increased, but the effect on specific disciplines, although positive, was not significant. The effects of block scheduling on the learning environment were inconclusive due to the lack of emerging patterns in the data. Also, block scheduling generally had an impact on the instructional strategies used by teachers in their classrooms. Teachers identified changes in their use of instructional strategies and attributed them to block scheduling. These changes typically called for increased student involvement and participation in learning (King, 1997). Switching to a block schedule can act as a catalyst for changing teaching methodologies, but it is not guaranteed (Canady and Rettig, 1995; O'Neil, 1995; Salvaterra and Adams, 1995). Research indicates that it is dangerous to assume that changing schedules necessarily leads teachers to change their teaching methods (Kramer, 1997b).

Freeman (1996) also studied the effect of block scheduling on the professional school community and effective teaching and learning. The sample included four high schools, two traditional and two block scheduling formats. One conclusion from this study is that changing to block scheduling for teachers decreased stress and improved morale, required instructional change, and allowed teachers to know students better. Students experienced less stress, were more focused and ready to learn, caused fewer discipline problems, and had more opportunity for electives (Freeman, 1996).

Larger blocks of time allow for a more flexible and productive classroom environment, along with more opportunities for using varied and interactive teaching methods. Other benefits listed by Sturgis (1995) include more effective use of school time, decreased class size, increased number of course offerings, reduced numbers of students with whom teachers have daily contact, and the use of more process-oriented strategies. Bryant (1996) examined teaching strategies used by teachers in a block schedule. The sample consisted of a random sampling of 10 percent of the eleventh and twelfth grade students from each of six high schools participating in the study. A Likert-type survey was used to determine student perceptions of the frequency of which ten specified teaching strategies were used in their classes. The results suggest that the implementation of block schedules in high schools may foster the use of more student interactive instruction.

Although surveys (Ross, 1977; Brophy, 1978; Averett, 1994) indicate that, in general, teachers on a block schedule use less lecture and more participatory teaching processes, this change may be more difficult for math than other subject areas. Reid (1995) interviewed five principals using block scheduling in British Columbia and found that math teachers in these schools had a harder time changing their instructional methods than did those in the other core subject areas.

In another study, King et al. (1978) found that in schools using block scheduling math students spent a larger percentage of time taking tests, doing seatwork, or listening to the teacher than students in any other subject. In the Skrobarcek, et. al. (1997) study, students reported in a telephone survey that the three materials most frequently used in their block classrooms were the textbook, worksheets, and calculators. Students also identified the usage of the overhead, the chalkboard, and lecture as the most prevalent teaching strategies used in their Algebra I block classes (1997). The overwhelming majority of math teachers interviewed for the Kramer (1997a) study who had moved to a block schedule said they had changed their teaching processes.

Although student surveys indicated less implementation of innovative and multi-representational activities, results of the teacher survey yielded similar findings to the Kramer study and were consistent with available literature (Dusky and Kifer, 1995; Kruse and Kruse, 1995; Short and Thayer, 1995; Hackmann, 1995). Teachers commented that the block fosters teacher innovation and creativity, allows adequate time for planning, allows more time for effective student evaluation, and allows more time for individualized instruction (Skrobarcek, et.al., 1997).

Wronkovich et al. (1997) identified four trends among teacher comments from a block scheduling survey. Teachers had concern over covering all the material, gaps in the math learning process, holding student's attention for 90 minutes, and the need for assimilation time between practice sessions.

Impact on Students. Time is one of the structural dimensions where the greatest amount of experimentation is occurring. Blocks of time are being created that allow teachers to spend more time with fewer students in order to encourage more complex learning interactions (Carroll, 1990). Wilson (1994) investigated the relationship between block scheduling and mathematics achievement. Two schools were used in the study, one had parallel block scheduling and the other traditional scheduling. Data from ISTEP (Indiana Statewide Testing for Educational Progress) scores for both schools were compared using a one way analysis of variance. Statistically significant differences were found in mathematics achievement in favor of the parallel block scheduled school.

Cox (1995) supports Wilson's findings of block scheduling benefiting students. Cox examined the benefit of a block scheduling program to students at-risk. Sixty ninth and tenth grade students, identified as at-risk, were assigned to three groups of twenty students each and received instruction in the academic core subjects. Measures of achievement indicated a significant gain in the blocked core courses from failing to passing grades. This study supports the implication that grouping students with one teacher for an extended amount of time of the school day can be beneficial to the student who is at-risk (Cox, 1995).

Pisapia and Westfall (1997) also found that grades overall seem to improve in both alternating and semester block schools with the greatest increases found in semester block schools. Both types of schedules seem to encourage teachers to teach differently, i.e., focus on concepts rather than just facts, problem solving and information usage, and go more in-depth on subject matter. Over the course of a year, increases from eight to twenty percent were noted in an overall grade analysis (Pisapia and Westfall, 1997).

The best achievement data currently available come from North Carolina and British Columbia. Averett (1994) summarized the change in test scores from North Carolina within the core subject areas. The study included approximately 2,000 students taking the Algebra II end of course examination. In the five core subject areas, the average change in final test scores was small, ranging from -0.4 percent to + 1.5 percent, compared to a standard deviation of 16.6 percent or greater on each test. Overall, Averett's data seem to indicate that switching to a block schedule had either no effect or a slightly positive effect on achievement in these five subject areas.

Marshall et al. (1995) reported data from British Columbia's 1995 Mathematics and Science Assessment. The study included 24,520 students who took the grade 10 math test, of who 67 percent were under a traditional schedule and 26 percent were under a semestered block schedule. All-year students scored higher than semestered students on the year end test. These results are not quite as strong as Beautician's (1990) where in math, all year students scored highest on 74 of the 80 items on the exam, and semestered students scored highest on only 3 items.

Kramer (1997b) attempted to identify factors that may have caused problems in British Columbia. He interviewed researchers, administrators, and ministry officials in British Columbia, and as a result the following factors may have contributed to reduced test scores in semester blocked math classes. Teachers had an irregular planning time, there was little opportunity to modify the curriculum, and standardized testing encouraged lecture and memorization.

In a contrasting study, Hammy (1997) examined scores of students on standardized tests from two block and two traditional schedule schools. Approximately 2000 students took each of four tests for each grade. Significant differences were found on the High School Competency Test, indicating that traditional scheduling improved student achievement.

Schroth and Dixon (1995) found that the test scores of lower achieving students who attended math classes more frequently and for longer periods of time were not significantly higher than those of low-achieving students in the traditional 50-minute, daily classes. Research supports the teacher held belief that students gain by attending classes in longer time segments, but those gains are not always reflected in test scores (Schroth & Dixon, 1995). A team of Harvard University researchers found students in a pilot block class to be better known by their teachers, and to have improved higher-order thinking and problem-solving abilities. But, test results showed no significant difference between the groups and no difference in retention of material (Carroll, 1994).

Time Strategies, published by the National Education Association, is a comprehensive report on the successful implementation of block scheduling by five schools across the country. Changes reported are numerous, including improved work day for teachers and students, and increased attendance and higher grades, but there is no mention of improved achievement documented by test scores (Dalheim, 1994).

Switching to block scheduling provides an opportunity for mathematics teachers to spend more time aiding students in the construction of their own knowledge. Block scheduling provides time for activities involving increased student involvement, and students are better able to focus on their work. Research indicates that block scheduling creates a positive school climate and reduces drop-out rates, but there is still little research on the effects of block scheduling in mathematics achievement. Of the three studies noted, contradictory results were found. Block scheduling does provide teachers with opportunities to use technology and manipulatives to aid student understanding, but the question still remains as to the effectiveness of block scheduling on increased mathematics achievement.

Summary

Since the previous review of literature confirms the fact that the graphing calculator, alternative instructional strategies, and alternative scheduling positively affect achievement, perhaps educators are more likely to try a more constructivist approach to teaching mathematics. This constructivist approach is a component in Ivey's organic structure (1996).

Ivey identified and studied two structures within the classroom, mechanistic and organic. The organic structure, where instruction is an integrated process, is representative of the constructivist approach to teaching mathematics. Students would be engaged in their own learning, using technology, manipulatives, and models to aid in their discovery of patterns and algorithms for mathematics. Organic structure within the classroom is the essence of the NCTM Standards and is another representation of the constructivist classroom.

The opposite of an organic classroom would be a mechanistic classroom. Ivey defines the mechanistic classroom as a machine where the teacher is working to produce a product, namely the student. In this structure, students are taught through lectures and examples. The teacher imparts his or her knowledge to the students and they are to absorb or memorize this information. Students in the mechanistic classroom would not use technology, manipulatives, or models of any kind in the learning process. In layman's terms, the mechanistic structure would be referred to as a traditional instruction classroom. The NCTM is calling for a more organic style of instruction, but as research has shown, many teachers are still following a more mechanistic structure.

One of the most powerful aids in attaining a more constructivist classroom is the graphing calculator. If teachers are shown how the graphing calculator can improve student outcomes within their classroom and are provided opportunities for training and support they may be more likely to integrate this technology into their daily instructional practices. Implementing the philosophy of the NCTM Standards requires teachers to alter their role within the classroom and seek alternative instructional strategies. If alternative instructional strategies, such as manipulatives, can improve student achievement then they will have a viable alternative to their traditional practices. Further, if block scheduling can lead to positive gains in mathematics achievement, teachers will have another avenue for instructional change. With standardized testing utilizing open-ended questioning, graphing calculator related questions, and questions relating to manipulative usage, educators are seeking alternatives to their current practices and becoming well versed in the implementation of these strategies.

The purpose of this study was to investigate the effects of block and traditional scheduling within the Algebra I classroom and determine if time is a factor in student achievement. In looking at classrooms on the two time schedules, the study also examined the practices of teachers to determine the effect of instructional practices upon student achievement. Through both quantitative and qualitative analysis of scheduling and instructional practices, this study provided an empirical research base for reference when implementing change within the classroom. Since little research is available on the effect of graphing calculator and manipulative usage in the Algebra I classroom, and the effect of block scheduling on achievement in Algebra I this study will add to the core of knowledge in mathematics education.

CHAPTER 3

RESEARCH METHODOLOGY

Mathematics achievement is a concern of educators, parents, and business leaders. Students are not reaching their potential in mathematics due in part to the instructional practices of mathematics teachers. Educators are looking for alternatives to traditional instructional strategies and to traditional scheduling formats. The NCTM suggests mathematical modeling, technology, and constructing one's own knowledge as avenues to the improvement of mathematics education (1989). This chapter provides a description of the procedures and methodologies used to collect and analyze data from mathematics classrooms in the north central Texas area. It includes a discussion of the general population, the instrumentation, the research design, and the procedures for data analysis.

This study was multi-level in nature, including both qualitative and quantitative analyses. The study included a quantitative analysis of a larger sample including all Algebra I students from a five county area, and a qualitative analysis of ten classrooms within the five county area. The large sample provided for the comparison of test scores between block and traditionally scheduled schools. Within these five counties, a smaller study of ten classrooms was conducted to determine instructional patterns, methodologies, etc. Qualitative analysis of the instructional practices within these ten classrooms were analyzed, and an additional quantitative analysis of scores based upon instructional strategies within the smaller sample was completed.

Population

The population for this study included all Algebra I classrooms by district taken from the north Texas region. The north Texas region was defined as an area including Denton, Dallas, Johnson, Parker, and Tarrant counties. From all of the regional Algebra I classrooms, a sample of block and traditional scheduled classes were used for end of course scores data collection. A block scheduled class is defined as any extended period class (70-90 minutes), and a traditional scheduled class is defined as any non-extended period class (45-60 minutes).

For the quantitative portion of the study, the sample of schools involved in the study included all urban and suburban districts within the north Texas region. Districts included all 1A, 2A, 3A, 4A, and 5A classifications. All schools involved in the study had classes scheduled on block or traditional formats.

All Algebra I teachers from the schools involved in the study were separated into two groups: block and traditional. Block teachers were from a school on block scheduling and teaching 70-90 minute classes. Traditional teachers were from a school on traditional scheduling and teaching 45-60 minute classes.

For the qualitative portion of this study, 26 teachers, 13 from the block scheduling group and 13 from the traditional scheduling group, were selected at random from the sample of the quantitative study. From these 26 teachers, 10 Algebra I teachers (5 block and 5 traditional) were selected based upon willingness to participate in the qualitative data collection process for this study. Each of the ten teachers in the qualitative portion of this study were teaching at least one Algebra I class, and have more than one years experience in the classroom. The students taking the algebra classes were eighth, ninth, and tenth graders ranging from fourteen to sixteen years of age.

<u>Instrumentation</u>

The dependent variable for student achievement is the score on the Texas End-of-Course Examination for Algebra I. The Texas End-of-Course Examination for Algebra I is based on ten objectives which were adopted by the State Board of Education in 1993. The objectives emphasize utilization of fundamental algebraic skills and concepts in solving real-world and mathematical problems (TEA, 1993). A list of the objectives for the Texas End-of-Course Examination for Algebra I can be found in Appendix A.

The development of the Algebra I examination included activities designed to produce an assessment instrument of the highest quality. Texas educator advisory committees, national experts, and algebra teachers contributed in the development of the Texas EOC Algebra I exam. Test items were reviewed for appropriateness of content, difficulty, and for cultural, ethnic, and sex bias. Test items were first field tested in the spring and fall of 1993 with a representative random sample of students. Field test data were reviewed by Texas educator advisory committees for appropriateness of difficulty and for possible bias (TEA, 1993).

The EOC exam is a forty question non-timed exam. The exam includes both multiple choice questions, and open ended questions. For the exam, students are allowed to use a graphing or scientific calculator. The 1998 Spring Texas End-of-Course Examination for Algebra I can be downloaded from the Texas Education Agency website.

Students in the block scheduling group and the traditional scheduling group took the Texas End-of-Course Examination for Algebra I in May of 1998. Each school district is allowed a two-week window within which to give the examination to their Algebra I students.

Data Collection and Analysis

Research Questions 1a. The researcher conducted a multi-level qualitative and quantitative study. The first level of the study examined the larger sample of five counties, their scheduling, and their EOC scores. The quantitative portion of this study looked at block and traditional scheduling and its effect on student achievement as measured by the Algebra I EOC exam scores for all students in the five county area. This post-test only design included a quasi-experimental study that used the block scheduling group and the traditional scheduling group of Algebra I classes as the independent variable. A causal-comparative approach was taken aimed at discovering a possible cause and effects relationship between block scheduling and the students' scores on the Texas End-of-Course Examination for Algebra I.

The post-test (EOC) was given in May by the state of Texas and administered by teachers to all students in the state including those in the study. The researcher analyzed end-of-course scores based upon district averages for all students enrolled in Algebra I within that district for the 1997-98 school year. An analysis of variance (ANOVA) was applied to determine if there was a significant difference in student achievement as a result of block and traditionally scheduled classes.

Research Question 1b. A second level of analysis was conducted involving nine campuses where the classroom observations were conducted. The Algebra I EOC exam scores at the campus level for the nine campuses involved in the second level of the study were analyzed with an ANOVA to determine if there was a significant difference in student achievement as a result of block or traditionally scheduled classes.

Research Question 2. As a component of the second level of the study, the researcher analyzed instructional strategies used by both block and traditionally scheduled teachers. Data was collected through classroom observations, interviews with teachers, and self-analysis done by teachers through questionnaires. The questionnaire used in data collection within the classrooms and in the teacher survey is in Appendix B. Teachers were randomly observed in their classrooms twice during the school year. Observation forms were completed during each of the two classroom visits, and interview forms were completed as necessary. Questionnaires were completed by the participating teachers and the other Algebra I teachers at each campus prior to the first classroom observation in November.

Instructional strategies were grouped according to the National Council of Teacher's of Mathematics Curriculum and Evaluation Standards for School Mathematics and The Professional Teaching Standards for School Mathematics. The NCTM categories for instructional strategies are as follows: problem solving, communication, reasoning, and connections. Classroom observations were also analyzed for the occurrence of: student engagement, student stimulation to make connections, encouragement for problem formulation, promotion of communication, clarification and justification of answers, and use of computers, calculators, models, pictures, and tables. All teachers in the study were free to use the instructional strategy of their choice.

Research Questions 3a. Upon completion of the analysis and classification of instructional strategies by campus, EOC scores from the students at the nine campuses were analyzed in an ANOVA to determine if there was a significant difference in student achievement as a result of technology usage. Data collected from teacher questionnaires and classroom observations were used to identify users and non-users of technology. The results from this smaller study were used to compare and contrast the findings from the larger quantitative portion of this study involving the five counties in north Texas.

Research Questions 3b. Teachers were asked to identify opportunities for students to make connections between abstract and concrete concepts, use models, charts, graphs, and manipulatives. Data collected from teacher questionnaires and classroom observations were used to identify users and non-users of manipulatives. Based upon the scores from the nine campuses involved in the smaller study, an ANOVA was used to determine if there was a significant difference in student achievement as a result of manipulative usage. The results from this smaller study were used to compare and contrast the findings from the larger quantitative portion of this study involving the five counties in north Texas.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Introduction

This chapter reports the findings of the research and presents the data in two sections. The first section presents the results of the quantitative portion of this study used to determine if there were measurable differences in Algebra I End of Course Exam scores between the two groups that can be attributed to the type of class scheduling. The second section presents the results of the qualitative portion of the study analyzing block and traditionally scheduled Algebra I classes to determine teaching styles and methodologies. The researcher addressed the following:

1a. Data were used to determine differences in Algebra I skills achievement found between the block scheduling group and the traditional scheduling group for the five counties within the North Texas area.

1b. Data were used to determine differences in Algebra I skills achievement found between the block scheduling group and the traditional scheduling group within the nine campuses involved in the qualitative portion of the study.

2. Data were analyzed to discover if there were any differences, similarities, or patterns in instructional strategies related to problem solving, communication, reasoning, and connections used in the ten class sample of block scheduled and traditionally scheduled classes.

3a. Data were used to determine any difference in Algebra I skills achievement for students from the ten class sample who utilized the graphing calculator during instruction.

3b. Data were used to determine any difference in Algebra I skills achievement for students from the ten class sample who utilized models and manipulatives during instruction.

Research Question 1a

Research question 1a is associated with the hypothesis that the mean score on the Texas Algebra I End-of-Course exam of a group of Algebra I students from the large sample of five counties instructed in block scheduling format will be significantly higher than the mean score of a group of Algebra I students who were instructed in a traditional scheduling format. The research hypothesis stated as a null hypothesis is that there is no relationship between student achievement on the Algebra I End-of-Course exam and block or traditional scheduling. The hypothesis was tested using ANOVA with the Algebra 1 EOC score as the dependent variable and the type of scheduling (1 for block 2 for traditional) as the independent variable. The ANOVA, one-way classification is the method for testing the equality of the population means. The test statistic and summary table for the ANOVA is presented in Table 2. The means, shown in Table 1, on the EOC scores between the two groups revealed a p = .7550. The F ratio, F = 0.098322, does not exceed the critical value F_{cv} = 4.04 at the α=.05 level, thus the null hypothesis was not rejected indicating no significant difference in Algebra I EOC scores between the block and traditional scheduling groups.

Table 1

One variable statistics for sample groups block and traditional scheduling.

Group	N	Mean	Std. Dev.
Block	44	44.568	20.551
Traditional	15	42.467	27.360

Table 2

Comparison of the Algebra I End-of-Course scores for block and traditional scheduling for the sample.

Source	df	SS	MS	F	Pr > F
Model	1	49.403	49.403	0.0983	0.7550
Error	57	28640.529	502.465		
Total	58	28689.932			

A further analysis of the data indicated that the inclusion of two perfect scores of 100 from districts that only tested eighth grade students should be excluded from the data. A score of 100 was deleted from each group and the results were recalculated. The test statistic and summary table for the ANOVA is presented in Table 4. The means, shown in Table 3, on the EOC scores between the two groups revealed a $p = 0.4267$. The F ratio, $F = 0.6410955$, does not exceed the critical value $F_{cv} = 4.04$ at the $\alpha=.05$ level, thus the null hypothesis was not rejected indicating no significant difference in Algebra I EOC scores between the block and traditional scheduling groups with the perfect scores from districts only reporting eighth grade scores removed.

Table 3

One variable statistics for sample groups block and traditional scheduling excluding the eighth grade only districts from both groups.

Group	N	Mean	Std. Dev.
Block	43	43.279	18.909
Traditional	14	38.357	23.094

Table 4

Comparison of the Algebra I End-of-Course scores for block and traditional scheduling for the sample, excluding scores for eighth grade only districts from both groups.

Source	df	SS	MS	F	Pr > F
Model	1	255.854	255.854	0.641	0.427
Error	55	21949.865	399.088		
Total	56	22205.719			

Research Question 1b

Research question 1b is associated with the hypothesis that the mean score on the Texas Algebra I End-of-Course exam of a group of Algebra I students from the smaller sample of nine campuses instructed in block scheduling format will be significantly higher than the mean score of a group of Algebra I students who were instructed in a traditional scheduling format. The research hypothesis stated as a null hypothesis is that there is no relationship between student achievement on the Algebra I End-of-Course exam and block or traditional scheduling. The hypothesis was tested using ANOVA and the test statistic and summary table for the ANOVA is presented in Table 6. The means, shown in Table 5, on the EOC scores between the two groups revealed a $p = 0.95653$. The F ratio, $F = 0.00319$, does not exceed the critical value $F_{cv} = 5.59$ at the $\alpha=.05$ level, thus the null hypothesis was not rejected indicating no significant difference in Algebra I EOC scores between the block and traditional scheduling groups for the nine campuses.

Table 5

One variable statistics for small sample groups block and traditional scheduling.

Group	N	Mean	Std. Dev.
Block	5	48.2	26.874
Traditional	4	47.0	37.103

Table 6

Comparison of the Algebra I End-of-Course scores for block and traditional scheduling for the small sample.

Source	df	SS	MS	F	Pr > F
Model	1	3.2	3.2	0.003	0.957
Error	7	7018.8	1002.686		
Total	8	7023.0			

A further analysis of the data indicated that the inclusion of the two scores from the eighth grade campuses should be excluded from the data. One score was deleted from each group and the results were recalculated. The test statistic and summary table for the ANOVA is presented in Table 8. The means, shown in Table 7, on the EOC scores between the two groups revealed a p = 0.56964. The F ratio, F = 0.36986, does not exceed the critical value F_{cv} = 6.61 at the α=.05 level, thus the null hypothesis was not rejected indicating no significant difference in Algebra I EOC scores between the block and traditional scheduling groups within the nine campus sample with the eighth grade scores removed.

Table 7

One variable statistics for sample of nine campuses including block and traditional scheduling excluding the eighth grade only campuses from both groups.

Group	N	Mean	Std. Dev.
Block	4	42.25	26.961
Traditional	3	30.667	21.548

Table 8

ANOVA for sample of nine campuses including block and traditional scheduling excluding the eighth grade only campuses from both groups.

Source	df	SS	MS	F	Pr > F
Model	1	230.01	230.01	.3699	.5696
Error	5	3109.42	621.88		
Total	6	3339.43			

Research Question 2

Research question 2 looks for similarities, differences or patterns of instructional practices with regard to problem solving, reasoning, connections and communications in the ten sample Algebra I classes. Following the classroom observations, observer notes were analyzed to determine classifications for the usage of class time. Classroom management, warm-up/quiz, previous day homework, new material, and classwork emerged from the analysis as categories for teacher usage of class time. Classroom management included taking roll, collecting materials (report cards, papers, etc.), and announcements. The warm-up or quiz category included any problems on the chalkboard or overhead for a class warm-up or a quiz given following the checking of the homework. The previous day homework category includes finishing the previous assignment or checking completed assignments. New material is the presentation of the day's lesson. This may include activities, group work, lecture, discussion, etc.. The last category of classwork is the time students spent working on specific classroom problems or their homework assignment for the day.

In both block and traditional classes, teachers spent less than five percent of their time on classroom management. Traditionally scheduled classes spent approximately sixteen percent of class time on warm-up problems or quizzes, while block scheduled classes spent only eleven percent of class time in the same category. Both block and traditionally scheduled classes spent less than fifteen percent of class time completing the previous day's homework or checking this homework.

The majority of class time in both block and traditionally scheduled classes (67 percent for block and 66 percent for traditional) was spent on the presentation of new material and the homework assignment over the new material. Block classes spent 4 percent more class time on the assignment or homework, while traditionally scheduled classes spent 5 percent more time on the presentation of the new material. This information is summarized in Table 9.

Table 9

<u>Percentage of Classroom Time Spent in Five Major Categories</u>

Categories	Percent of Classtime Spent Per Category	
////////////////////	Block Classes	Traditional Classes
Classroom Management	4.8%	4.3%
Warm-up / Quiz	10.9%	15.9%
Previous Homework	14.5%	12%
New Material	31.8%	35.6%
Classwork	35.2%	30.5%

Based upon teacher questionnaires, data show that teachers from both block and traditional groups address connecting mathematics to the real world and communication weekly or up to twice a week. Teachers involved in block scheduling noted developing problem solving skills more often than traditional scheduled teachers. Block teachers identified developing problem solving skills more than twice per week where traditional scheduled teachers worked with problem solving skills less than two times per week. This information is summarized in Table 10.

Table 10

Data Summary From Teacher Surveys: Problem solving

Categories	Number of Times Used Per Week (Survey)	
	Block Classes	Traditional Classes
Connecting Math with the Real World	2	2
Communication	2	1-2
Developing Problem Solving Skills	2-3	1-2

Based upon classroom observations, block and traditional classroom teachers utilized communication and making connections to the real world and other subjects the same number of times. Out of ten observations from both groups, teachers were observed encouraging communication, mostly oral and some written, in all ten classroom observations. Of the ten classes observed from each group, seven applications or connections to other subjects or the real world was observed by the researcher. Observed connections included making up problems, geographical locations, literature, and consumerism.

In four of ten traditionally scheduled classes, teachers were observed aiding students in the development of problem solving and reasoning skills. This compares to three of ten block scheduled classes where teachers were observed aiding students in developing problem solving skills. In traditional classes, teachers were observed developing student's reasoning skills in three of ten classes as compared to one of ten block scheduled teachers observed developing student's reasoning skills.

Other areas of instruction addressed on the questionnaire included discovery learning as an instructional strategy, degree of student engagement in the learning process, and group work. Both block and traditionally scheduled teachers identified using discovery learning and group work at least once a week and occasionally more than once per week. Both groups identified students as being actively involved in the learning process more than twice per week, but not on a daily basis. This information is summarized in Table 11.

Table 11

Data Summary From Teacher Surveys: Engagement

Categories	Number of Times Used Per Week (Survey)	
	Block Classes	Traditional Classes
Discovery Learning	1	1
Student Engagement	2	2
Group Work	1-2	1-2

In contrast to teacher survey results, classroom observations revealed only one block class utilizing discovery learning and no traditionally scheduled classes using discovery learning as an instructional strategy. Discovery learning is defined by the researcher as learning opportunities for the student to encounter and understand a new concept through engagement in their own learning process. This includes opportunities for students to observe and determine patterns prior to developing algorithms or abstract representations of a concept.

The researcher also observed more block classes (five of ten observations) utilizing group work than in traditional scheduled classes(three of ten). In the block classes, students were put into groups to write application problems and complete class work related to different methods for solving quadratic equations. In all classes, students were observed being engaged in their own learning process to the extent of presentation of homework, oral discussions/explanations, and demonstrations. There were no observations of students looking for patterns in a given set of data or problem situation.

Both block and traditionally scheduled classes used technology in their classrooms. Based upon the teacher questionnaires, teachers used computers less than once a month or not at all in their classroom, and used the graphing calculator at least once a week, and depending upon the unit on a daily basis. Both groups of teachers (block and traditional) also identified using the graphing calculator as part of assessment on a weekly and often daily basis. This information is summarized in Table 12.

Table 12

<u>Data Summary From Teacher Surveys: Technology</u>

Categories	Number of Times Used Per Week (Survey)	
	Block Classes	Traditional Classes
Use Computers in Class	0	0
Use Graphing Calculators in Class	1-2	1-2
Use Graphing Calculators in Assessment	1-2	1-2

The data collected from the classroom observations identified five different classes in the block group where graphing calculators were used during the class period. This compares to only two classes out of ten observed using the graphing calculator in traditionally scheduled classes.

Data collected from teacher questionnaires showed teacher usage of manipulatives in the block scheduled classes to be at least once a week and often multiple times weekly. Teachers in traditionally scheduled classes identified using manipulatives on a monthly basis, and only as an introduction of new material when appropriate. Block scheduled teachers also identified using models, charts, graphs, etc. at least twice weekly, where traditionally scheduled teachers identified using the same methodologies on a weekly basis. Both groups identified helping students make connections between abstract and concrete representations on a weekly and often daily basis. This information is summarized in Table 13.

Table 13

Data Summary From Teacher Surveys: Manipulatives

Categories	Number of Times Used Per Week (Survey)	
	Block Classes	Traditional Classes
Using Manipulatives	1-2	0-1
Using Models/Charts/Graphs	2	1
Connecting Concrete to Abstract	2	1-2

Classroom observations found the same usage of manipulatives in both types of classes. Each group was observed using manipulatives in four of ten classes. And, both groups were observed using models, pictures, graphs, etc. during seven of ten classes. On each of the occasions that the models, graphs, and or manipulatives were used, the teacher helped the students make the connection from the pictorial or concrete to the more abstract or symbolic representation.

Research Question 3a

Research question 3a is associated with the hypothesis that the mean scores on the Texas Algebra I End-of-Course exam for the sample group of students who have utilized the graphing calculator during instruction will be significantly higher than the mean score of the sample group of Algebra I students who did not utilize the graphing calculator. The research hypothesis restated as a null hypothesis is that there is no relationship between student achievement on the Algebra I End-of-Course exam and students observed using technology and those observed not using technology during instruction. Both block and traditional classes were observed using technology in the classrooms. ANOVA was used to determine if there was a significant difference between the mean scores on the Texas Algebra I End-of-Course exam for the sample group of students from the nine campuses who were observed utilizing the graphing calculator during instruction and those who did not. The test statistic and summary table for the ANOVA is presented in Table 15. The means, shown in Table 14, on the EOC scores between the two groups revealed a $p = .8629$. The F ratio, $F = 0.0320$, does not exceed the critical value $F_{cv} = 5.99$ at the $\alpha=.05$ level, thus the null hypothesis was not rejected indicating no significant difference in Algebra I EOC scores between the sample group of students who were observed utilizing the graphing calculator during instruction and those who did not.

Table 14

One variable statistics for nine campus sample of students observed using/not using graphing calculators.

Group	N	Mean	Std. Dev.
Using Graphing Technology	6	49	31.53
Not Using graphing Technology	3	45	31.76

Table 15

ANOVA for nine campus sample of students observed using/not using graphing calculators.

Source	df	SS	MS	F	Pr > F
Model	1	32.0	32.0	0.032	0.863
Error	7	6990.0	998.571		
Total	8	7022.0			

Research Question 3b

Research question 3b is associated with the hypothesis that the mean score on the Texas Algebra I End-of-Course exam for the sample group of students from the nine campuses who utilized models and manipulatives during instruction will be significantly higher than the mean score of the sample group of students who did not utilize models or manipulatives. The research hypothesis restated as a null hypothesis is that there is no relationship between student achievement on the Algebra I End-of-Course exam and students observed using models or manipulatives and those who did not use models or manipulatives during instruction. Students in both block and traditionally scheduled classes were observed using manipulatives, models, charts, and graphs. ANOVA was used to determine if there was a significant difference between the mean score on the Texas Algebra I End-of-Course exam for the sample group of Algebra I students from the nine campuses who utilized models and manipulatives during instruction and those who did not utilize models or manipulatives. The test statistic and summary table for the ANOVA is presented in Table 17. The means, shown in Table 16, on the EOC scores between the two groups revealed a $p = .9946$. The F ratio, $F = 0.0000498$, does not exceed the critical value $F_{cv} = 5.99$ at the $\alpha=.05$ level, thus the null hypothesis was not rejected indicating no significant difference in the mean score on the Texas Algebra I End-of-Course exam for the sample group of Algebra I students who utilized models and manipulatives during instruction and those who did not.

Table 16

One variable statistics for nine campus sample of students observed using/not using manipulatives.

Group	N	Mean	Std. Dev.
Using models/ manipulatives	4	47.75	36.646
Not Using models/ manipulatives	5	47.6	27.355

Table 17

ANOVA for nine campus sample of students observed using/not using manipulatives.

Source	df	SS	MS	F	Pr > F
Model	1	.05	.05	.0000498	.9946
Error	6	7021.95	1003.136		
Total	7	7022.0			

CHAPTER 5

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The purpose of this study was two-fold in nature. First to investigate the effectiveness of block or traditional scheduling in the Algebra I classroom based upon the Algebra I End-of-Course exam scores, and second to investigate instructional practices observed at the classroom level and determine if a relationship existed between these practices and student achievement. The first component of the multi-level study was comprised of a sample including five counties in the North Texas area. This level of the study was designed to give an overall view of block and traditional scheduling and the relationship scheduling has with student achievement. Then as a smaller sample ten algebra I classrooms were selected at random from the five counties of Denton, Dallas, Johnson, Parker and Tarrant. Each of the ten classes were observed on two occasions during the 1997-98 school year. Five of the classes were block scheduled (70-90 minute classes)and five were traditional scheduled (45-60 minute classes). This second level of the study took the researcher to the campus level to observe instructional practices in both block and traditionally scheduled classes. At this level, the researcher looked at both campus instructional strategies and individual teaching strategies within the classroom.

Each of the ten teachers participating in the study completed a questionnaire over their instructional practices, and the same questionnaire was completed by the other Algebra I teachers at their campus. Data collected for each of the ten classes in the sample included two teacher observations, teacher questionnaire, campus questionnaires/survey, interview notes, and Algebra I End-of-Course exam campus scores.

Following the observations, interviews, and surveys, the Algebra I End-of-Course exam was administered at each campus per state guide lines. This portion of the study looked at the relationship between instructional practices and student achievement on the Algebra I End-of-Course Exam.

Summary of Findings

The data from the large sample for research question 1 was examined using an Analysis of Variance (ANOVA) in which the raw scores from the Algebra I End-of-Course exam were statistically analyzed by a computer to determine if there were measurable differences between the two groups (block scheduled and traditionally scheduled) in achievement on the

Algebra I End-of-Course Exam. The same process was followed for examining the smaller sample of Algebra I EOC scores from the nine campuses. The data were examined to determine if there was a significant difference in Algebra I EOC scores between the block and traditionally scheduled classes from the smaller sample.

The qualitative data, including observations, questionnaires, and interviews, were examined for patterns and categorization. This data was then used to determine if differences in student achievement existed for those using technology or manipulatives and those who did not. The major findings resulting from the analysis of the statistical and qualitative data in this study were the following:

1. No significant difference was found on the mean score from the Texas Algebra I End-of-Course exam for a group of Algebra I students from the North Texas area instructed in block scheduling format and the mean score of a group of Algebra I students from the North Texas area who were instructed in a traditional scheduling format.

2. No significant difference was found on the mean score from the Texas Algebra I End-of-Course exam for a group of Algebra I students from the sample of nine campuses instructed in block scheduling format and the mean score of a group of Algebra I students from the sample of nine

campuses who were instructed in a traditional scheduling format.

3. Based upon the qualitative findings, instruction in a block scheduled class is similar in time allocation and methodology to that of a traditionally scheduled class.

4. No significant difference was found on the mean scores from the Texas Algebra I End-of-Course exam for the sample group of students who utilized the graphing calculator during instruction and the mean score of the sample group of Algebra I students who did not utilize the graphing calculator during instruction.

5. No significant difference was found on the mean score from the Texas Algebra I End-of-Course exam for the sample group of students who utilized models and manipulatives during instruction and the mean score of the sample group of students who did not utilize models or manipulatives during instruction.

Conclusions

Although this study identified two different types of classroom scheduling (block and traditional), the classes observed in this study were very similar in structure, style, and time allocation. Both the block and traditionally scheduled classes spent approximately two-thirds of their classtime presenting new material. This indicates that although block scheduled classes have more "in class" time each day, teachers in both settings are using class time in a similar manner.

Since the time in both types of classes is allocated to old material, new material, etc. in a similar fashion, it follows that the instructional activities observed in both classroom settings would be similar. Instruction observed in the ten classrooms continues to follow the more traditional or mechanistic structure (Ivey, 1996).

The concept of mechanistic structure developed from Pepper's(1942) description of four world views or hypotheses, and was expanded by Geddis (1982) who considered the possible influence that a teacher's world view could have on her instructional practices. Ivey furthered these hypotheses by considering that the traditional mathematics classroom incorporates a mechanistic world view, while the classroom envisioned by the NCTM Standards epitomizes an organic world view (1996). Ivey's view of culture within the classroom is particularly powerful for this study because changes being instituted in classroom organization, such as scheduling, require changes in what students and teachers do. There are two world views identified by Ivey that will provide support for this study, mechanistic and organic. The mechanistic view uses the root metaphor of the machine.

The world is viewed in terms of cause and effect, action and reaction, and stimulus and response (Pepper, 1942; Quina, 1982). In an organic structure, the world is seen as an integrative process. This view of reality is the whole in relation to its parts, where all parts must be integrated into the picture (Pepper, 1942; Ivey, 1996).

In the mechanistic structure, Ivey identifies the school as the machine, the teacher as the worker, and the student as the product(1996). In this environment, the class begins with grading the previous nights homework, presentation of new material with examples, practice, and an assignment.

The mechanistic structure provides a basic framework of what was observed in both the block and traditional classrooms. Students were not as involved in their own learning as what teachers wanted or viewed them to be. The teacher was the instructor and the students received this instruction through verbal or written directions and examples. In this mechanistic environment, there was little use of models or manipulatives, technology, or group interaction among the students. The findings of this study support King's (1978) findings of most teachers making very little adjustment in their instructional practices. And, Kramer's (1997b) statement that changing schedules does not necessarily lead teachers to change their instructional practices is also supported through this study. Structural change without additional support does not lead to changes in instruction (Newman and Wehlage, 1995).

Research shows that math teachers have a more difficult time changing their instructional practices than do those in other core subject areas (Ross, 1977; Brophy, 1978; Averett, 1994; Reid, 1995). In changing instructional practices, teachers would be moving toward a more organic structure. The organic view is a more integrated approach where students would have an opportunity to synthesize the new material as it is learned. In this framework, the students are the skilled workers and the teachers are the managers. There is more verbal communication, and multiple solutions are sought when solving a problem. Instructional time is spent with students working in groups to solve a common problem or reach a common goal (Ivey, 1996). In this environment, discovery learning, models or manipulatives, and technology would be integrated together to further understanding. Students would be actively engaged in their own learning on a continuous basis.

The benefits of technology and manipulative usage integrated into learning process were evident in the mean scores from the smaller sample group. Although no significant difference was found, those students who utilized the graphing calculator during instruction had a higher mean score on the EOC exam. These results support the belief that the graphing calculator facilitates a departure from traditional algebraic practices and has a positive effect on the learning environment (Dugdale, et.al., 1995; Hembree and Dessart, 1986; Sivin-Kachala, 1993; Quesada and Maxwell, 1994; Usiskin, 1993),

In 1993, the Texas Education Agency (TEA) mandated that districts must provide students with graphing calculators by the 1995-96 school year. They did not mandate that students use these graphing calculators on a daily or even weekly basis. As noted in the observations and interviews from this study, students and teachers are using graphing technology on a minimal or weekly basis. Technology is not integrated into the teaching and learning of Algebra I.

With five of ten block classes observed utilizing graphing technology and only two of ten traditionally scheduled classes using graphing technology, the impact of the use of technology in the Algebra I classroom still remains to be seen. Based upon the observations and interviews, it does appear that teachers in block classes have more time to devote to using technology in their presentation of new material.

Similar to the usage of technology, the use of models or manipulatives in the algebra classroom was minimal. The groups observed using manipulatives did have a higher mean score on the EOC exam, but the difference was not significant. The findings of higher scores for students using manipulatives or models supports previous studies documenting that the usage of manipulatives resulted in higher scores than teacher explanation alone (Dyer, 1996; Goldsby, 1997). Observations and questionnaires revealed time as the major factor in hindering usage of manipulatives.

With no significant difference in mean scores related to technology usage and manipulative usage, and classroom time being allocated similarly, it is understandable why there was no significant difference on the mean score from the EOC for the large group of Algebra I students instructed in block scheduling format and the mean score of a group of Algebra I students who were instructed in a traditional scheduling format. Although there was no significant difference, the block scheduling group had a higher mean score on the EOC exam, and the scores had a smaller range than the traditional scheduling scores.

When the districts who only reported eighth grade scores were removed from both the block and traditional groups, the block scheduled group had a mean score on the EOC that was five points higher than the traditional group. Although the difference was not significant, it does merit further research and observation. The findings from this study support the belief that mathematics educators have accepted a more constructivist view of learning mathematics but learning mathematics in school still continues to be dominated by the traditional transmission view of knowledge (Wood, Cobb & Yackel, 1991).

Implications

Therefore, this study lends itself to the same premise as the review of literature in Chapter 2. Namely, that changing the structure or schedule of a class will not improve student achievement by itself. Since the publication of the NCTM Standards, educators have known that "Alternative methods of instruction will require the teacher's role to shift from dispensing information to facilitating learning" (p. 128). It is this shift that administrative personnel are attempting to implement through block scheduling, and research has shown that scheduling is not the way to accomplish this. In general, research into school restructuring indicates that structural change alone, without additional support, does not lead to changes in instruction (Newmann and Wehlage, 1995). Quoting Canady and

Rettig, two of the nation's strongest advocates of block scheduling, "We urge school personnel NOT to move to any form of block scheduling if teachers are not provided with a minimum of 5, and hopefully 10 days, of staff development (1995, p. 205).

Although none of the analysis related to this study resulted in significant differences, it should be noted that the smaller sample of nine campuses or ten classrooms was a realistic "picture" of what is going on in mathematics classrooms today. Many teachers are teaching within the time structure of block scheduling without the proper training or support that is needed. It can clearly be seen from the statistical data combined with the qualitative data that students receiving instruction in block scheduled classes had better Algebra I End-of-Course scores. It is in these block classes that teachers had more opportunities to use technology, manipulatives, and other alternative instructional strategies. Students can attain the same higher levels of achievement in a block or traditionally scheduled class if the instruction that they receive is a more non-traditional approach that includes technology, manipulatives, and applications. And although time is not the principal ingredient effecting student achievement, it does provide teachers with more instruction options than those on traditional scheduling.

These findings imply that the teacher is the major influencing factor for student achievement on the Algebra I EOC exam. The instructional practices of the teacher determine whether the student will encounter technology, models, applications to other subjects, opportunities for communication, etc. For these instructional practices to be implemented, teachers need time in class and training outside of the classroom. Teachers need to be trained within the field of mathematics on how to integrate such applications and technology. The classroom is ever changing, thus requiring teacher training on an on-going basis.

In addition to increased training and support for mathematics teachers, there needs to be increased training for preservice teachers. College students wanting to become mathematics teachers should be trained and taught using organic instructional practices. Technology, communication, and models should become an integral part to the solution of any problem.

Recommendations for Further Research

Increasing the length of time in the classroom does not appear to be the way to increase student achievement, but it does appear to provide teachers with more opportunities to implement technology, models, etc. into their instructional practices which in turn do improve student achievement. This researcher recommends that teachers receive more training on how to teach mathematics using the graphing calculator and manipulatives based on research that supports the fact that student achievement increases with the usage of these materials.

Whether in block or traditional scheduling, teachers need to learn how to use their time wisely using instructional practices and materials that will best benefit them and their students. Without the support in the form of staff development and adequate planning time it is unlikely that teachers will be able to alter their instructional practices. Without such support, switching to a block schedule may actually decrease student achievement (Kramer, 1997).

Findings of this study suggest the following:

1. Examine whether block or traditional scheduling is more beneficial to lower level students than higher level students.

2. Another study might focus on just eighth grade Algebra I students.

3. Examine whether group interaction or group work is beneficial to all algebra students.

4. Extend this study to include a larger first level

sample, possibly an entire state of student EOC scores.

5. Examine block and traditional scheduling at two comparable schools with comparable student populations and look at achievement in several subjects.

6. Examine whether additional staff development and pre-service increases student achievement.

7. The procedures for training future mathematics educators must be based upon an organic structure allowing pre-service educators to experience mathematics education from a constructivist perspective.

8. Mathematics teachers need to take a more proactive role in the establishment and implementation of policy and procedure as it effects the mathematics classroom.

The underlying philosophical changes in the roles of teacher and student that are a part of any organizational change require careful consideration. "The changes suggested by the Standards are not cosmetic; they represent real changes in the way mathematics classes are conceived of by teachers and students. Yet, organizational innovations that appear to be only surface changes may actually encourage lasting systemic changes" (Ivey, 1988, p. 141). A quote from Prisoners of Time suggests the essence of alternative scheduling and the focus of this study, "Both learners and teachers need more time - not to do more of the same, but to use all time in new, different, and better ways. The key to liberating learning lies in unlocking time" (p. 10).

APPENDIX A

Objectives and Instructional Targets
Algebra I End-of-Course Examination

DOMAIN: Graphing

Objective 1: The student will demonstrate an understanding of the characteristics of graphing in problems involving real-world and mathematical situations.
* Describe the domains and ranges of various functions and relations.
* Identify the effects of simple parameter changes on the graphs of relations and linear, quadratic, and absolute value functions.

Objective 2: The student will graph problems involving real-world and mathematical situations.
* Graph a line given its characteristics or equation.
* Graph linear inequalities in one or two variables.
* Graph systems of inequalities and recognize the solution(s) from the graph.

Objective 3: The student will write equations of lines to model problems involving real-world and mathematical situations.
* Write an equation of a line given its graph or description.

DOMAIN: Equations and Inequalities

Objective 4: The student will formulate or solve linear equations/inequalities and systems of linear equations that describe real-world and mathematical situations.
* Formulate or solve linear equations/inequalities.
* Formulate or solve systems of linear equations.

Objective 5: The student will formulate or solve absolute value equations/inequalities and quadratic equations that describe real-world and mathematical situations.
* Formulate and solve quadratic equations.

Objective 6: The student will perform operations on and factor polynomials that describe real-world and mathematical situations.
* Perform operations on polynomials.
* Factor polynomials using models.

Objective 7: The student will solve rational and radical equations that describe real-world and mathematical situations.
* Solve rational equations.

DOMAIN: Problem Solving

Objective 8: The student will use problem-solving strategies to analyze, solve, and/or justify solutions to real-world and mathematical problems involving exponents, quadratic situations, and right triangles.

* Analyze and/or solve problems involving the laws of exponents.
* Analyze and/or solve problems involving quadratic equations.
* Analyze and/or solve problems involving right triangles.

Objective 9: The student will use problem-solving strategies to analyze, solve and/or justify solutions to real-world and mathematical problems involving one-variable or two-variable situations.

* Analyze and/or solve problems involving one variable situations.
* Analyze and/or solve problems involving two-variable situations.

Objective 10: The student will use problem-solving strategies to analyze, solve and/or justify solutions to real-world and mathematical problems involving probability, ratio and proportion, and graphical and tabular data.

* Analyze and/or solve problems involving probability.
* Analyze and/or solve problems involving ratio and proportion.
* Analyze graphical and tabular data including scatter plots and/or make predictions based on this data.

APPENDIX B

Teacher Name: ______________ School Name: _____________________

Rate the following, from non-use (1) to daily use (5), according to usage within your classroom.

		Not Used	Monthly	Weekly	Twice Weekly	Daily
1.	Students developed problem solving skills.	1	2	3	4	5
2.	Students related the algebraic concept to the real world.	1	2	3	4	5
3.	Students made connections between concepts and visual examples.	1	2	3	4	5
4.	Students use manipulatives to connect abstract and concrete examples.	1	2	3	4	5
5.	Students made connections between algebra concepts and other subjects.	1	2	3	4	5
6.	Students used graphs/charts/models to solve problems.	1	2	3	4	5
7.	Students use discovery learning techniques in problem situations.	1	2	3	4	5
8.	Students are actively involved in their own learning process.	1	2	3	4	5
9.	Students work in groups.	1	2	3	4	5
10.	Students express solutions both verbally and in writing.	1	2	3	4	5
11.	Students used computers in the learning process.	1	2	3	4	5
12.	Students used graphing calculators in the learning process.	1	2	3	4	5
13.	Students used graphing calculators as a tool for discovery.	1	2	3	4	5
14.	Students used the graphing calculator in an assessment process.	1	2	3	4	5

Please answer the following questions as accurately and thoroughly as possible. Attach any handouts or ancillary materials used during the lesson.

1. Describe the instructional strategies used in this unit.

2. Describe the assessment of the unit, both formative and summative (include copies if possible).

3. Describe classroom opportunities for:
   a) problem solving
   b) communication

   Describe classroom opportunities for (cont.):
   c) technology usage
   d) making connections

4. Describe or list unique resources used in this unit.

5. What are the instructional strategies used?
   Text -
   Manipulatives -
   Technology -

6. Describe classroom opportunities for:
   a) problem solving
   b) communication
   c) technology usage
   d) making connections

4. Describe uses of technology (as specific as possible).

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