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Equity in mathematics: Algebra for everyone

Regina Lynn Hervey
College of William & Mary - School of Education

EQUITY IN MATHEMATICS: ALGEBRA FOR EVERYONE

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EQUITY IN MATHEMATICS:

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by

Regina Lynn Hervey

Approved August 1999 by

Robert J. Hanny, Ph.D.
Chair of Doctoral Committee

James H. Stronge, Ph.D.

Brenda T. Williams, Ed.D.

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DEDICATION

This dissertation is dedicated to my parents, Roosevelt and Violet Hervey, for their love, support, and encouragement throughout this endeavor. I am forever indebted to them for sharing their wisdom and knowledge, but most especially for instilling in me a passion about education. A most grateful daughter says "Thank You".

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Abstract

Research over the past twenty years supports the teacher as the critical factor in the implementation of educational programs. The primary purpose of this mixed design study was to determine teachers' perceptions in implementing the required Algebra I program that was mandated by the state of Virginia in 1995. The research was examined through the lens of the recommendations of the National Council of Teachers of Mathematics (NCTM): communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. This study was limited to ninth grade Algebra I teachers in a school division in Virginia. Two Concerns Based Adoption Model (CBAM) instruments were used in this research. The Stages of Concern (SoC) Questionnaire determined the teachers' concerns regarding implementation of the required Algebra I program. The Levels of Use (LoU) focused interview data supported the teachers' areas of concern. In addition, the grounded theory method was used to analyze the observation and interview data. Results were presented as narrative descriptions from which major categories of concerns emerged. Findings revealed that the NCTM recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically were not implemented in the required Algebra I program. Teachers were unaware that the required Algebra I program was designed to meet the needs of a changing population. This study supports the need for comprehensive and ongoing training for teachers if the needs of a more diverse population are to be realized in a required Algebra I program.

EQUITY IN MATHEMATICS:

ALGEBRA FOR EVERYONE

Chapter 1: The Problem

Introduction

In 1995, the Virginia Board of Education established a new requirement as a part of the Standards of Learning that all students must pass Algebra I in order to receive a high school diploma (Standards of Learning for Virginia Public Schools, 1995). This new requirement replaced the traditional practice of offering Algebra I as an elective class, primarily intended for college-bound students. The assumption was that the required Algebra I program would serve to provide equity of educational and economic opportunity. In fact, the study of algebra has been discussed as an equity issue for two decades (Oakes, 1985). The new algebra requirement has significant implications for teachers as they strive to meet the needs of a more diverse student population.

The Curriculum and Evaluation Standards published by The National Council of Teachers of Mathematics (NCTM) recommended the development of algebraic thinking to achieve "mathematical power" a term defined as ". . . an individual's ability to explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve nonroutine problems" (NCTM, 1989, p.5). The required Algebra I program reflects the importance of algebraic knowledge in mathematical reasoning, problem-solving skills, analytical thinking, and technology (Moore-Harris, 1997). The application of these skills is deemed necessary to solve everyday problems. However, this seemingly simple algebra requirement has raised many complex issues regarding the teaching and learning of algebraic thinking in the K-12 mathematics curriculum. In addition, new technology standards also have been included in the mathematics curriculum.

The mathematics needed today differs significantly from the mathematics needed earlier in the century. The higher order thinking skills required to function in a complex, changing society have become strong forces for change and reform in mathematics education (Romberg, 1992). Cumbersome computations are accomplished more quickly and precisely with calculators and computers. "Our world is becoming more mathematical" (Willoughby, 1990, p.1). Present day society requires number sense, estimation skills, ability to analyze data intelligently, and knowledge of probability.

The need for education reform in mathematics instruction was reflected in the findings of the National Assessment of Educational Progress (NAEP, 1990) report Only 46 % of the students consistently demonstrated a successful performance with problems involving decimals, percents, fractions, and algebra by the twelfth grade. These findings indicated that traditional teaching methods did not mathematically empower students.

Furthermore, the equity issue in mathematics was reflected in the mathematics strand of the National Assessment of Educational Progress (NAEP, 1996). This strand included simple patterns at grade 4, basic algebra concepts at grade 8, and sophisticated analyses at grade 12. Results by demographic subgroups revealed that Black, Hispanic, and American Indian students achieved far below Asian/Pacific

Islander and White students in mathematics. Interestingly, the report noted that assessments in mathematics revealed few significant gender differences. Not surprisingly, students with well-educated parents continued to perform at higher levels than did students with less educated parents (Reese, Miller, Mazzeo, & Dossey, 1997).

Traditionally, differences in student achievement were often attributed to the influence of home factors. The overarching home factor considered was socioeconomic status which encompassed family income, occupation, educational level of parents, and household possessions. However, Secada (1990) reminded the education community that student demographic characteristics were social, contextual settings that did not, in themselves, cause poor mathematics achievement. Student demographics reflected class structures. Bowles and Gintis (1976) recognized that schools played a significant role in the reproduction of a class structure that maintained a capitalist society. These researchers believed that educational messages were differentially distributed in schools and appeared to be more advantageous for certain students. Ability grouping and tracking unintentionally created a caste system in which many were destined for failure.

The required Algebra I program was intended to reduce student enrollment inequities by increasing the number of minority groups in higher level math courses and thereby, expanding their economic opportunities. Furthermore, the racial and ethnic balance is shifting within the United States. De Vita (1996) stated that by 2020, " 118 million Americans are projected to be of minority backgrounds" (p. 19). These changing demographics will result in a more diverse population requiring significantly different instructional practices (Steen, 1992). A critical examination of present teaching practices is needed to better understand the changes necessary to meet the needs of all students.

Furthermore, the Curriculum and Evaluation Standards (National Council of Teachers of Mathematics, 1989) reported that traditional teaching practices remained the norm across the nation. Most mathematics teachers continued to use the lecture as their primary instructional method while relying heavily on textbooks and daily worksheets to practice new skills. There was little evidence of instructional practices involving group work, calculators, computers and other manipulatives. House (1988) noted that mathematics instruction continued to emphasize the acquisition of information rather than a sound understanding of algebraic concepts and the ability to use knowledge in new and unexpected ways. Emphasis on memorized formulas and correct responses to textbook examples has remained as benchmarks of Algebra Instruction. The teacher, rather than the student, was the central focus of the learning process. The National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards (1989) suggested that traditional algebra teaching practices do not meet the needs of students, especially minority groups. Therefore, the report contended that the emphasis in algebra courses should shift from mere symbol manipulation to the understanding of algebraic thinking to enable students to solve complex problems.

A review of the research identified numerous promising programs, many of which included computer-assisted components. The computer-assisted programs were excluded from this study. The programs selected were germane to this study as they reflected the National Council of Teachers of Mathematics (NCTM) recommendations. These programs include the "Thinking Mathematics" approach (1989), the University of Chicago School Mathematics Project, UCSMP (1983), the Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project (1994), the Algebra Project (1989), and the Hawai'i Algebra Learning Project (1994). The content and delivery of instruction utilized in these programs are significantly different from the approaches taken in traditional algebra courses. These programs are further discussed in chapter 2.

Changes in standards, technology, and student diversity require a radically altered mathematics curriculum and delivery of instruction. These changes significantly increase the demands placed on teachers. Past research suggested that the increased demands placed on teachers must be addressed before new programs can be successfully implemented (Hord, 1987). Earlier reform efforts often overlooked the role of the teacher. The early work of Hall, George and Rutherford (1979) focused on the concerns of teachers which were identified as being present in all program implementations. These concerns served as the basis for the development of the Concerns-Based Adoption Model (CBAM). This model developed by Hall and Hord (1987), provided the theoretical framework used to study the concerns of teachers as they implemented new programs. The successful progression of a program from initiation to institutionalization was dependent on recognizing and supporting these concerns.

Statement of the Problem

Hall and Hord (1987) define an innovation as any new program, practice, materials, or any new element. In this study, the required Algebra I program for all students, is the innovation. Typically, college-bound students take Algebra I in the seventh or eighth grade. The recent Algebra I graduation requirement has resulted in the other students taking algebra in the ninth grade. Therefore, the ninth grade Algebra I classes include students who previously would not have enrolled in an algebra course. The challenge for Algebra I teachers is to meet the needs of this changing student population.

The purpose of this study was to determine the concerns of the ninth grade Algebra I teachers in implementing the required Algebra I program. The study examined the required Algebra I program from a teacher perspective through the lens of the National Council of Teachers of Mathematics' recommendations (NCTM, 1989) for teaching mathematics. In addition, the study investigated the end-of-year pass rates of students with respect to the expressed concerns of the teachers.

Research Questions

1. What are the concerns of ninth grade Algebra I teachers in implementing the required Algebra I program?

2. To what extent are the National Council of Teachers of Mathematics (NCTM) recommendations reflected in the required Algebra I program?

3. To what extent do the Levels of Use (LoU) focused interview data support the identified teacher Stages of Concerns type, "self," "task," or "impact" ?

4. Do teachers identified by their major Stages of Concern (SoC) Questionnaire type, "self," "task," or "impact" differ in their pass rates on the required Algebra I final grades?

Significance of the Study

The results of this study contribute to the limited body of knowledge on the impact of the required Algebra I program on teachers and student achievement. This study also contributes to the research on factors affecting teachers in the implementation of programs for diverse groups of students. Students who are deficient in algebra will not be allowed to graduate from high school. Schools that have a high failure rate are at risk of losing state accreditation (Regulations Establishing Standards for Accrediting Public Schools in Virginia, 1997). Clearly, the stakes are high and the selected local school division has a vested interest in the outcomes of the study

Definitions

Algebra Achievement: A measurement of student performance as indicated by his or her final Algebra I grade.

Algebra Curriculum: The program offerings, curriculum guides, learning objectives, and assessment tools that are reflective of the Virginia Standards of Learning for algebra (Standards of Learning for Virginia Public Schools, 1995)

Contemporary algebra: The language through which most of mathematics is communicated. Algebraic thinking is essential to mathematical literacy needed by all students to successfully participate in society. Algebra uses the application of abstract concepts to foster generalizations and insights beyond the original context to real life situations.

Equity. Comparability of access to educational opportunity provided by the Algebra I requirement. For the purpose of this study, the term equity is not meant to include issues of equity related to fiscal budgets or other areas

Implementation: The process of putting into practice a new idea, program, or set of activities (Fullan & Stiegelbauer, 1991).

Innovation: The program or process being implemented whether products, such as new textbooks or curriculum materials, or process, such as instructional procedures (Hall & Hord, 1987).

Stages of Concern: The composite representation of the feelings, considerations, thoughts, and preoccupations given to a particular issue or task as measured by the Stages of Concern (SoC) Questionnaire. The questionnaire contains 35 Likert-scale items designed to measure seven developmental stages of concern about an innovation that is being implemented: (a) awareness, (b) informational, (c) personal, (d) management, (e) consequences, (f) collaboration, and (g) refocusing (Hall et al., 1979).

Levels of Use: A focused interview that elicits information from teachers about specific behaviors associated with using an innovation (Hall & Hord, 1987) The Levels of Use (LoU) focused interview requires responses specific to the research question number 2, the extent to which the NCTM recommendations are reflected in the required Algebra I program. The structured format of the interview progresses from general to specific information relative to the implementation level of the individual.

National Council of Teachers of Mathematics (NCTM) Recommendations: Statements used to judge the quality of a mathematics curriculum or methods of evaluation (Curriculum and Evaluation Standards for School Mathematics, 1989)

Teacher Capacity: The power or ability of the teacher to deliver instruction based upon knowledge, skills, dispositions, and views of self (David, 1993).

Limitations of the Study

The following limitations should be considered when interpreting the results of this study: (a) the study was limited to the analysis of data from ninth grade Algebra I teachers in the four high schools located within a school division in Virginia. (b) algebra achievement was measured by final grade pass rates. The foregoing factors may limit generalizations to other school divisions.

Major Assumption

The major assumption of this study was that the Concerns Based Adoption Model (CBAM) instruments of Stages of Concern (SoC) Questionnaire and the Levels of Use (LoU) focused interview served as accurate measures of teacher concerns in the implementation of the required Algebra I program.

Chapter 2: Review of the Literature

Introduction

Algebra has been described as the "gatekeeper" to educational and economic opportunity. Rose (1989) described the obligation underlying the gateway perception:

> The challenge that has always faced American education...is how to create both the social and cognitive means to enable a diverse citizenry to develop their ability. It is an astounding challenge: the complex and wrenching struggle to actualize the potential not only of the privileged. (p. 225)

To establish a rationale for the study, this chapter reviews the relevant literature in five major areas: algebra and economic opportunity, implication of ability grouping, the National Council of Teachers of Mathematics (NCTM) recommendations for algebra instruction, teacher capacity and algebra instruction, and promising programs in algebra instruction.

Algebra and Economic Opportunity

The issue of equity in mathematics education served as a context within which the study was conducted. The equity concept in mathematics was reflected in the requirement that all students take algebra. Historically, only college-bound students were taught algebra which, thereby, denied the majority of students access to advanced mathematics. The reform efforts of the 1990s not only sought to improve mathematics achievement, but to ensure that all students were exposed to and succeeded in higher level mathematics courses. This more inclusive perspective advocated Algebra I as a minimal requirement for graduation.

The position that all students take more advanced courses was supported by The National Council of Teachers of Mathematics (NCTM) "An Agenda for Action" (1980). The major objective was to engage students in higher level thinking skills in mathematics. Students were encouraged to use the language and symbols of mathematics to communicate. Mathematical confidence was developed through experiences that allowed students to verbalize problem-solving strategies. Emphasis was placed on a deeper understanding and application of mathematical concepts in everyday situations.

"A Nation at Risk," published by the National Commission on Excellence in Education (1983), was a wake up call to the public and specifically, to educators that many students in this country were achieving far below their academic potential. This perception was supported by the steady decline in The College Board's Scholastic Aptitude Test (SAT) scores from 1963 to 1980. Mathematics scores decreased by nearly 40 points. Furthermore, between 1975 and 1980, there was a 72% increase in the number of remedial mathematics courses offered at four-year colleges.

The Curriculum and Evaluation Standards (National Council of Teachers of Mathematics, 1989) document served as a guide to reform mathematics in the present decade. The standards included the specific skills to be achieved in grades K-12. The content of the mathematics standards was intended to increase the mathematical power of students through the following four goals: communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. The Curriculum and Evaluation Standards (National Council of Teachers of Mathematics, 1989) recognized the importance of these four areas by their foremost placement within the Curriculum Standards K-12 document.

The Standards define mathematics as communications so that all students can:

- reflect upon and clarify their thinking about mathematical ideas and relationships;
- formulate mathematical definitions and express generalizations discovered through investigations;
- express mathematical ideas orally and in writing;
- read written presentations of mathematics with understanding,
- ask clarifying and extending questions related to mathematics they read or hear about;
- appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas.

The standards define mathematics as connections so that all students can:

- recognize equivalent representations of the same concept;
- relate procedures in one representation to procedures in an equivalent representation;
- use and value the connections among mathematical topics,
- use and value the connections between mathematics and other disciplines

The Standards define mathematics as problem solving so that all students can:

- use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content;
- apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics;
- recognize and formulate problems from situations within and outside mathematics;
- apply the process of mathematical modeling to real-world problem situations

The Standards define mathematics as reasoning so that all students can:

- make and test conjectures;

- formulate counterexamples;
- follow logical arguments;
- judge the validity of arguments;
- construct simple valid arguments; and so that, in addition, college-intending students can-
- construct proofs for mathematical assertions, including indirect proofs and proofs by mathematical induction.

These standards served as a foundation to support the study of algebra and other higher mathematics courses. The Curriculum and Evaluation Standards was a critical document to reform efforts in mathematics.

" An Agenda for Action," " A Nation at Risk," and The Curriculum and Evaluation Standards supported the position that all students should take more advanced courses in mathematics. Critics of the position argued, however, that the more advanced mathematics courses merely exacerbated existing student inadequacies. In theory, the required Algebra I program allowed students access to advanced mathematics classes and perhaps greater opportunities overall. However, success for a number of students was inhibited by many factors: low self-esteem, feelings of inadequacy, previous failures, poor organizational skills, difficulties with abstract symbolism, and inadequate teaching strategies (Chazan, 1994) Furthermore, Steen (1992) contended that first-year Algebra I in its present form was not relevant to students Algebra I, therefore, needed to be restructured to reflect the needs of students in order for them to be empowered mathematically.

Implications of Ability Grouping

Much research suggested that grouping and tracking practices significantly contributed to the lack of mathematics achievement for many students. For example, the practice of homogeneous grouping for math instruction has resulted in inequities of learning opportunity (Wheelock, 1994). Students placed in lower level math groups in elementary school, usually do not take algebra at the high school level. According to the National Educational Longitudinal Study of 1988, the percentage of students grouped homogeneously for math was 57% in fifth grade and 94% in ninth grade. Oakes (1992) noted that "It has been estimated that 60% of all elementary schools and 80% of all secondary schools track students even though no empirical research in the past twenty-five years has substantiated its effectiveness"(p.16). A 1993 study conducted by the National Association of Secondary School Principals reported that ability grouping in separate classes existed in 82% of their schools (Wheelock, 1994).

Oakes (1985) demonstrated that tracking limited educational opportunity, particularly for students with disabilities, minority, female and poor students. Furthermore, national statistics (National Assessment of Educational Progress, 1996) on these groups of students revealed inequities in mathematics achievement which were also supported in the data of academic achievement, high school completion, acquisition of college degrees, and occupational status and income. While the practice of tracking remained the norm, many policymakers including the National Governors Association, the Carnegie Council for Adolescent Development, The College Board, the National Education Association, and the National Council of Teachers of English were increasingly opposed to the practice of tracking (Oakes, 1985).

Bowles and Gintis (1976) noted that ability grouping and curriculum tracking exemplified school structures and procedures that contributed greatly to different educational experiences for children. Algebra I, an elective course, was a specific example of a school structure that served as a vehicle to sort and track students into college preparatory, vocational, or general education tracks. Oakes (1992) noted that sorting students into "high" and "low" tracks severely limited the educational and occupational futures of low-income and minority students. Furthermore, in racially mixed schools, tracking limited opportunities for meaningful interracial contact and perpetuated stereotypes of minority students as being less intelligent than white students.

Johnson and Johnson (1981) stated that "there is no consistent evidence that ability grouping increases student achievement at any ability level" (p. 22). Goodlad (1984) in his study of schools found numerous differences between high- and low-track classes:

> Consistently, the differences in curricular content, pedagogy, and class climate favored the former [high track]. Consistently, the practices and atmosphere of the low track classes conveyed lower academic and, indeed, more modest expectations generally, as well as greater teacher reinforcement of behaving, following rules, and conforming... Almost without exception, classes not tracked into levels but containing a heterogeneous mixture of students achieving at all levels were more like high than low track classes in regard to what students were studying, how teachers were teaching, and how students and teachers were interacting in the classroom. (Goodlad, 1984, p. 159)

This research suggested that students in heterogeneous classes accomplish higher levels of achievement than students in homogeneous classes. Traditionally, tracking practices excluded the majority of students from enrollment in algebra classes

Nevertheless, Goodlad and Oakes (1988) stated, "Nearly all can benefit from studying the important concepts of algebra. Some will learn more, some less. But tracking excludes many children from ever being in classes where these "high status" subjects are taught" (p. 19).

On the other hand, the tracking issue remained controversial because some parents and educators thought that high-achieving students were not challenged in heterogeneous classes. Kulik, Kulik, and Bangert-Drowns (1990) presented evidence that high achievers performed better in accelerated classes for the gifted and talented. Also, Silverman (1990) maintained that eliminating programs for gifted students would be as unethical as removing programs for students with disabilities. Feldhusen (1990) supported this position: "We do know that students in high-track classes will learn less in heterogeneous classes" (p. 7). However, Fenstermacher (1983) noted that:

> It is possible that some students may not benefit equally from unrestricted access to knowledge, but this fact does not entitle us to control access in ways that effectively prohibit all students from encountering what Dewey called "the funded capital of civilization." (p. 83)

The equity issue was discussed in the Curriculum and Evaluation Standards (NCTM, 1989) which stated:

> The consequences of dealing with students with different talents, achievements, and interests have led to such practices as grouping and tracking and to special programs for the gifted or handicapped students who need and deserve special attention. However, we believe that all students can benefit from an opportunity to study the core curriculum specified in the Standards. This can

be accomplished by expanding and enriching the curriculum to meet the needs of each individual student, including the gifted and those of lesser capabilities and interest . . . We believe the current tracking procedures are inequitable, and we challenge all to develop instructional activities and programs to address this issue directly. (p. 253)

National Council of Teachers of Mathematics Recommendations

The findings of the National Council of Teachers of Mathematics, (1989); the National Research Council, (1989); Weiss, (1995); and the National Assessment of Educational Progress, (1996), suggested that teaching practices, for the most part, have not changed to meet new standards and requirements. The typical classroom practice followed a sequence: correction of the assigned homework, working out of difficult problems, explanation of a new skill, assignment of homework, and time for students to begin the assignment in class. As Goodlad (1984) observed, students are generally involved in the passive activities of listening to teachers, writing answers to questions, and taking tests and quizzes. This view of learning supports the notion that poor mathematics achievement is a problem of pedagogy rather than inability on the part of the learner (Blais, 1988). Piaget (1974) stated that the teaching of mathematics is "psychologically archaic insofar as it rests on the simple transmission of knowledge" (p. 17). These findings suggested that traditional practices were not consistent with the recommendations of the National Council of Teachers of Mathematics (NCTM, 1989).

The National Council of Teachers of Mathematics' "Professional Teaching Standards" (1991) and the "Curriculum and Evaluation Standards for School Mathematics" (1989) were designed to promote a vision of mathematics teaching that would provide quality mathematics instruction for all students. High school graduates must think mathematically about complex issues. As Kamii (1990) stated, "mathematical literacy is fast becoming a prerequisite not only for participation in a global economy driven by technological change, but for citizen participation itself" (p.392). The National Council of Teachers of Mathematics (NCTM) recommendations advocated instruction based upon problem solving and the construction of learner-generated solutions rather than memorization of formulas and teacher-generated solutions to textbook examples. The Standards also recommended the use of calculators and other manipulatives, cooperative groups, and authentic assessment .

Construction of mathematical knowledge. Central to the recommendations of the National Council of Teachers of Mathematics (NCTM) was the idea that knowledge became something that learners must construct for themselves. Piaget wrote:

> To understand is to discover. . . A student who achieves a certain knowledge through free investigation and spontaneous effort will later be able to retain it; he will have acquired a methodology that can serve him for the rest of his life, which will stimulate his curiosity without the risk of exhausting it. At the very least, instead of having his memory take priority over his reasoning power he will learn to make his reason function by himself and will build his own ideas freely . . . The goal of intellectual education is not to know how to repeat or

> retain ready-made truths. It is in learning to master the truth by oneself at the risk of losing a lot of time and of going through all roundabout ways that are inherent in real activity. (p. 93 and p. 106)

Learning mathematics as an active process. The major tenet of the National Council of Teachers of Mathematics (NCTM) recommendations viewed learning as an active process. This position was congruent with the constructivist philosophy that students acquire knowledge by processing and perceiving the essence of a problem situation. Brooks and Brooks (1993) shared five overarching principles of constructivist pedagogy:

> (a) posing problems of emerging relevance to learners; (b) structuring learning around "big ideas" or primary concepts; (c) seeking and valuing students' points of view; (d) adapting curriculum to address the students' suppositions; and (e) assessing student learning in the context of teaching... Deep understanding occurs when the presence of new information prompts the emergence or enhancement of cognitive structures that enable us to rethink our prior ideas" (p. 15)

Guidelines for reform in mathematics. The National Council of Teachers of Mathematics' Professional Teaching Standards (1991) urged educators who were serious about changing teaching practices to consider adopting the Standards as a framework for change:

> We challenge all who have responsibility for any part of the support and development of mathematics teachers and teaching to use these standards as a basis for discussion and for making needed change so that we can

reach our goal of a quality mathematics education for every child.(p. vii)

The National Council of Teachers of Mathematics (NCTM) established the guidelines for reform in its publication, "Standards for Curriculum and Evaluation" (1989). The standards were designed to serve as a framework for schools to improve the teaching and learning of mathematics. These educational goals emphasized mathematical literacy for all students and included:

(a) that they learn to value mathematics;

(b) that they become confident in their ability to do mathematics;

(c) that they become mathematical problem solvers;

(d) that they learn to communicate mathematically; and

(e) that they learn to reason mathematically. (p 21).

Therefore, it was essential that instructional methods used by teachers incorporated reasoning and investigation skills, mathematics as a means of communication, and the development and appreciation of the role of mathematics in human affairs

Challenge for mathematics educators: The challenge for mathematics educators was twofold: (a) to teach algebra to all students, and (b) to change delivery of instruction to meet National Council of Teachers of Mathematics' recommendations. The teaching of algebra needed to address how to assist students in making the transition from arithmetic to algebraic thinking beginning at the kindergarten level. Essentially, algebraic thinking "embodies the construction and representation of patterns and regularities, deliberate generalization, and most important, active exploration and conjecture" (Chambers, 1997, p 85) Critical elements of algebraic thinking could be developed in a systematic and coherent manner through problem-solving experiences. "The key is the development of students' pattern-building capabilities through appropriate problems and questions designed to build a bridge from arithmetical to algebraic thinking" (Day & Jones, 1997, p. 212).

Importance of algebraic thinking: Questions should prompt students to look for patterns among the variables, make and provide reasons for their conjectures, and represent their patterns and reasoning. Curcio and Schwartz (1997) observed a young kindergarten girl weighing colored plastic bears on a balance scale. The child placed a baby bear on one side of the scale. Next, she placed a momma bear on the other side of the scale causing it to tip. Soon the student recognized the pattern that for each momma bear, two baby bears were needed to balance the scale. The student was able to verbalize the relationship between the weight of the momma bear counters and the weight of the baby bear counters. The teacher guided the class in translating the problem into the symbolic notation $m = 2b$, whereby m was the number of momma bears and b was the number of baby bears. Students analyzed the discovered patterns and relationships to make generalizations based on teacher probes. The teacher then reviewed the momma and baby bear relationship using words, concrete objects, pictures, tables, graphs, and symbols. Curcio and Schwartz (1997) noted that most elementary teachers limited similar investigations to simply weighing the bears and recording the data. Therefore, students were denied the opportunity to use algebraic thinking in the exploration of patterns and relationships.

The concept of function, which permeates all of mathematics, is a central building block in the study of algebra. According to Davidenko (1997), most mathematical functions used in everyday life were not thought of in terms of domain, range, or the rules that defined them. However, young students were able to understand the concept of function within a problem solving situation. Davidenko (1997) provided the example of a school store situation in which a student established the price of small notebooks at 79 cents, large notebooks at $1.49, pencils at 20 cents, and erasers at 5 cents. The student interpreted "price" as a function to be "evaluated" on each product. For this function product (p), there were the following: domain: the set of products available at the school store, range: the set of prices, and definition: p (product) = price, and example: p(eraser) = 5 cents. When the student was asked if anything cost $100.00, the child answered that nothing at the school store cost more than $20.00. By stating this response, the student suggested an upper bound for the range of the function. The structure and language of function were then used to describe the information already known and understood by the students. The bear and the school store examples indicate how opportunities for the inclusion of algebraic thinking are available at the elementary level. However, Davidenko (1997) noted that most elementary teachers were not aware of these algebraic connections themselves. As a result many students have not been taught to think algebraically until they encounter an algebra course. While the recent emphasis placed on the Standards of Learning (SOL) has increased teachers' accountability to instruct the specific objectives, many teachers are unaware that the mathematics standards reflect the National Council of Teachers of Mathematics (NCTM) recommendations. According to Curcio and Schwartz (1997), instruction in algebraic thinking must begin at the Kindergarten level.

As Steen (1992) noted, "For most students the current school approach to Algebra Is an unmitigated disaster..." As a result, students have not learned algebra as a style of mathematical thinking, involving the normalization of patterns, functions, and generalizations, and as a set of competencies involving the representation of quantitative relationships. Everyday examples should include manipulatives, graphs, and spreadsheets in order to allow students to demonstrate their mental representations of abstract thinking (National Council of Teachers of Mathematics, 1989). As Hilliard (1989) stated " the design of teaching has less to do with inequity than making pedagogy better for all" (p.69).

Teacher Capacity and Algebra Instruction

Historical overview. According to the literature, the teaching of mathematics has not changed significantly over the past 70 years (Blais, 1988; Dewey, 1933; Goodlad, 1984; Sowder, 1989). The "new math" movement begun in the late 1960's emphasized the need for student engagement in the solving of problems (Polya, 1981) However, the research of the 1960s demonstrated that the delivery of new programs to teachers could not be equated with successful implementation. By the 1970s, it became apparent that the top-down models of program implementation did not work, because they failed to recognize the critical role of the teacher Furthermore, the decade of the 1970s was essentially one of "documenting failure - the failure of the curriculum reform movement to affect practice " The Effective Schools Movement of the 1980s yielded data, that indeed, the teacher was central to change in the instructional process (House, 1988). Few of the algebra programs resulted in improved student achievement, thereby reinforcing the concept that programs in themselves did not result in mathematical literacy. From this period evolved the reform efforts of the 1990s, which continued to focus on the role of the teacher as the critical element in implementation efforts.

Algebra teachers' instruction was based on their understanding of, and beliefs about programs, which unfortunately, remained reminiscent of the early 1900s (Hopkins, Ainscow, & West, 1994). The National Council of Teachers of Mathematics (NCTM) established the Commission on Standards to increase student achievement. The standards most germane to algebra instruction were communication, connections, problem solving, and reasoning. The challenge of the late 1990s is to implement these standards within the context of teacher capacity: knowledge, skills, dispositions, and views of self.

Current perspective on teacher change. Thus, the research on teacher change of the 1990s included a developmental perspective. Changing teaching practices hinged on identifying and addressing the concerns of teachers as a prerequisite to improved student achievement according to Hall and Hord (1987). In addition, Hall and Hord (1987) identified the teacher perspective as critical to the successful implementation of innovations in curriculum and observed this perspective through the expressed concerns of teachers on the Stages of Concern (SoC) Questionnaire and Levels of Use (LoU) focused interview instruments. These instruments identified teachers' concerns by the three categories of "self," "task," and "impact" Teachers with "self" concerns focused on doubt about their own abilities, for instance, the inability to teach a new program. Examples included intense concerns about what the innovation was in terms of its description and what the implementation entailed

Teachers with "task" concerns focused on issues about implementing the program. Examples included concerns about materials, pacing, sequencing, relating subject matter, student interaction, assessment, and classroom management issues. Teachers with "impact" concerns focused on refining the innovation to increase student achievement. Examples included professional development and dialog with colleagues. The expressed concerns of teachers identified as "self," "task," or "impact" focused on the teachers' perspectives in implementing new programs according to Hall, George, and Rutherford (1979).

Emergence of the term, " teacher capacity." Research on educational reforms of the past revealed an initial emphasis on instructional programs which gradually shifted to recognize the perspective of the teacher. The teacher perspective was acquired through the expressed concerns of teachers (Hall & Hord, 1987). The concept of teacher perspective was gradually replaced by the more inclusive term of teacher capacity. Teacher capacity is a new description of teacher perspectives and does not have a different meaning. For that reason, from this point forward, the term "capacity" is followed by "perspective" in parentheses.

O'Day, Goertz, and Floden (1993) defined capacity (perspective) as the power or ability of the teacher to deliver instruction based upon knowledge, skills, dispositions, and views of self. In educational reform, capacity referred specifically to the idea that all students should meet more challenging standards (David, 1993). Hopkins, Ainscow, and West (1994) related the concepts of teacher change and teacher capacity (perspective). Change was ultimately perceived as an individual achievement, requiring a response to the demands of curriculum implementation which included: (a) changes in the structure and organization of the school; (b) new or additional teaching materials; (c) teachers acquiring new knowledge; (d) teachers adopting new behaviors in terms of teaching style; and (e) changes in beliefs or values on the part of some teachers.

Knowledge within the capacity (perspective) construct referred to a teacher's ability to assist students in learning. This ability was dependent on the teacher's own knowledge base. The knowledge base was examined in terms of subject matter, curriculum, delivery of instruction, and students (Shulman, 1986). Knowledge, specific to algebra instruction, was reflected in the teachers' concerns and teaching of algebraic expressions, equations, and inequalities to analyze functions; algebra objectives (Standards of Learning); pacing, teaching strategies, and learning environment; and, the diverse needs of students.

Skills within the capacity (perspective) construct referred to a teacher's ability to utilize the necessary knowledge of what and how to teach in an effective manner. This ability was dependent upon the teacher's skill base. The skills base was examined in terms of effective teaching strategies within a developmentally appropriate learning environment. Skills, specific to algebra instruction, were reflected in the concerns and use of teaching strategies, which included manipulatives such as graphing calculators to solve real life mathematical problems. Brophy and Good (1986) and Rosenshine (1987) revealed a robust relationship between pedagogical skills and student learning.

Disposition within the capacity (perspective) construct referred to a teacher's attitude toward students, and expectations for student achievement and performance. This ability was dependent on the teacher's disposition base. The disposition base was examined in terms of the teacher's attitude regarding student abilities and behavior; student achievement; and meeting new standards for student learning. Dispositions, specific to algebra instruction, were reflected in the teacher's concerns about student readiness for abstract thinking, prerequisite mathematics skills; and participation in class.

Views of self within the capacity (perspective) construct referred to a teacher's beliefs about the teacher's role in classroom activity and to the persona adopted in the classroom (O'Day, Goertz, & Floden, (1993). This ability was dependent on the teacher's own perception of self. This view of self was examined in terms of the teacher's self view as a classroom facilitator, and as a learner. View of self, specific to algebra instruction, was reflected in expressed concerns relative to implementing the Algebra I requirement. The capacity (perspective) construct of knowledge, skills, disposition, and views of self presented a framework by which teachers' perspectives on program implementations can better be analyzed.

Teacher capacity (perspective) subsequently defined the value attached to innovations by teachers. The value attached to the programs oftentimes, determined the degree of implementation: completely, partially, or not at all. Resistance to implementation on the part of the teacher usually focused on program content. This resistance was reflected in the phenomenon commonly known as the hidden or implicit curriculum (Goodlad, 1984). Implicit curriculum referred to the manner in which the explicit curriculum (Program of Study) was presented within the classroom environment. In addition, the importance of teacher perspective was expressed by Brown and Cooney (1982): "Teachers' conceptual systems, that is, beliefs about teaching, mathematics, and how students learn, are exceedingly important areas of inquiry if we are to understand the psyche of teachers and the types of decisions they make" (p. 14). The teachers' perspectives reflected how knowledge of a subject matter is integrated into instructional planning, delivery of instruction, and beliefs about students learning abilities.

Teacher change process. The concept of teachers' perspectives on teaching algebra to all students has received cursory treatment by researchers. The teachers' views have differed with regard to procedural and conceptual elements in algebra instruction. Furthermore, Haver (1996) found that in Virginia, teachers' unfamiliarity with the National Council of Teachers of Mathematics (NCTM) recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically suggested that reform efforts were not being implemented. Teachers did not internalize the recommendations advocated by the National Council of Teachers of Mathematics (NCTM) recommendations, and therefore, effective algebra instruction was not realized. Knowledge of these recommendations was essential to teacher change in order to implement the recommendations needed for effective Algebra instruction

Bridges (1991) described the changes teachers experienced as a three-step transitory process. The first step was the ending phase, in which people identified and stated their beliefs about what had been removed from the curriculum The second step was the neutral zone, in which people experienced anxiety and discomfort The third step was the beginning stage, in which people began to view the change in terms of purpose, outcomes, and initial planning. This three-step transitory process reflected the complexity involved in the teacher change process. Additionally, the process underscored the importance of providing teachers with opportunities to make sense of proposed organizational change. Bridges also noted the importance of changing teacher behaviors in the context of social, supportive settings rather than in autocratic, isolated environments.

Furthermore, Fullan (1985) noted that fundamental changes in teacher beliefs and practices hinged on time to read, to think, to plan, to discuss, and to observe in other schools. Fullan identified several implications involved in change: (a) changes take place over time; (b) change initially involves anxiety and uncertainty; (c) technical and psychological support is crucial; (d) the learning of new skills is incremental and developmental; (e) organizational conditions within and in relation to the school make it more or less likely that school improvement will occur; and (f) successful change involves pressure and support within a collaborative setting.

Promising Practices in Algebra Instruction

A review of the literature included The National Council of Teachers of Mathematics (NCTM) recommendations (1989) and the National Assessment of Educational Progress (NAEP) 1990, which pointed to problems with algebra teaching practices and student learning of algebraic concepts. The National Assessment of Educational Progress (1996) suggested that mathematics teaching practices did not reflect the NCTM standards advocated since 1989. A search of Dissertation Abstracts International (DAI) and Educational Research International Clearinghouse (ERIC) revealed several mathematics programs which reflected the Professional Teaching

Standards (1991) and Curriculum and Evaluation Standards (1989) published by the National Council of Teachers of Mathematics (NCTM).

However, this review of promising practices revealed little achievement data other than that found in internal working papers. This data is included in the discussions of each of the programs germane to this study. These programs included the recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically as a contextual framework for teaching mathematics. While the five programs emphasized the development of algebraic thinking, only two of the programs were specific to an Algebra I curriculum. The general mathematics programs include the "Thinking Mathematics" approach (1989), the Algebra Project (1989), the University of Chicago School Mathematics Project (UCSMP) 1983, the Quantitative Understanding: Amplifying Student Achievement Project (QUASAR) 1994, and the "Hawai'i Algebra Learning Project" (1994). The programs shared the philosophy that student achievement based on effort was more significant than innate ability in algebra achievement.

The "Thinking Mathematics" approach was designed by Bodenhausen (1992) to develop remedial high school students' understanding of algebraic concepts A study based on the "Thinking Mathematics" approach was piloted in ninth grade remedial mathematics classes in an urban high school over a three-year period. Included were daily warm ups on prerequisite skills such as counting, proportional reasoning, estimation, and the mental mathematics necessary to make the connections to more abstract algebraic concepts. Two assumptions guided instruction (a) prior knowledge is essential for learning new knowledge that is based on the interpretation and application of problems in varied situations, and (b) contextual situations are essential for the development of mathematical concepts. The instructional goal of this approach was to develop mathematical concepts which students then used to complete problem-solving tasks. Situational problems utilized multiple solutions and multi-step procedures which required students to explain and justify their thinking.

Instruction resulted in the following student capacities: (a) students demonstrated increased confidence in their mathematical abilities, (b) students recorded ideas and insights on various mathematics topics, and (c) students pursued a variety of solutions. Topics were reviewed periodically to assure mastery over time. Students worked in pairs or groups to solve problems. Furthermore, the use of manipulatives was considered essential to develop students' understanding of algebraic concepts. The Thinking Mathematics, Volume 2: Extensions (Bodenhausen, 1992) reflected the philosophy of the "Thinking Mathematics" approach:

> All students are capable of what were once considered higher order skills deemed appropriate for only the brightest. All students can solve problems and think critically given appropriate environments. We reject the notion that students should be labeled and categorized for instruction according to a strictly hierarchical view of knowledge. That view has served to relegate many students to receiving instruction in only the simplest forms of knowledge--which has been delivered as isolated pieces to be learned by rote--with no thought of ever involving these children in the rich, exciting web of mathematical connections or in real problem-solving. (Bodenhausen,

p. 1)

The "Thinking Mathematics" approach was designed to bridge basic mathematical skills and abstract algebraic concepts. The outcome was increased student confidence in the ability to think mathematically. Bodenhausen (1992) noted that the passing rate on the proficiency examination increased from 16% to 48%. Although low, the 48% passing rate was significant because it was twice the passing rate of students who were not enrolled in the "Thinking Mathematics" approach classes. Other positive outcomes included improved students' attitudes towards mathematics and school in general. Furthermore, Bodenhausen noted a significant improvement in attendance and behavior.

The University of Chicago School Mathematics Project (UCSMP) was begun by co-directors Usiskin and Senk in 1983 as a response to the National Council of Teachers of Mathematics (NCTM, 1989). Hirschhorn, Thompson, Usiskin, and Senk (1995) noted that the UCSMP curriculum was based on a comprehensive study of numerous mathematics programs from foreign countries including Japan, Korea, Britain, the Netherlands, and Russia. The project revealed that students in these countries had learned algebra prior to the ninth grade.

A major component of the University of Chicago School Mathematics Project (UCSMP) was the development of a six-year secondary mathematics curriculum that began with a seventh-grade Transition Mathematics course. The University of Chicago School Mathematics Project (UCSMP) curriculum materials covered a wide range of content and approaches that matched the recommendations stated in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) This project utilized the acronym SPUR to address differences in learning styles in the acquisition of mathematical concepts: (1) Skills-procedures used to get answers, (2) Properties-the underlying mathematics principles, (3) Uses-application of mathematics to real situations, and (4) Representation-pictures, graphs, or objects to illustrate concepts.

According to longitudinal research conducted by Hirschhorn (1993),

> Students who have an opportunity to study Transition Mathematics, geometry, and advanced Algebra I in grades 7-10, learn as much mathematics as older students and further stated that at the end of their sophomore year, students performance on standardized tests is comparable with that of typical 11th grade students.

Furthermore, these students have greater choice available to them in selecting mathematics courses of study in the remaining high school years. The mathematics sequence increased the mathematics abilities of all students as visualized in the Standards document. The University of Chicago School Mathematics Project (USCMP) differed from the other mathematics programs in that it addressed the average student, not necessarily the poor performing student.

The Learning Research and Development Center at the University of Pittsburgh developed The Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project (Thomas, 1994). The project was designed to address the needs of schools serving economically disadvantaged students in urban communities. The catalysts for the project were documents published by the National Research Council (NRC) and the National Council of Teachers of Mathematics (NCTM) which emphasized reasoning, problem solving, communication, and connections. A major premise underlying the QUASAR project was that low performance of poor urban students was not due to the lack of ability but rather "educational practices that fail[ed] to provide them with high-quality mathematics learning opportunities" (Silver & Stein, 1996). Creators of the QUASAR project believed that all students could attain mathematical proficiency. Instructional practices included the application of mathematics to meaningful problems. Mathematical tasks were structured so that students could relate symbols, rules, procedures, and concepts to real life problems. Students were required to interpret, frame, plan, and regulate their own thinking processes to explain and justify their strategies. Physical and mental models were utilized as a basis for abstract principles. Observation data collected over a three year period revealed that over two-thirds of the tasks involved multiple representations. The project emphasized a blend of basic and advanced material with frequent opportunities for students' collaboration.

Another distinctive characteristic of the Quantitative Understanding Amplifying Student Achievement and Reasoning Project (QUASAR) was the training of teachers which emphasized high expectations for all students. Teachers expected students to understand the mathematics they were required to learn. In addition, the project included staff development, ongoing teacher support, school-based assessment design, and outreach to parents and the community.

The Algebra Project developed by Silva and Moses (1990) evolved as a response to the increasing number of disadvantaged minority and urban students who failed algebra. The project included approximately eighty seventh and eighth grade students in the King Open Program. The Algebra Project emphasized mathematical literacy as a critical component of the technology revolution. In addition, the Algebra Project provided the necessary connection between arithmetic and algebra. As Kamii (1990) noted, the Algebra Project recognized and addressed the conceptual barrier students faced in the transition from arithmetical to algebraic thinking. The Algebra Project also viewed algebra as the critical juncture for students to take more advanced mathematics programs.

The key assumption of the Algebra Project was that all children be aware of the importance of algebra in their lives and develop the skills necessary to be successful in algebra. This assumption differed from the conventional belief that ability was the essential ingredient for mastering advanced school mathematics. The Algebra Project introduced each new concept through student engagement in real life problem solving. Students then created a model such as a graph or chart of the introduced concept. This visual representation was considered a first step in understanding an abstract concept. Student discussions demonstrated an understanding of the relationships between algebra and everyday events. Students' abilities to organize their thinking, defend their positions, and explain their reasoning were revealed in class presentations. Silva and Moses (1990) noted that the presentations developed confidence in students to express themselves in front of their peers. The Algebra Project placed high expectations of responsibility on students, teachers, and parents. Students were held responsible for effort, self-discipline, and confidence. Teachers were held responsible for the perception of achievement as a matter of individual effort rather than simply innate ability. Parents were held responsible for active participation in the mathematics achievement of their children. The project noted the critical importance of algebra as the initial course in the sequence of all advanced mathematics programs of study. In addition, parents were informed that students should take algebra by the end of the eighth grade to allow greater participation in advanced mathematics courses. Parents were made aware that the study of algebra provided a gateway for higher education and socioeconomic opportunity.

The Algebra Project trained teachers on the use of the facilitative teaching model. Training focused on content and delivery of instruction. Teachers shared their concerns on the training and developed plans to implement the Algebra Project within their classrooms.

Prior to the Algebra Project, few students took the optional ninth grade mathematics placement examination. None of these students passed it. However, more than one-half of the students who participated in the Algebra Project took the optional ninth grade mathematics placement examination. Seventy-nine percent of the students who took the examination passed it and had the choice to take the high school ninth grade algebra sequence or enter directly into the honors algebra or geometry

The "Hawai'i Algebra Learning Project" was designed by Matsumoto, Dougherty, Wada, and Rachlin (1994). The major objective of the Hawai'i Algebra Learning Project was to reduce algebraic misconceptions held by students. The project utilized Vygotsky's work (1978) on learning to examine student misconceptions. Five factors were identified as critical to student learning (a) problem solving, (b) communication, (c) connections, (d) development over time, and (e) challenging tasks. A progressive approach was used in the development of topics over an eight-day period. New concepts were introduced with a problem solving task which encouraged students to explore many possible solutions. Students gradually developed algorithms as skills to solve problems. Cooperative groups were utilized for student collaboration and justification of ideas. Non-routine tasks developed problem solving processes such as reversibility, flexibility, and the ability to generalize. Furthermore, open-ended tasks which utilized computers, calculators, and manipulatives such as algebra tiles supported the problem solving approach to algebra. Teacher training and ongoing support were provided to assist teachers in: (a) analyzing content, (b) improving their own problem-solving skills, (c) understanding how students learn mathematics, (d) developing instructional techniques, and (e) constructing multidimensional assessment approaches.

Significantly, the Hawai'i Algebra Learning Project presented a challenge to both students and teachers who were accustomed to more traditional methods. The Hawai'i Algebra Learning Project recognized the importance of addressing attitudinal changes within teachers with respect to student capacity and how students learn. The challenge was for teachers to accept a paradigm shift. The traditional belief held that repeated practice developed students' algebraic concepts. The Institute's belief, on the other hand, held that progressive exploration developed students' algebraic concepts. The institute addressed the inevitable tension that resulted from this paradigm shift through training and ongoing support. In addition, teachers were likely to meet resistance from students, who at first, were not comfortable in the role of active participants. Therefore, an acclimation period was required at the beginning of the school year to ensure a smooth transition from the traditional setting to a more cooperative instructional environment. The authors of the Hawai'i Algebra Learning

Project discussed the problematic issue of assessment. Available commercial tests were not congruent with the Hawai'i Algebra Learning Project. The Eleventh Mental Measurements Yearbook (Kramer & Conoley, 1992) included Algebra I assessments which reflected only traditional multiple-choice formats. Therefore, the Hawai'i Algebra Learning Project used Goals: A Performance-Based Measure of Achievement, (Harcourt-Brace, 1992) which better reflected the problem-solving approach to assessing algebra. Data collected from two sites in Mississippi and one site in Hawai'i revealed gains of 15 to 21 percentile points on the posttest results.

In summary, the five programs reflected the National Council of Teachers of Mathematics (NCTM) recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. Implementation of these programs required algebra teachers to rethink traditional beliefs about who should take algebra and how it should be taught According to the Curriculum and Evaluation Standards for School Mathematics (NCTM), "The vision of mathematics education in the Standards places new demands on instruction and forces us to reassess the manner and methods by which we chart our students' progress" (1989, p. 192). However, the current Algebra I standardized achievement tests continue to measure traditional curriculum and instruction

Chapter 3: Methodology

Introduction

The purpose of this mixed design study was to generate an understanding and description of a required ninth grade Algebra I program from the teacher perspective. The major question of this study focused on the expressed concerns of teachers during the implementation of the required Algebra I program. The data collected were viewed through the lens of the National Council of Teachers of Mathematics (NCTM) recommendations for teaching mathematics. These recommendations were clearly stated as goals in the Standards of Learning for Virginia Public Schools (1995) for mathematics to include algebra: communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically.

The qualitative aspects were the primary focus of this mixed design study. Krathwohl (1993) noted the contribution of the qualitative point of view:

> Researchers seek to learn how people understand their world and their surroundings... One is studying the meaning-making process, asking, "How do these individuals construct the meaning of their world?" This knowledge is a social construction of behavior... People are seen as acting according to the meaning of things and persons to them; their reality is socially constructed. From this viewpoint, it is necessary to see the world through the eyes of the

actor to reach a full understanding of the purpose of that person's acts...(p. 322)

Erickson, Florio, and Buschman (1980) suggested that qualitative methods were best in seeking answers to (a) What is happening in the field setting? and (b) What do the happenings mean to the people involved in them? These two questions were critical in guiding the investigation of the teachers' concerns on the implementation of the required Algebra I curriculum.

Researchers in the various disciplines who employed the naturalistic inquiry perspective were in agreement regarding the qualitative research method (Borg & Gall, 1989; Burgess, 1985; Lincoln & Guba, 1985). Qualitative research methods include case study, grounded theory, ethnography, and life history. Two distinctive features of qualitative research are (a) that it is "grounded in the data" and (b) that it uses inductive analysis procedures. The selection of a particular qualitative method is based upon the nature of the research investigation.

The grounded theory method of analysis was used in this investigation. This method allowed the researcher to examine a group of teachers through the collection of data from questionnaires, observations, and interviews to gain an in-depth understanding of the required Algebra I implementation. Furthermore, theory validation and theory building are suited to qualitative methods and are particularly appropriate in the educational setting according to Borg and Gall (1989).

> A major criticism of education is the dearth of educational theory. Even when we consider that much educational practice is supported by theory from other behavioral sciences such as psychology and sociology, much of what we do

in education still has no theoretical basis whatsoever. (p. 407)

Grounded Theory Method

The grounded theory method was developed through the combined research perspectives of Glaser and Strauss (1967). Both sociologists, Glaser, trained in quantitative research, and Strauss, trained in qualitative research, recognized the need for a methodology to use in the building of theory:

> Historically linked with the change in relative emphasis from generation to verification of theory was the clash between advocates of quantitative and qualitative data. The generators of theory in the late 1930's, by and large, had used qualitative data in a nonsystematic and nonrigorous way (when they used data at all), in conjunction with their own logic and common sense. In addition, monographs based on qualitative data consisted of lengthy, detailed descriptions which resulted in very small amounts of theory, if any. (p. 15)

The grounded theory approach, therefore, evolved from a need to establish procedures in data analysis in order to build theory. These procedures include specific strategies whereby data are coded and analyzed both inductively and deductively (Strauss & Corbin, 1990). The grounded theory method utilizes a systematic set of procedures. Application of these procedures and the awareness of theoretical sensitivity are applied to the data analysis process.

Strauss and Corbin (1990) noted that doing analysis was, in reality, making interpretations. Similarly, Diesing (1971) stated "Concepts, hypotheses, and theories are not found ready-made in reality but must be constructed" (p. 14)

The grounded theory method developed by Glaser and Strauss (1967) emphasized two basic analytic procedures: (a) asking questions about the data and (b) making comparisons for similarities and differences between each incident. Theoretical sensitivity is a personal quality that allows the researcher to gain a better insight into the real meaning behind the words and behaviors of the teachers. The recommended sources of literature, professional and personal experiences, and the analytical processes suggested by Strauss and Corbin (1990) were utilized to increase the theoretical sensitivity of this researcher. "Theoretical sensitivity is the ability to recognize what is important in the data and to give it meaning. It helps to formulate theory that is faithful to the reality of the phenomena under study" (p. 46). The rationale for developing theoretical sensitivity was stated:

> Each of us brings to the analysis of data our biases, assumptions, patterns of thinking, and knowledge gained from experience and reading. These can block our seeing what is significant in the data, or prevent us from moving from descriptive to theoretical levels of analysis. (p. 95)

Analysis of the data also required flexibility in thinking, creativity, and perseverance. Coding refers to the main set of procedures by which data are broken down, conceptualized and put back together in new ways. The purpose of the four-fold procedure is to: (a) build rather than only test theory; (b) give the research process the rigor necessary to make the theory "good" science, (c) help the analyst to break through the biases and assumptions brought to, and that can develop during, the research process; and (d) provide the grounding, build the density, and develop the sensitivity and integration needed to generate a rich, tightly woven, explanatory theory that closely approximates the reality it represents. (p. 57)

The grounded theory approach utilizes three types of coding processes in the analysis of the data: open coding, axial coding, and selective coding. Each of the three processes has a specific function within the analysis. Strauss and Corbin, (1990) defined open coding as the process of breaking down, examining, comparing, conceptualizing, and categorizing data. In this study, the concepts which depicted significant happenings and events were identified. These identified concepts were then compared and grouped together into categories. The categories were analyzed in terms of their properties and attributes. The properties of the categories were then dimensionalized, that is, placed on a continuum. The categories which emerged during the open coding process are discussed in chapter 4.

During axial coding, the data were regrouped in order to discover new relationships and make connections among the categories. The process of axial coding resulted in the construction of a paradigm which defined the required Algebra I program in terms of its causal conditions, context, intervening conditions/interaction strategies, and consequences. The Algebra I Program Paradigm was based on the paradigm format designed by Fogarty (1995)

Finally in the selective coding process the core category was identified and systematically related to the other categories. This process created a descriptive narrative about the central phenomenon of the research, the implementation of the required Algebra I program. Transcriptions of large segments of lessons and interviews were included in chapter 4 to demonstrate the nature of the Algebra I classroom. This comprehensive view was critical to the investigation. A discussion of the required Algebra I teachers' paradigm was used to demonstrate how the emerging theory was grounded in the critical incidents identified in the data.

This study employed the primary investigative tools of questionnaires, observations, and focused interviews to obtain the necessary data. The primary purpose of this mixed design research was to provide a rich description of teacher concerns about the implementation of the Algebra I requirement with respect to the National Council of Teachers of Mathematics (1989) recommendations.

Research Plan Schedule

Stage One

1. Conducted a pilot study to gain practice in conducting focused interviews and classroom observations

2. Adapted focused interview questions to more closely reflect the National Council of Teachers of Mathematics' recommendations

Stage Two

1. Arranged with principals to administer the Stages of Concern (SoC) Questionnaire to the 13 algebra teachers

2. Contacted the 13 teachers

3. Arranged interview and observation times

Stage Three

1. Collected interview and observation data

2. Transcribed, categorized, and coded data

3. Analyzed data using grounded theory method

Pilot Study

The pilot study was conducted with a middle school algebra teacher to allow the researcher to gain field experience in conducting focused interviews and observations. The data obtained indicated the need to revise specific interview questions for the actual study. The pilot study provided samples of data from the Stages of Concern (SoC) Questionnaire, the Levels of Use (LoU) focused Interview, and the Classroom Observation Checklist. In addition, the pilot provided insight into the time required to administer the instruments. Based on the pilot study, a number of the questions on the Levels of Use (LoU) focused interview were refined to gain data specific to the use of the NCTM recommendations.

Accessible Population

The guidance director at each of the four high schools provided the researcher with the names of the 13 ninth grade Algebra I teachers for the 1997-1998 school year. The researcher then contacted each teacher through a letter explaining the purpose of the research and requesting his or her participation in the study. Of the 13 teachers contacted, 12 teachers agreed to participate.

Demographics of the Sample

The sample consisted of twelve Caucasian Algebra I teachers who agreed to participate in this research. The demographic information in Table 1 includes gender, age bracket, and highest degree earned.

Table 1

Demographics

Measure	Number of Participants
Gender	
Female	7
Male	5
Age Bracket	
20-29	1
30-39	3
40-49	4
50-59	4
60+	0
Highest Degree Earned	
Bachelor	5
Masters	6
Ed.S/CAS	1
Doctorate	0

The seven female and five male teachers ranged in age from the mid-twenties to the late fifties. Four of the 12 teachers received Bachelor's degrees in general engineering, electrical engineering, finance, and health and physical education and later earned endorsements in mathematics. Two teachers were retired military officers, and one teacher was an engineer prior to teaching high school mathematics

Instrumentation

According to Borg and Gall (1989), the researcher is the primary instrument in gathering, analyzing, and interpreting data in qualitative research. The primary investigative tools of observations and interviews were used to obtain the necessary data. Furthermore, the study required one quantitative measure, the Stages of Concern (SoC) Questionnaire to determine the types of teacher concerns.

The Concerns Based Adoption Model (CBAM) was the research-based instrument used to analyze concerns and behaviors in implementing an innovation. The Concerns Based Adoption Model has three dimensions: (a) Stages of Concern (SoC) Questionnaire, (b) Levels of Use (LoU) focused interview, and (c) Innovation Configurations. Two dimensions were utilized: Stages of Concern (SoC) Questionnaire and Levels of Use (LoU) focused interview.

Stages of Concern (SoC) Questionnaire. The Stages of Concern (SoC) Questionnaire contains 35 Likert-scale items designed to measure seven developmental stages of concern about an innovation that is being implemented: (a) awareness, (b) informational, (c) personal, (d) management, (d) consequences, (e) collaboration, and (f) refocusing. The seven developmental stages ranged from concerns about self (Stages 0-3) to task concern (Stage 3) and finally to impact concerns (Stages 4-6). The Stages of Concern (SoC) Questionnaire takes approximately 15 minutes to complete. One assumption identified by Hall and Hord (1987) was to acknowledge change as a highly personal process that entails developmental growth in feelings and skills. A second assumption was that the point of view of the participants was critical in the change process.

Stages of Concern (SoC) Questionnaire Seven Specific Stages

Stage 0	Awareness: Little concern about or involvement with the innovation is indicated.
Stage 1	Informational: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. S/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.
Stage 2	Personal: Individual is uncertain about the demands of the innovation, his/her adequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision making and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.
Stage 3	Management: Attention focuses on the processes and tasks of using the innovation and the best use of information and resources. Users related to efficiency, organizing, managing, scheduling, and time demands are utmost.
Stage 4	Consequences: Attention focuses on impact of the innovation on students in his/her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.
Stage 5	Collaboration: the focus is on coordination and cooperation with others regarding use of the innovation.
Stage 6	Refocusing: the focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation (Hall et al., 1979).

"The Stages of Concern (SoC) Questionnaire provided a formal and precise measure of the stages of concern. The (SoC) Questionnaire was developed through a procedure of reviewing the literature, developing lists of statements describing concerns, item writing, Q-sorting by a panel of judges, completion of a 195 item prototype, administering the prototype to 366 individuals, and factor analysis" (Savage, 1992, p. 36). Seven factors emerged and became the seven Stages of Concern.

Each question on the questionnaire corresponds to a stage of concern. The participants respond to each question using a seven-point scale. The responses are entered on a chart according to its corresponding stage of concern. There are five questions for each stage of concern.

0	1	2	3	4	5	6	7
Irrelevant		Not true of Me now		Somewhat true of me now		Very true of me now	

The obtained scores from each question are converted into percentiles using the (SoC) Questionnaire Quick Scoring Device. The percentiles are plotted on a graph to provide the pattern for interpretation and descriptive profiles.

The reliability of the Stages of Concerns (SoC) Questionnaire was determined by the alpha coefficients of internal consistency for each of the seven Stages of Concerns. These coefficients reflected the degree of reliability among items on a scale in terms of overlapping variance. The formula was a generalization of the Kuder-Richardson Formula 20 for dichotomous items (Cronbach, 1951, cited in Hall, George, & Rutherford, 1979). Program TESTAT on the VSTAT library (Veldman, 1967) was used to compute these coefficients using data from a stratified sample of 830 teachers and professors (Hall, George, & Rutherford, 1979). Many of these teachers and professors provided data for the two-year longitudinal studies of concerns. The coefficients in the Table 2 below were computed on the basis of their responses in the fall of 1974, their first exposure to the questionnaire.

Table 2

Coefficients of Internal Reliability for the Stages of Concern (SoC) Questionnaire

Coefficients of Internal Reliability for the Stages of Concerns Questionnaire, N=830							
Stage	0	1	2	3	4	5	6
Alphas	.64	.78	.83	.75	.76	.82	71

A sample of 171 individuals was asked to complete the (SoC) Questionnaire a second time, two weeks after their initial completion of the instrument. One hundred thirty-two completed and mailed in this 'retest' data. The Stages of Concern (SoC) Questionnaire Test-Retest correlations ranged from .65 to .86 with four of the seven correlations above .80 (Hall et al., 1979). The Test-Retest correlations are presented in Table 3.

Table 3

Test-Retest Correlations on the Stages of Concern (SoC) Questionnaire

Test-Retest Correlations on the Stages of Concern Questionnaire, N=132							
Stage	0	1	2	3	4	5	6
Pearson-r	.65	.86	.82	.81	76	84	71

(Hall, George, & Rutherford, 1979, p. 11)

The validity of the Stages of Concern (SoC) Questionnaire was based on several studies. The initial validity study utilized the strategy outlined by Cronbach and Meehl (1955) to demonstrate how scores on the questionnaire related to each other. A 195-item pilot checklist became the prototype instrument. Table 3 illustrates the resulting intercorrelation matrices that were used to validate the Stages of Concern (SoC) Questionnaire scores. The results supported the validity of the stages as separate constructs within the instrument based on two analyses. The first analysis utilized data from 359 persons who had completed the questionnaire. The data indicated that 83% of the items correlated more highly with the stage to which they had been assigned than with the total score on the instrument. Furthermore, the second analysis, demonstrated that 72% of the items correlated more highly with the stage to which they had been assigned than with any other stage. The intercorrelation matrix is presented in Table 4.

Table 4

Intercorrelation of 195-Item Stages of Concern (SoC) Questionnaire Scales

		Stages					
		1	2	3	4	5	6
Stages	1	1.0	.68	.47	.21	.21	.19
	2		1.0	78	43	.37	43
	3			1.0	.60	.51	.59
	4				1.0	.82	.80
	5					1.0	77
	6						1.0

The correlations near the diagonal are higher than those more removed from it The results expressed as a simplex pattern, according to Guttman (1954, 1957), demonstrated a matrix that corresponded to stages having degrees of similarity and dissimilarity with one another. In addition, each stage was more like a stage immediately beside it than like any other stage on the line. Therefore, the seven scales constructed as part of the validation process readily reflected the seven independent constructs identified with the 7 Stages of Concern.

Levels of Use (LoU) Focused Interview Protocol The Levels of Use (LoU) focused interview (Loucks, Newlove, & Hall, 1975) format was used to gain in-depth information on how an individual is implementing a program The Levels of Use

(LoU) focused interview required responses specific to the research questions. The structured format of the interview progresses from general to specific information relative to the implementation level of the individual (Hall & Hord, 1987). The Levels of Use (LoU) focused interview was developed at the University of Texas, Austin, Research and Development Center at the same time the Stage of Concern Questionnaire (SoC) was developed.

Levels of Use (LoU) Focused Interview

Level 0	Nonuse: The user has little or no knowledge of the innovation, no involvement with the innovation and is doing nothing toward becoming involved.
Level I	Orientation: The user has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon user and user system.
Level II	Preparation: The user is preparing for first use of the innovation.
Level III	Mechanical Use: The user focuses most effort on the short term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet users needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.
Level IVA	Routine: Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
Level IVB	Refinement: The user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for clients.
Level V	Integration: The user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence.

Level VI Renewal: The user reevaluates the quality of use of the innovation, seeks major modifications of, or alternatives to, present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals and the system.

The focused interview questions were constructed by this researcher according to the guidelines provided by the instrument developer (Loucks et al., 1975, p. 28). "In combination, the Stage of Concern (SoC) Questionnaire and Levels of Use (LoU) focused interview provided a powerful description of the dynamics of an individual involved in change..." (Hall et al., 1979, p.4). Furthermore, Hall et al.(1979) contended that the SoC and LoU could be used as diagnostic tools for assessing where individual members of an organization are in relation to the adoption of an innovation. In addition, change managers can use the resulting diagnostic data in developing needed interventions.

The Level of Use (LoU) focused interview provided information on the behavior of teachers and their perceptions of the implementation. The issue of reliability for LoU was a problem because it was impractical for researchers to conduct hundreds of intensive observations in the field. This problem was resolved by the development of a special type of interview procedure called a focused interview (Hall & Hord, 1987). A focused interview begins with an open-ended structure and proceeds through a sequence of questions that focuses in on the topic. Each of the basic branching questions is followed by a series of level-specific and category-specific queries.

A special validity study was conducted by Loucks, Newlove, and Hall (1975) to establish the validity of the Levels of Use interview. Qualitative data gathered by ethnographic procedures involving day-long observations and selected interviews were used to assign a Level of Use rating. This rating was correlated with the rating attained as a result of the actual Level of Use focused interview. Loucks et. al. (1975) statistically compared the two ratings to determine whether the focused interview assessed actual behavior. A correlation of .98 was found between the qualitative Levels of Use (LoU) focused interview rating and the interviewer's rating.

Classroom observation checklist. One informal instrument, The Classroom Observation Checklist (Winocur, 1983) (Appendix C) used affective and cognitive descriptors in assessing the teacher's role. This instrument consisted of 15 items of teachers' classroom behaviors and contained the headings of, "yes," "no," or "unsure" This instrument was used during the observations of required Algebra I lessons to assess teaching behaviors. The checklist identified the cognitive and affective behaviors of the teacher which were important to the creation of the algebraic thinking atmosphere. The findings of this informal observation instrument were used to confirm interview and stages of concern data for each teacher. The checklist was a descriptive tool of what users were doing and was designed to capture the essence of the required Algebra I program implementation. A comparison made between this informal instrument and the NCTM recommendations revealed 12 of the 15 items matched.

Data Collection

Data on the teaching practices of the algebra teachers were collected via questionnaires, observations, and interviews. The researcher called the four high school principals to request permission to conduct the study in their schools The questionnaire was administered in November, 1997 after approval by the Human Subjects Review committee.

The Observation Checklist was used to organize data during classroom observations. The Levels of Use (LoU) focused interview format was used for the interviews.

Data obtained from the practice interviews and observations informed the researcher as to the fit of the instruments to the purposes of the study. The researcher scheduled an observation and a focused interview with each of the twelve Algebra I teachers. The observations and interviews were completed by the end January, 1998. The researcher conducted the observations and interviews used in the study

<u>Data Analysis</u>

Table 5 presents the primary sources of data used to answer the four research questions. The quantitative instrument, the Stages of Concern (SoC) Questionnaire allowed the researcher to categorize teachers by their types of concerns. These data were critical to understanding teacher capacity (perspective) with respect to the required Algebra I program. The Levels of Use (LoU) focused interview data were used to support the Stages of Concern (SoC) Questionnaire data to develop an in-depth understanding of the teachers' concerns regarding the Algebra I program Triangulation of data for this study included The Classroom Observation Checklist which substantiated the information collected on the Stages of Concern (SoC) Questionnaire and Levels of Use (LoU) focused interview Finally, the final grades of students in the required Algebra I program were related to the data obtained on the three instruments which are listed in Table 5.

Table 5

Research Questions and Primary Sources of Data

Research Questions	Primary Sources of Data
1. What are the concerns of Algebra I teachers regarding the implementation of the required Algebra I program?	Stages of Concern (SoC) Questionnaire Levels of Use (LoU) focused interview
2. To what extent are the National Council of Teachers of Mathematics (NCTM) recommendations reflected in the required Algebra I program?	Classroom Observation Checklist Levels of Use (LoU) focused interview
3. To what extent do the Levels of Use (LoU) focused interview data support the identified teacher concerns type: "self," "task," or "impact" ?	Levels of Use (LoU) focused interview Stages of Concern (SoC) Questionnaire
4. Do teachers identified by their major Stages of Concern (SoC) Questionnaire type: "self," "task," or "impact" differ in their final-grade pass rates of required Algebra I students?	Stages of Concern (SoC) Questionnaire Final Algebra I Grades Standards of Learning test results

The Stages of Concern (SoC) Questionnaire (Hall, George, & Rutherford, 1979) was used to examine the first research question: What are the concerns of ninth grade algebra teachers in implementing the required Algebra I program? The questionnaire measured the degree to which the program had been implemented based on the areas of greatest concern to the teacher. The data revealed the nature of the concern for each teacher: "self," "task," or "impact".

The Stages of Concern (SoC) Questionnaire (see Appendix A) was used to collect data on the three major SoC types: "self," "task," and "impact" concerns. The Levels of Use (LoU) focused interview (see Appendix B), and the Classroom Observation Checklist (see Appendix C) were used to examine the implementation data. The data obtained were examined with respect to the National Council of Teachers of Mathematics (NCTM) recommendations: mathematical communication, mathematical connections, problem solving, and mathematical reasoning. The researcher examined the final grade pass rates with respect to ninth grade Algebra I teachers' Stages of Concern (SoC) Questionnaire types: "self," "task," or "impact".

The CBAM Stages of Concern (SoC) Questionnaire instrument was used to analyze the concerns ninth grade Algebra I teachers were experiencing in implementing the required Algebra I curriculum. Interview and observation data were collected using the CBAM Levels of Use (LoU) focused interview and the Classroom Observation Checklist instruments. The interview and observation data were taped, transcribed, and entered into a qualitative data base to provide descriptions of the participants' perceptions of the required Algebra I program. Furthermore, by the process of inductive and deductive reasoning utilized in grounded theory, the researcher gained insight into the teachers' perspectives. Critical incidents specific to teacher behaviors and concerns relative to the implementation of the required Algebra I curriculum and National Council of Teachers of Mathematics (NCTM) recommendations were analyzed for emergent patterns and themes. These research procedures were consistent with the critical incident method (Copas, 1984) and the principles of grounded theory research (Bogden & Bilken, 1982; Miles & Huberman, 1984).

The Levels of Use (LoU) focused interview instrument answered the concerns component of the second research question: To what extent are the National Council of Teachers of Mathematics (NCTM) recommendations reflected in the practices and expressed concerns of teachers? The Levels of Use (LoU) focused interviews were conducted after the classroom observations so that the interview questions did not affect the lessons.

Student final Algebra I grades provided data to answer the third research question: Do teachers identified by their major Stages of Concern (SoC) Questionnaire type, "self," "task," or "impact" concerns differ in their pass rates of required Algebra I students? The data was expressed in final-grade pass rate percentages for each teacher. The selected school division's grading system defines the letter grades of A, B, C, and D as passing grades. The letter grade of F denotes failure. The pass rate reflects the percentage of students who passed the required Algebra I program for each teacher.

The small sample size used in this study precluded the application of traditional quantitative measurements. The Stages of Concern (SoC) Questionnaire instrument, however, categorized teachers by their concerns type and the final-grade pass rates reflected student achievement in the required Algebra I program. The qualitative instruments, Levels of Use (LoU) focused interview, and the Classroom Observation Checklist provided data which enriched the descriptions of the teacher narratives

Ethical Safeguards

This study was conducted according to the guidelines established by The College of William and Mary. A coding system was utilized to protect the confidentiality of participants and in the collection of the data. This proposal was submitted to and approved by the Human Subjects Committee of the School of Education of The College of William and Mary.

Chapter 4: Analysis of the Data

Introduction

Both quantitative and qualitative methods were used to examine the research questions: (1) What are the concerns of Algebra I teachers in implementing the required Algebra I program? (2) To what extent are the National Council of Teachers of Mathematics (NCTM) recommendations reflected in the required Algebra I program? (3) To what extent do the Levels of Use (LoU) focused interview data support the identified teacher concerns type: "self," "task," or "impact"? and (4) Do teachers identified by their major Stages of Concern (SoC) Questionnaire type: "self," "task," or "impact" differ in their final-grade pass rates of required Algebra I students?

Quantitative findings:

The Stages of Concern (SoC) Questionnaire was administered to the 12 teachers who participated in the study to identify their concerns in implementing the required Algebra I program. Table 6 summarizes the results from the Stages of Concern (SoC) Questionnaire and partially answers research question 1. For purposes of interpretation, the seven stages are clustered into 4 categories as follows: (a) Stage 0 is unawareness with little concern for the implementation; (b) Stages 1 and 2 are categorized as "self" with 1 being informational and 2 personal; (c) Stage 3 is categorized as "task" with concerns about management; and (d) Stages 4, 5, and 6 are categorized as "impact" with 4 as consequences, 5 as collaboration, and 6 as refocusing.

Table 6

Teacher Categories of Stages of Concerns (SoC)

	"Unawareness"	"Self"		"Task"	"Impact"		
Stages	0	1	2	3	4	5	6
N/Teachers	9	1	1	0	0	1	0

The nine teachers who scored at nonuser concerns Stage 0 did not perceive the required Algebra I program as a new implementation and expressed no need to change their teaching practices. Teachers identified at the "Self" concerns stages: Stage 1- informational, and Stage 2- personal, reflect a general awareness and interest in an innovation and want additional information. One teacher scored at Stage 1 and one teacher scored at Stage 2 on the Stages of Concern (SoC) Questionnaire which indicated their awareness of and interest in seeking information about the required Algebra I program. Teachers identified at the "Task" concerns stage: Stage 3- Management are concerned with time, resources, and scheduling decisions required in implementing programs. None of the teachers scored at Stage 3 on the Stages of Concern (SoC) Questionnaire. Teachers identified at the "Impact" concerns stages Stage 4-Consequences, Stage 5-Collaboration, and Stage 6-Refocusing are concerned with refining a program to improve student achievement. One teacher scored at Stage 5 on the Stages of Concern (SoC) Questionnaire which indicated an interest in collaborating with colleagues in the implementation of the required Algebra I program. These findings are further discussed in the summary following the teacher narratives.

The Levels of Use (LoU) focused interview was conducted to verify the levels identified by the Stages of Concern (SoC) Questionnaire type, "self," "task," or "impact". It was also used to gain a rich description of the teachers' perceptions of the required Algebra I program. Table 7 indicates a summary of the Levels of Use (LoU) administration.

Table 7

Teacher Levels of Use (LoU)

Levels	0	I	II	III	IV	V	VI
N/Teachers	8	2	0	2	0	0	0

Eight of the twelve Algebra I teachers scored at the Level 0, nonuse, which indicates no involvement with an implementation. These eight teachers did not use contemporary algebra teaching practices in the implementation of the required Algebra I program. Two Algebra I teachers scored at the Level I, orientation, which indicated an interest in obtaining more information about an implementation. These two teachers were interested in attending conferences and meeting with colleagues to improve their teaching of the required Algebra I program. Two algebra teachers scored at the Level III, mechanical use, which indicated a day-by-day disjointed effort to implement an innovation with little time for reflection. These two teachers were attempting to use contemporary algebra practices in their required Algebra I programs. The findings regarding the Levels of Use scores indicate that teachers are not using the National Council of Teachers of Mathematics recommendations, but rather the traditional approach to teaching algebra.

Table 8 includes the Algebra I teachers' Stages of Concern (SoC) Questionnaire types and their Levels of Use (LoU) designation. In addition, the final Algebra I grades are expressed as pass rates. The names used are pseudonyms.

Table 8

Stages of Concerns, Levels Of Use, and Final Algebra I Grades

Name of Teacher	SoC Type	LoU	Pass Rate/N	Pass Rate Percentage
School A				
Joe Reynolds	0	0	23/45	51%
Ann Jones	I	III	15/17	88%
Bill Smith	0	0	31/36	86%
Total			69/98	70%
School B				
Barbara Williams	0	0	28/42	67%
Beth Walker	0	0	29/48	60%
Sharon Turner	0	0	51/68	75%
Bob Lane	0	0	15/23	65%
Total			123/181	68%

Name of Teacher	SoC Type	LoU	Pass/Rate N	Pass Rate Percentage
School C				
Donna Lewis	0	0	38/48	79%
Jane Dover	0	0	23/37	62%
Matthew Brown	2	I	37/43	86%
Total			98/128	77%
School D				
Susan White	5	III	16/30	79%
Mark Townsend	0	I	29/55	53%
____________	N/A	N/A	60/75	80%
Total			105/160	66%

Table 8 provides data relative to research question 3. The findings revealed that the Levels of Use (LoU) designations were congruent to the teachers' Stages of Concern (SoC) types. Both the Stages of Concern (SoC) Questionnaire and the Levels of Use (LoU) focused interview instruments reflected the teachers' limited perceptions of the required Algebra I program as a new implementation designed to meet the needs of the diverse population. The majority of the teachers focused on personal concerns rather than on instructional or program refinement concerns. Furthermore.

the low Levels of Use (LoU) designations reflected the traditional teaching practices and partially provided data to answer research question 2. Teacher instruction did not reflect use of the National Council of Teachers of Mathematics (NCTM) recommendations. The pass rates of the final Algebra I grades for the four high schools ranged from 51% to 88% which suggested that the implementation was not successful. The final Algebra I grades of the teacher who chose not to participate in this study were included to reflect the overall pass rate for School D. The findings demonstrate that the eight teachers who scored at 0 on the Stages of Concern (SoC) Questionnaire and the Levels of Use (LoU) focused interview, six had pass rates below 76%. The three teachers with scores above 0 on both the Stages of Concern and the Levels of Use had pass rates that ranged from 79% to 88%.

Qualitative Findings

The qualitative findings were derived from the application of analytic procedures described in the grounded theory method found in chapter 3. The narratives which evolved provided insight on how teachers viewed the implementation of the required Algebra I program. In addition, the interviews and classroom observations revealed the extent to which the National Council of Teachers of Mathematics (NCTM) recommendations were evident in the implementation of the required Algebra I program. Data were analyzed using the three prescribed types of coding procedures described by Strauss and Corbin (1990). In open coding, the observation and interview transcripts were examined to identify categories. These categories were further analyzed to identify critical incidents (Strauss & Corbin, 1990). The question of how teachers were implementing the Algebra I program guided the analysis of the questionnaires, classroom observations, and focused interview data. Three major categories emerged during open coding: (a) perceptions of algebra, (b) classroom practices, and (c) beliefs and attitudes. These categories, once identified, were further developed in terms of their properties and dimensions. The following characteristics helped define each category:

1. Perceptions of Algebra Included traditional teaching, which emphasizes abstract concepts or contemporary teaching which emphasizes mathematical literacy and empowerment

2. Classroom practices included instruction and student interactions that ranged from lecture to cooperative problem solving in the development of algebraic concepts

3. Beliefs and attitudes included teacher perceptions of algebra as a required course and students' abilities that ranged from a course for college-bound students to an unnecessary course for students who were not college-bound

Strauss and Corbin (1990) then suggest that each category is dimensionalized along a continuum from traditional algebra instruction to contemporary algebra instruction based on the National Council Teachers of Mathematics (NCTM) recommendations. The following examples taken from classroom observations and interview transcripts demonstrate where teachers fell on the continuum of traditional to contemporary practices. In the perception of algebra category: the data from the teachers supported traditional practices. An example would be, " With this required algebra, you won't have the same results you had ten years ago when this was an elective course." In the category of classroom practices, the data supported traditional practices. For example, " Open your book and complete the twenty problems on page 105 for homework." Students were then given time to work on the homework in class. Finally, in the category of beliefs and attitudes, the data supported that most of the teachers believed that algebra was not for all students. For example, "Many of my students don't know basic arithmetic... all students do not need algebra to be successful in life."

The next step in the process is axial coding, (Strauss & Corbin, 1990) where the data obtained during open coding were organized by determining the relationships among the categories. A coding paradigm was developed to show the relationships among the categories. Finally, selective coding procedures (Strauss & Corbin, 1990) are used to reduce the data to a simple core category. The core category, the very center of this study, evolved as: the challenge of traditional algebra teachers to teach contemporary algebra to students with a wide range of abilities and mathematical experiences. The contemporary algebra phenomenon was the critical issue woven throughout the teacher narratives.

Theoretical sampling. Theoretical sampling, according to Strauss and Corbin (1990), is the next step of the procedure. This procedure was used to identify sample incidents that are typical of the categories and are reflective of the categories which emerged during the coding processes. The incidents selected were related to the required Algebra I program specific to teachers' beliefs and practices in implementing the program.

Grounded theory research requires the development of a theoretical framework represented in this study by the Required Algebra I Program Paradigm in Table 9. The next step in grounded theory is to develop a framework which is embedded in the Required Algebra I Program Paradigm and serves in discussing the results of the teacher interviews and observations. The elements of the phenomenon, understanding the implementation of the required Algebra I program, and its causal condition serve as an introduction to the teacher narratives. The remaining six paradigm elements, properties, dimensions, context, support, intervening conditions, and consequences are described within the teacher narratives.

Table 9

The Required Algebra I Program Paradigm

Basic Elements	Actions and Description
Phenomenon	Implementation of required Algebra I program
Causal conditions	Requirement to implement the Algebra I program to all students
Properties of the required Algebra I program	A one-year Algebra I course based on the Standards of Learning in which Algebra is used to represent and solve practical problems. Content includes tables and graphs to interpret algebraic expressions, equations, inequalities, functions, and matrices
Dimensions of the required Algebra I program	Utilization of four major NCTM recommendations: algebra as communication, connections, problem solving, and reasoning
Context	Creation of an algebraic thinking atmosphere
Implementation support	Staff development on instructional strategies, classroom management, and professional dialog with colleagues
Intervening conditions/interaction strategies	Teacher-made tests, multiple retests, use of manipulatives, after-school tutoring, pacing, and teachers' perceptions of the required Algebra I program
Consequences	Degree to which NCTM recommendations were reflected in the required Algebra I program and student achievement

As Glaser and Strauss (1967) noted a vivid description of the phenomenon is necessary in order for the reader to "almost literally see and hear its people...but always in relation to the theory" (p.228). The narratives, which follow, reflect the relationships among the major categories which evolved from the data: (a) perceptions of algebra, (b) classroom practices, and (c) beliefs and attitudes. The narratives integrate the teacher observations and interviews to more clearly portray the implementation of the required Algebra I program. Fictitious teacher names were used to protect the anonymity of the teachers involved in the research.

Program paradigm context. The former assistant superintendent of instruction recommended that all students take algebra in order to lessen the effects of tracking at the middle and high school levels. In 1992, a major review of the school division's mathematics curriculum revealed the need for increased articulation among elementary, middle, and high school mathematics teachers. The review also cited the lack of algebra achievement for many students. In addition, the review identified the need to replace the seventh grade general mathematics course with pre-algebra classes. Furthermore, the curriculum review recommended that all students take a required Algebra I program by ninth grade as a graduation requirement. This requirement preceded the 1995 Virginia Department of Education mandate to teach algebra to all students.

The National Council of Teachers of Mathematics (NCTM) recommendations of communication, connections, problem solving, and reasoning are not reflected in traditional algebra instruction which is based on lecture, explanation, and the modeling of equation solving procedures at the blackboard. Furthermore, in the traditional algebra classes, the focus is on solving equations rather than exploring mathematical solutions to real life problems.

This study explores the required Algebra I program as a new implementation which should reflect student inquiry as opposed to the teacher-led instruction found in traditional algebra classes. The challenge for the ninth grade Algebra I teachers is to provide instruction that meets the needs of all students. The study included twelve of the thirteen algebra teachers in the school division. One teacher chose not to participate in the study.

The narrative descriptions below provide insight from the teacher's perspective of the required Algebra I implementation. The introduction to each narrative includes the teacher's years of experience, willingness to participate in the study, and a general classroom description. Classroom practices reflect classroom management concerns, student readiness, and use of National Council of Teachers of Mathematics (NCTM) recommendations. Each teacher narrative concludes with the identified Stages of Concern (SoC) Questionnaire type, the identified level of program implementation based on the Levels of Use (LoU) focused interview, and the final-grade pass rates for the required Algebra I course. The narratives provide a rich description of the teachers' perceptions of algebra, classroom practices, and attitudes and beliefs concerning the implementation of the required Algebra I program.

Teacher Narratives

The eight elements of the Required Algebra I Program Paradigm in Table 9 guide the story line for each of the teacher narratives. The first element, phenomenon, implementation of the required Algebra I program, was examined through classroom observations and interview data. The second element, causal condition, for the Algebra I program was the state requirement that all students take Algebra I in order to graduate. The third element, properties, of the required Algebra I program were the Standards of Learning objectives used to teach algebraic representation and problem solving. The fourth element, dimensions, revealed the level to which the four major National Council of Teachers of Mathematics (NCTM) recommendations were implemented, that is, dimensionalized. For example, in problem-solving, the dimensionalization ranged from traditional textbook word problems with one correct solution to real life problems such as issues related to perimeter issues in yearbook design and lay out. The fifth element, context or creation of an algebraic thinking atmosphere, was based on the National Council of Teachers of Mathematics (NCTM) recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. The sixth element, implementation support, was ascertained in the teacher interviews. The seventh element, intervening conditions and interaction strategies, included multiple retests, after-school tutorials, easy problems, and slow pacing. The eighth element, consequences, was determined by final Algebra I grades.

<u>Barbara Williams</u>

Teacher 1, Barbara Williams, has taught algebra for seven years. As Table 9 indicates, Williams scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 67% of Williams' students passed the course.

Williams, a willing participant, was quite flexible in scheduling observation and interview sessions. The observer arrived as the teacher was beginning the lesson. William's room contained the traditional rows of desks. A bulletin board in a corner of the room listed various announcements and flyers. The Standards of Learning objectives for each class period were included as part of the daily schedule on the chalkboard. One section of the chalkboard contained an oversized grid for graphing.

Williams demonstrated a no nonsense approach to classroom management and quickly moved into the instructional task. She appeared to be well organized and created smooth transitions between examples worked at the blackboard and problems assigned in the textbook. Basically, the lesson consisted of a short review of how to determine the slope of a line. This review was followed by the students practicing problems using the formula $y = mx + b$. The teacher called on various students to explain each step of the procedure to solve the equation $-4x + 3y = 12$. She then called on individuals to provide the solutions and name the respective slopes: straight, intersecting, or parallel lines. While the majority of students appeared attentive, only a few students consistently answered the questions. Many similar problems were practiced throughout the lesson. Again, the same few students responded. Williams' teaching behavior was typical of traditional teaching which emphasized the correct procedural steps in solving equations. The verbal exchanges between the teacher and students were limited to brief responses concerning the examples.

Williams' classroom management style was evident in the behavior of students. Her no nonsense approach and occasional verbal reminders to students maintained an orderly classroom. Although most of the students appeared attentive, the same few students responded to the teacher's questions.

Williams shared that her eighth grade algebra class was less "challenging" than her ninth grade algebra class. She covered more material in the eighth grade algebra classes as she believed these students were better prepared to handle the algebraic concepts. When asked about the impact of the required Algebra I program on her instruction, she expressed concern that too much time was needed to remediate students in the basic mathematics skills. Williams shared, "It's been very poor. I can ask a question three times before I get a response." Williams discussed the National Council of Teachers of Mathematics (NCTM) recommendations in terms of cooperative learning and the use of manipulatives. Williams stated during the interview that she mainly used lectures to cover the required material. Past attempts to work with cooperative groups were described as unsuccessful, an outcome she attributed to the students' lack of reasoning and communication skills. In addition, she stated that small group settings called attention to the reading difficulties of many students. Williams did not use manipulatives because she viewed them as "cutesy games and not really algebra".

She questioned the value of cooperative learning and the use of manipulatives when her ninth grade students' appeared unresponsive and disinterested. For as she stated, "In previous years, eighth grade students would compete to respond while these ninth grade students immediately shut down when a real life word problem is presented." Williams attributed this behavior to students' lack of reading and logical thinking skills. In addition, she felt that the pressure to cover the curriculum was compounded by the students' limited knowledge of decimals, fractions, and percents. The Algebra I requirement posed numerous problems for this teacher who was ill-prepared to meet the needs of her diverse student population.

Williams expressed concern that students failing at mid-year were locked into a year-long algebra class. She suggested that these students be allowed to repeat Algebra I mid-year. Another concern was the lack of consistency in the coverage of ninth grade algebra curriculum among the four high schools. As Williams stated, "If I cover six chapters in a semester and someone else covers only three and they [the students] get the same Algebra I credit, that's not fair." Williams felt that this situation needed to be remedied. When asked about the impact of the National Council of Teachers of Mathematics (NCTM) recommendations on her instruction, Williams stated that she agreed with most of them. She made reference to only cooperative learning groups and manipulatives. "However, there is no time to use manipulatives. I like doing them and I have done them before. Now that I have the lower level students, I can't do the fun things like cooperative groups or lectures. These students required more individual assistance." Furthermore, "low ability students would not find algebra beneficial to them later on life. It's not going to open any doors for them." She believed these students would benefit more from a consumer mathematics course. "They will never use algebra and will be perfectly fine." Interestingly, Williams perceived algebra as a gateway for future engineers and scientists. "It's going to open all kinds of doors for them. Williams' view of the Algebra I program reflected her belief that algebra as a gatekeeper was an inevitable outcome for many students.

Beth Walker

Teacher 2, Beth Walker, has taught algebra for 27 years. As Table 9 indicates, Walker scored at the nonuser Stage 0 on the Stages of Concern (SoC) questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 60% of Walker's students passed the algebra course. The following narrative supports these results.

Initially, Walker was somewhat reluctant to participate in the study and requested that neither the observation nor the interview be audiotaped. However, she later gave permission to have the interview audiotaped. The observer arrived a few minutes before the class was scheduled to begin. Walker's room contained many large plants and several bulletin boards covered with brightly colored posters. The Standards of Learning objectives and the assignments for the day were posted on one wall. As the bell rang, students entered chatting and took their seats which were arranged in traditional rows.

Walker's style of classroom management involved constant reminders to students as she instructed them. Statements included, "Ladies and gentlemen, we're getting a little bit loud, listen up, shh, everybody stay focused." However, it appeared to the observer that most of the students were on task, but struggling with the skills being discussed.

Walker began the class by calling on students to give the answers to their homework assignment. Then Walker circulated among the students and noted complete and incomplete assignments in her grade book. She asked students if they had difficulty with any of the problems. After writing these problems on the blackboard, she guided students through the procedure to solve the problems. Throughout the lesson Walker maintained eye contact with students and called them by name. During part of the lesson, students worked in pairs or small groups. At the end of the lesson while students took a practice test, Walker averaged their grades on slips of paper which she then gave to them. The practice test was corrected in class and again, the more difficult problems were worked out on the blackboard. In the interview, Walker noted that block scheduling was not conducive to teaching Algebra I as the class period was too long. She recommended that next year Algebra I be offered during the shorter seventh period. Walker also stated that she did not use manipulatives and did not know if there were any available in the building. Walker used traditional methods which focused on the correction of homework followed by explanation and demonstration of problems on the blackboard. In summary, there was little evidence to suggest that Walker encouraged students to explore, share, or justify their thinking in the development of algebraic concepts.

Walker, an experienced teacher, expressed her frustration with the required Algebra I program in these terms: "Don't tell me after thirty years of teaching to do it differently." She believed that algebra was the most important mathematics course a student could take. Walker stated, "I honestly believe if you truly understand algebra and it's a good course, you will never have trouble in math." Walker did not like the adopted algebra textbook and preferred more practice problems versus the real life problems included in the algebra textbook. According to Walker, the real life problems presented in the textbook were not relative to the students. In contrast, Walker believed that the 1932 algebra book used by her mother was wonderful

"There are no color pictures and no little cute history notes, but all of the math is there." Walker appeared to be struggling with the demands of the required Algebra I program. When asked about the impact of the required Algebra I program on her instruction, Walker replied that she had students complete more work at the blackboard. Furthermore, she allowed students to work in small groups so they could get up and move around.

Walker did not believe that algebra was for all students. She found the required Algebra I students to be immature and often unwilling to complete homework assignments. In addition, lack of parental support for the Algebra I program was a major concern. "I think somewhere along the line somebody decided that if you're not good in math, you're not bright which I think is the wrong message. I think whatever you do, be it a fingernail technician, a plumber or landscaper-- all are equally important, respectful professions. This idea that if you're not carrying around a big thick math book, you're not a bright person, is the wrong message." When asked about the impact of the National Council of Teachers of Mathematics (NCTM) recommendations, Walker responded, "I've probably read them." When probed further about the connections recommendation, she noted that the textbook includes real life problems, but felt that the majority were not relevant to students. Walker believed the major issue is the lack of a clearly articulated mathematics curriculum "for today's world".

Sharon Turner

Teacher 3, Sharon Turner, has taught algebra for 30 years. As Table 9 indicates, Turner scored at the nonuser Stage 0 on the Stages of Concern (SoC) questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 75% of Turner's students passed the course. The following narrative supports these results.

Although Turner requested that neither the observation nor interview be audiotaped, she was a willing participant and freely shared opinions about the required Algebra I program. The observer arrived prior to the beginning of class. The desks were arranged in traditional rows. One section of the chalkboard contained an oversized grid for graphing. A few posters of foreign countries were placed around the room and various announcements were posted on a small bulletin board next to Turner's desk.

The bell rang and students entered the classroom. Turner reminded students to complete the warm up exercises written on the whiteboard and stopped by each student's desk to record completion of the homework assignment. She then asked if any of the students planned to attend the after school tutorial session. As Turner walked around the room, she called students by name to provide answers to the warm up problems. Turner probed students to expand on their answers and encouraged students to answer each other's questions. Next, the students used graphing calculators to check the warm up exercises. The students appeared quite competent in their use of the calculators as they plotted the coordinates and determined the slope of the lines. Then, Turner used an overhead graphing calculator to review the specific steps needed to solve the problems. In addition, several students were called on to use the overhead calculator to solve problems. Turner reminded students to take notes on the key attributes of linear combination methods as they occurred during the lesson

Shortly, before the end of the lesson, Turner checked off the students' names as they turned in their calculators at that point of the lesson. Then students worked alone or in groups on the new homework assignment for the remainder of the class period.

Turner's classroom management style was evident in the behavior of students who stayed on task throughout the lesson. No discipline problems surfaced during the observation. In summary, the lesson was presented in a logical, orderly manner with smooth transitions between activities.

Turner developed student thinking through her questioning techniques which resulted in student verbalization of algebraic concepts. This thinking process was further extended to the pictorial representations during the graphing calculator activity. This hands on approach to the use of mathematical tools is supported in the National Council of Teachers of Mathematics (NCTM) recommendations. Turner's delivery of instruction reflected her favorite quote, "I hear and I forget, I see and I remember, I do and I understand." When asked about the impact of the required Algebra I program on her instruction, Turner replied that she has always incorporated group and board work but now, more time is spent on teaching less complicated problems. Furthermore, Turner referred to the required Algebra I as a mediocre curriculum compared to the traditional Algebra I instruction

Turner believes that Algebra Is a gatekeeper because not all students need algebra to be successful in life. Furthermore, she noted, "some students are not ready [for algebra] and would be better off learning practical things they are going to use Besides, there are thinking skills involved in consumer mathematics that are beneficial to students." Furthermore, Turner described many of the Algebra I students as being immature and lacking the study habits and self-discipline required to study algebra.. Although Turner's instruction emphasized reasoning skills as advocated by the National Council of Teachers of Mathematics (NCTM) recommendations, the other areas of communication, connections, and problem solving were not evident in the observation or interview.

Donna Lewis

Teacher 4, Donna Lewis, has taught algebra for five years. As Table 9 indicates, Lewis scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 79% of Lewis' students passed the course. The following narrative supports these results.

Lewis shared a mobile classroom with another teacher. Student desks were arranged in rows and the teacher's desk was placed in a corner in the back of the classroom. Many colorful posters lined the walls. Lewis was a friendly participant who readily agreed to be audiotaped during both the observation and the interview. The observer arrived early and noted that Lewis appeared to have a good rapport with her students. She greeted students by name and joked good- naturedly with them as they entered the classroom.

The class schedule on the blackboard consisted of the objective (factoring trinomials), correction of homework, several practice problems, a quiz, and the next day's homework assignment. Lewis distributed a set of corrected quizzes and asked if there were any questions. A student asked for an explanation of the factoring process used to solve one of the problems. Lewis modeled the factoring process emphasizing the questions students should ask themselves in each step of the procedure. Suddenly, a boy sitting at the front of the class recognized his mistake on the problem and muttered "dumpsky' to which Lewis responded, "Don't feel stupid, that's why quizzes only count for 30% of your grade." She added, "Everyone learns from their mistakes." Then she reminded the students that class attendance and completion of homework were also important factors in their algebra grade. Next Lewis handed out a practice worksheet and circulated among the students to check their progress and provided assistance as needed. Ten minutes later, the students corrected their worksheets as Lewis called out the answers. Following this activity, the students were told to take out a piece of paper for a factoring quiz on the overhead transparency. Students were given approximately ten minutes to complete the quiz. As Lewis collected the quizzes, she told the students to complete the even numbered problems of the homework assignment. Lewis noted later that the required Algebra I program impacted minimally on her instruction. However, she realized that she was encouraging more students to stay after for additional assistance than she had in her traditional algebra classes. Lewis felt the most important factor in helping students achieve in algebra was the attitude of the teacher: "You need to like the students, your job, and the subject. If you don't, it will come across to the students." This attitude was reflected in the positive rapport evident in the classroom.

Lewis' classroom management style was reflected in her response to students who were talkative and not completing their assignment. For instance, she would make a humorous comment such as "I feel a really big assignment coming on" or call off-task students by name. Again her positive attitude was reflected in her clear delineation of student requirements with respect to attendance, homework, quizzes, and examinations to pass Algebra I. This approach emphasized student responsibilities rather than threats of failure.

Although Lewis has taught algebra for five years, she felt she lacked the expertise necessary to suggest curriculum improvements to the required Algebra I program. She was opposed, however, to the school division's alternative offering of the AIMS two-year integrated algebra and geometry course. "It's unfair that those students who take AIMS I and AIMS II get the same credit as the required Algebra I students who are busting their tails taking Algebra I and geometry as separate courses. There is no comparison between Algebra I and geometry to AIMS I and AIMS II. Even AIMS III is a watered down algebra course." When asked about the impact of the required Algebra I program on her instruction, Lewis stated that there had been no change. "I know to a degree I still have to teach to the general average kid. The students who need extra help are just going to have to make the extra effort to stay after. I certainly encourage them. Sometimes, all it takes is ten minutes for them to catch on."

Lewis believed that the majority of students were not mature enough to think in the abstract terms required of algebra. Lewis viewed algebra "...as a gatekeeper for students who were going to be, for instance, construction workers. These students need to understand decimals, factoring, and percentages. They need a consumer mathematics course. For the college-bound students, Algebra I is a gateway, a stepping stone for them to advance to geometry, Algebra II, and trigonometry." While Lewis stated that she was open to new ideas and enjoyed attending workshops, she was largely unaware of the National Council of Teachers of Mathematics (NCTM) recommendations. However, when queried about the recommendations she responded, "If the National Council of Teachers of Mathematics (NCTM) recommends I use calculators for every lesson, then I do not agree with them."

Jane Dover

Teacher 5, Jane Dover, has taught algebra for fifteen years. As Table 9 indicates, Dover scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 62% of Dover's students passed the course. The following narrative supports these results.

Although, Dover agreed to participate and be audiotaped, her manner was somewhat brisk. Student desks were arranged in traditional rows in her mobile classroom. There were several wildlife posters on the walls. However, the poster over the chalkboard that caught the observer's attention was titled, "Your Education is Your Responsibility." The observer arrived as the students were entering the classroom. They quickly settled down when Dover began the lesson.

The lesson began with the correction of homework. Dover walked around the room calling on students by name for answers to the homework problems. Dover provided the correct answer to any incorrect student solutions. This was an introductory lesson on the use of the graphing calculator. It was evident by the halting nature of the demonstration that Dover was unfamiliar with the use of the graphing calculator. Students helped each other to enter the data correctly to solve sample equations written on the blackboard. Once the students had completed these problems, Dover distributed practice problem worksheets for students to solve. She called out the answers to the practice problems while students corrected them. After the calculators were collected, she wrote the next day's homework assignment on the blackboard. Students copied the assignment as the bell rang to signal the end of the class period.

Dover demonstrated a no nonsense approach to classroom management. Students who were off task were sharply reprimanded. "Excuse me folks. I can't deal with the noise." Furthermore, she responded to a student question by stating. "I don't know, do it again. You solved your problem incorrectly." In summary, the observation reflected Dover's inexperience in introducing the graphing calculator to the students.

When asked about the impact the required Algebra I program on her instruction, Dover cited two changes. She had increased the number of opportunities for students to work in groups and to work out problems at the blackboard Previously, she stressed the importance of mathematics terms through regular vocabulary quizzes; now due to time constraints, she lists the words as part of their homework assignment. Dover considered equation solving, factoring, and fractions as the major concepts in algebra. She stated that she did not use manipulatives and doubted the value of the calculator which she viewed as used as a crutch rather than as a tool for learning algebra. "I think students need to work the problems themselves and understand the underlying arithmetic before they use a calculator."

Dover believed that the required Algebra I program was being "... watered down a little bit because the kids are coming to us unprepared. The time is much more rushed and I don't get to spend time on major things I think are important." Dover believed that algebra was a gateway stating, "They need it. I don't care how much they think they're not going to need it." When asked about the National Council of Teachers of Mathematics (NCTM) recommendations, Dover noted that she was not familiar with them. Dover stated that students should be self-motivated. "I figure at that age they're old enough to motivate themselves." She would like to see more parental support on the completion of student homework. Dover also mentioned that more computers and appropriate software would be helpful in teaching algebra.

Matthew Brown

Teacher 6, Matthew Brown, is in his first year of teaching Algebra I. As Table 9 indicates, Brown scored at the personal Stage 2 on the Stages of Concern (SoC) Questionnaire. The interview data reflected an orientation Level I on the Levels of Use Focused Interview. The final Algebra I grades indicated that 86% of Matthew's students had passed the course.

He was a willing participant who readily agreed to be audiotaped His background in calculus provided him with a unique perspective on teaching Algebra I The classroom served as a science lab which contained tables with sinks, Bunsen burners, and other science materials. The large science tables made the room appear smaller than most of the other classrooms Six to eight students sat at each table Their coats and bookbags were piled at the back of the room. There were three posters of famous African-Americans on the wall. An overhead transparency projector was located on a table at the front of the room. The class had just started when the observer entered the classroom.

Brown was referring to a transparency on the overhead that listed several equations. Students were asked to choose one of two pairs of numbers (1, -1) or (0, 3) to make the y=3-2x a true statement. Next, students graphed the x and y coordinates to find the slope. Students were then given approximately fifteen minutes to complete a review worksheet. After the students had finished the worksheet, Brown called on four students to write out their solutions to problems on the blackboard. However, there was a sudden announcement that school would be closing early due to an approaching storm. Brown had a difficult time regaining the students' attention amid the cheers. Finally, the class settled down and returned to correcting problems. After these problems were corrected, the students were dismissed.

Brown's classroom management style was reflected in his response to several incidents of misbehavior designed to distract instruction. He shared his frustrations regarding the students behavior stating that, "Students in Algebra I are quite different in their behavior from students in the calculus classes."

When asked if he had changed his teaching approach from the beginning of the year, Brown replied that he had shifted the responsibility for solving problems to the students so they would do the thinking involved. Brown referred to the students' efforts at problem solving as "controlled floundering". Brown emphasized the thinking process rather than the correct answers. Brown stated that he wanted students to communicate their mathematical reasoning in a problem solving context. However, he noted that his efforts to promote cooperative groups were unsuccessful. "I've seen some deplorable stuff. A lot of students get the impression that they are relieved of their individual responsibility to contribute to the project. I would like to get more training on cooperative learning." Brown's background in engineering and teaching calculus provided concrete examples in the introduction of algebra concepts. For example, students raced battery-operated bulldozers on a 20-meter course. Students used stopwatches to time the bulldozers. The time and distance of each bulldozer was recorded for later use in a graphing activity. While Brown claimed to be vaguely familiar with the National Council of Teachers of Mathematics (NCTM) recommendations, he demonstrated a good grasp of the connections recommendation. An example of a connections recommendation he gave was the problem of introducing wolves to an area with an existing moose population. He planned to share data pertaining to the size and requirements of each population and to ask students to determine when the two populations would be equal in size.

Brown viewed algebra as a gateway, important as reading and writing literacy. The reasoning recommendation of the National Council of Teachers of Mathematics (NCTM) is reflected in Brown's comment that students develop their mathematical thinking by expressing algebraic concepts in their own words. Brown thought manipulatives might be helpful; however, he did not use them in his classes. When asked about calculators, Brown stated, " I use them a lot. However, I can also do without them even if it [solving the problem] takes a little bit longer. I'm finding some of these kids are simply "clueless without calculators." He added that there should be fewer students in Algebra I and that algebra should be taught within the context of a problem solving curriculum. Brown expressed a need for inservice on how to effectively reach low ability students and implement integrated learning aimed at skill mastery. He also expressed the need for information on how to best prepare students to take the Standards of Learning algebra test.

Joe Reynolds

Teacher 7, Joe Reynolds, has taught algebra for four years. As Table 9 indicates, Reynolds scored at the nonuser stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 51% of Reynolds' students passed the course. The following narrative supports these results.

Reynolds' willingness to be observed and interviewed encouraged another algebra teacher who had concerns about being observed teaching Algebra I students. He convinced her that the observer should see the behavior problems which occur in the required Algebra I program. The student desks in Reynolds' room were arranged in traditional rows. Three signs were posted strategically next to the door, by the clock, and above the chalkboard. These signs emphasized Reynolds' three keys to success: (1) Listen, (2) Take notes, and (3) Complete homework. The observer entered just after the class had started.

While Reynolds credited the students' homework in his grade book, he reminded students that re-tests would be given on Thursday after school. Reynolds placed an overlay of the homework answers on the overhead. He emphasized that parentheses must be used to indicate ordered pairs. Reynolds graphed one of the problems on the overhead to demonstrate how to plot the coordinates along the x and y axes. He emphasized the correct placement of ordered pairs with respect to the x and y axes. He reminded them that since, alphabetically, x comes before y, the first number of the ordered pair is graphed on the x axis and the second number of the ordered pair is graphed on the y axis. The students were confused as to which numbers they should choose to solve the equations. Reynolds repeatedly reminded students to try either 0 or 1 first, to simplify the equation solving process. " Why do you guys make it so hard? Pick a value for x. One is good. Four is okay, but I would pick 0. I always pick zero or one." Reynolds' increasing frustration was apparent when he said, "You guys keep hoping variable equations are going to go away, but they're here for the rest of the course. I'm not kidding you. They are here to the bitter end." Reynolds then handed out a ten-item quiz containing similar equations. When the students finished the quiz, Reynolds placed a transparency with the answers on the overhead. Students then corrected their own papers. Again, students expressed confusion in solving the equations and Reynolds demonstrated the more difficult problems on the overhead. A student collected the quizzes. Reynolds assigned problems in the textbook for homework. The students copied the assignment and left the classroom. When asked about the impact of the required Algebra I program on his instruction, Reynolds noted the difficulty of adapting instruction to meet the wide range of student abilities and readiness.

Reynolds' classroom management style was evident in his interaction with the students, many of whom were experiencing difficulty in understanding the algebra lesson. Frequently, when he stopped to help one student with a problem, several other students would loudly express their frustrations in a disrespectful manner. This situation was due largely to the inability of many students to understand his directions For example, "You're confusing me and I don't know how to graph it."

Reynolds, a relatively inexperienced teacher, expressed a genuine concern in helping students. He offered to work with students during his lunch period and after school. Unfortunately, few students attended these tutorial sessions. In addition, he complained that many students did not complete homework. The algebra period was limited to thirty-minute instructional activities due to the students' short attention spans. He mentioned his opposition to the practice of using tangible rewards at the high school level. Reynolds believed that teacher collaboration would significantly improve the Algebra I program, especially with respect to disruptive students. He stated, "I don't mind sharing. It would be nice to have a curriculum specialist for algebra. I would be happy to give the guy my filing cabinet to take whatever he liked. It would be nice to know what everyone else is doing."

When asked about the National Council of Teachers of Mathematics (NCTM) recommendations, Reynolds stated that the recommendations had been referenced in some of his courses. He shared, "I'll be quite honest with you. I really haven't had the time to go back and compare them to everything we're doing." Reynolds discussed the use of cooperative learning when questioned about different instructional strategies. He found cooperative groups difficult to manage. A major concern focused on the use of word problems due to the poor reading skills of many students. In addition, he was disheartened when students were unwilling to grapple with the real life problems of racetrack speed ratios and yearbook layouts.

<u>Anne Jones</u>

Teacher 8, Ann Jones, has taught for five years. As Table 9 indicates, Jones scored at Stage one on the Stages of Concern (SoC) Questionnaire. The interview data reflected a mechanical Level III on the Levels of Use Focused Interview. The final Algebra I grades indicated that 88% pass of Jones' students passed the course The following narrative supports these results.

While she was a willing participant, Jones expressed concern about the observation because of behavior problems in the class. The observer reassured her that the anonymity of the participants in the study would be protected in the research findings. The observer arrived a few minutes prior to the beginning of class. The student desks were arranged in rows and the teacher's desk was placed in the front of the class next to the wall. A large bulletin board next to the door contained samples of students' graphs. An overhead was located at the front of the room.

Students entered the room noisily and took their seats. Jones assigned students several problems to complete while she stamped their homework record booklets. Then students corrected their homework as she called out the answers. Jones used the overhead to demonstrate the solutions to the more difficult problems. Next, she told the students that they could use their notes with the daily quiz. Jones demonstrated on the overhead the procedure for finding the slope for the first problem. After the quiz, she handed out a worksheet. She began the main part of the lesson by asking students, "Did I tell you what letter we use to represent slopes?" Students responded that she had. Jones stated that M would represent slope. She explained that M was determined by the ratio of rise to run and demonstrated how to graph the coordinates. The students were then directed to pick two numbers to do rise over run and determine the slope of the line. The students began graphing sample problems on their own. Her specific directions precluded student participation and discussion during the activity

Interestingly, a student was overheard to comment, " We need her everyday (referring to the observer)...she (the teacher) is being nice." Jones reminded the students to copy their homework assignment as the class ended. When asked about the impact of the required Algebra I program on her instruction, she indicated her instruction had changed to reflect the emphasis placed on covering all the Standards of Learning objectives. Jones stated that she did not use cooperative groups with the required Algebra I students because of their inability to work together. Furthermore, Jones indicated that manipulatives were not used due to time constraints of the Standards of Learning tests.

Jones' classroom management style was dependent on the traditional "chalk and talk" approach which she rationalized, "...if they start practicing wrong, then we're in trouble." Students stayed on task while she demonstrated algebraic procedures. However, no opportunity was provided for student interaction. Off task behavior occurred whenever Jones transitioned from one activity to the next, such as from correcting the homework to beginning the quiz.

Several years ago Jones attended a two-week summer training on the Hawai'i Algebra Learning Project. Jones and a colleague piloted the Hawai'i Algebra Learning Project at their school before Jones left to accept a position with her current school division. Students in the pilot program had used the Hawai'i Algebra Learning Project manipulatives and other materials. Those students frequently worked in cooperative groups that emphasized working backwards to solve word problems. However, Jones found that cooperative groups did not work with her required Algebra I class. Jones stated that working in cooperative groups was a source of embarrassment for students with weak mathematics skills. Furthermore, she stated that cooperative groups were problematic "...in terms of behavior, once you do get them to work together, it's a zoo. ...a lot of times the kids aren't mature enough to get out of it what they're suppose to." When asked about the impact of the required Algebra I program on her instruction, Jones responded that she worked with students individually after school. She observes them completing a problem so that she can clear up the confusion or mistake. Interestingly, Jones noted success with the Hawai'i Algebra Learning Project which incorporated all of the National Council of Teachers of Mathematics (NCTM) recommendations. However, she felt that she was unable to implement the National Council of Teachers of Mathematics (NCTM) recommendations in the required Algebra I classes due to problems with student behavior.

Jones perceived algebra as a gatekeeper stating that, "Students who do not pass algebra should not graduate; otherwise, a diploma means nothing." She noted that all students could pass required Algebra if they would put forth the effort. In addition, Jones found that block scheduling was not conducive to teaching algebra, especially to inclusion students. "Algebra students find it very difficult to take in two sections worth of material in one class period. They can't sit there and listen to that much lecture." She was overwhelmed with the sheer number of Standards of Learning (SOL) objectives. Also, she was surprised that the Standards of Learning omitted the prerequisite concepts necessary for the more difficult skills. "I'm spending two weeks on this topic that isn't in the SOL but [this prerequisite skill] is completely necessary for me to go on." Jones believes the required Algebra I program tracks students because the more successful students take Algebra I in the middle school

Bill Smith

Teacher 9, Bill Smith, has taught algebra for thirteen years. As Table 9 indicates, Smith scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a nonuse Level 0 on the Levels of Use Focused Interview. The final Algebra I grades indicated that 86% of Smith's students passed the course.

Smith was a willing participant who agreed to have the observation and interview audiotaped. The room was arranged neatly with students' desks in traditional rows. The Standards of Learning objectives were posted on a bulletin board behind the teacher's desk which was located at the front of the room. The observer arrived approximately ten minutes after the class had begun. Most of the students were involved in the lesson while a few students were talking among themselves.

Smith told the students to find the slope of the line passing through several ordered pairs of numbers listed on the blackboard. The students were given a few minutes to work out the problem. Smith then sketched the slope of the line using the ordered pairs of numbers on the board. As he explained each step in determining the slope of the line, he reviewed the procedure for addition of signed numbers. Smith stated, "Let's check and make sure. We don't always notice two negative numbers." He then prompted students to recall the relationship between the line and the steepness of the slope. Smith then compared the slope drawn on the blackboard to a ski slope "...down one and over two. I can do it as many times as we want, can't I? Once I've done that all those points fall in line, don't they? Did we get a line with a negative slope? Is it fairly unsteep? Could most of you even ski this?" Smith continued to ask several questions which he then answered. Interestingly, students were attentive during this lecture. The only question posed by a student was, "Mr. Smith, have you ever been skiing? Smith replied that he was indeed a skier and knew from personal experience that steepness is a critical factor of slope. Next, Smith announced that students would be given twenty minutes to complete problems from a page in their textbooks. After approximately fifteen minutes, he announced that "Ann and Jane had figured out that problems 9-12 required them to determine slope. They found a point, put their pencil on it, and counted the rise over run. Whatever their rise over run was, that was their answer." Smith then continued the lecture approach to clarify possible problem areas for students. As the bell rang, Smith assigned the homework to the students.

Smith's teaching style and use of language such as "dude" for student appealed to the class. Although the students were not active participants in the lesson, they were attentive and well behaved.

Smith stated that he used the graphing calculators with his students. However, he found that manipulatives confused students, and therefore did not help to clarify algebraic concepts. When questioned about cooperative learning, Smith stated that there were lots of drawbacks. "I feel more comfortable and the kids feel more comfortable when we don't use groups ... I tried to force it and it just didn't work." When asked about the impact of the required Algebra I program on his instruction, he responded that the Standards of Learning were the major concern in teaching students with a wide range of abilities. In addition, he was quite hopeful about a two-year

Algebra I pilot program that would allow greater flexibility and pacing in instruction. Smith also mentioned the use of varied activities. "I try to make things as visual as possible, but at the same time I'm going to have to do a lot of talking."

Smith believes that students have different styles and learn at different speeds. Smith cautioned that, "Just because a kid is not the world's strongest math student, it doesn't mean they're not college bound. It just means maybe they're college bound in a different area." He also stated that many students were not prepared to take algebra as it was currently structured in a one-year program. However, Smith felt confident that students in his pilot two-year Algebra I program would pass the Standards of Learning Algebra I test. Students earn two mathematics credits if they successfully pass the two-year Algebra I course. Students then can take a higher level mathematics course to earn the three mathematics credits required for graduation. When asked about the National Council of Teachers of Mathematics (NCTM) recommendations, Smith stated that he was familiar with the recommendations but did mention any of them. Furthermore, he stated the main point he had learned from the National Council of Teachers of Mathematics (NCTM) recommendations was the use of graphing calculators. He also cautioned that "the trick is to make sure that you use them [graphing calculators] as a tool for learning, not as a crutch..."

Susan White

Teacher 10, Susan White, has taught algebra for 26 years. As Table 9 indicates, White scored at the collaborative Stage five on the Stages of Concern (SoC) Questionnaire. The interview data reflected a Level III on the Levels of Use Focused

Interview. The final Algebra I grades indicated that 53% of White's students passed the course. The following narrative supports these results.

White was a willing participant and readily agreed to both the observation and the interview. The observer arrived a few minutes prior to the beginning of class. The students' desks were arranged in the traditional rows. There were several posters on the walls. White also had an interesting collection of irregular-shaped boxes and containers in a corner of the room. She stated that she had students use them to determine area and volume.

White began the lesson by having students correct their homework assignment. After the problems were corrected, she asked if there were any questions. White then called on six students who experienced difficulty with the problems to work them out on the blackboard. Several students began chatting or making remarks while students solved the problems at the blackboard. Periodically, White would reprimand the off task students. White explained the steps to each problem on the blackboard. After the homework was corrected, White wrote several equations on the blackboard and reviewed the steps for solving them with the class. On impulse, students called out answers, questions, or comments. Several students starting talking. The behavior in the classroom became noisy and disruptive. One student announced loudly that she was sleepy and put her head down on the desk. White ignored this outburst, however, she did tell the class they needed to settle down. She then assigned a homework page from their textbook which they began in class.

Students in White's class exhibited many off task behaviors. White's classroom management style was evident in her interactions with students. She constantly called students to task throughout the lesson.

On the topic of staff development, White mentioned attending a local conference that pertained to algebra which she found to be helpful. White viewed equation solving, basic graphing skills, and working with polynomials as the building blocks of algebra. Although White liked cooperative learning, she found that it was not successful for her students. When asked what impact the required Algebra I had on her instruction, White stated that she spent additional time using other approaches to reteach skills. She stated that she used a combination of lecture and student exploration. In addition, students worked problems at the blackboard. White also noted that she used manipulatives such as algebra tiles for teaching factoring. Furthermore, she attempts to connects skills to real life when possible. For example, when studying slope, she discusses a specific local area exit ramp or a carpenter's work on roofs. In addition, White stated that students could use calculators when they were graphing quadriatic equations, but found that many students would play with them. However, the observed lesson utilized only traditional teaching instruction.

White believed that students were not prepared because they had not learned basic arithmetic skills. According to White, she had a number of students who had failed and stated that "tracking by failure" was in effect. White believed that algebra was a gateway, basic to all other mathematics courses. White expressed her frustration by stating, "The challenge is to teach students who do not love algebra." White further stated that she related the importance of algebra to future careers students may pursue. She also reminded students that if they understood problem solving, they could adapt it to any area. White was not certain why all students were being required to take algebra mentioning, "probably to raise expectations, but that actually, algebra was watered down and that there were many failures." When asked about the National Council of Teachers of Mathematics (NCTM) recommendations, White responded that she was aware of the recommendations and tried to use a number of occupational examples in class.

Mark Townsend

Teacher 11, Mark Townsend, has taught algebra for sixteen years. As Table 9 indicates, Townsend scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire. The interview data reflected a Level I on the Levels of Use Focused Interview. The final Algebra I grades indicated that 53% of Townsend's students passed the course. The following narrative supports these findings

Townsend was a willing participant who graciously accommodated scheduling changes for the observation and the interview. The observer arrived a few minutes prior to the beginning of class. The students' desks were arranged in the traditional rows. There were no wall decorations. A large screen computer and piles of books competed for space on the teacher's desk. There was also an overstuffed leather chair near the teacher's desk.

Townsend directed the students to work in groups of four to factor trinomial equations listed on the overhead as he walked around the classroom to check their homework. He then called on several students to work some of the homework problems on the blackboard while the students in the groups served as checkers The checkers conferred within their groups or called out comments to students working problems at the blackboard: "Are you sure there's nothing wrong with number 9? Yeah, right. Can you write any slower? Oh my God, she messed up!" When students had completed the problems at the blackboard, Townsend asked the class if they saw anything wrong with any of them. No one responded. The checkers agreed that the problems on the blackboard were correct. Townsend then told students that they would need the supplementary algebra books and asked several students to pass them out. He assigned numbers 1-14 on page 216 and he worked out problem number one on the blackboard. He noted that in the equation ax2 + bx + C, that a was always the term coefficient of x2, b was the always the coefficient of the x term, and c was always the constant term at the end. Students were given approximately ten minutes to complete the problems and then students were called to the blackboard to work them out. Most students worked them correctly. Students collected the books just as the end-of-the-day announcements were read over the public announcement system.

Townsend's management style was informal. There was an exchange of friendly banter throughout the class period. Students were allowed to have soft drinks and snacks during class. However, when necessary, he could assume a serious tone to which they readily responded. For example, "Quiet. Okay guys, excuse me. Let's move on."

When asked about the impact of the required Algebra I program on his instruction, Townsend replied that his lessons now included more one-to-one instruction in addition to small cooperative group work. He stated that he had students work out the problems on the blackboard so that he could monitor their thinking processes. A benefit of block scheduling according to Townsend, was that it allowed more time for practice during the lesson. Interestingly, reflecting on his instruction, Townsend noted that "I think the only thing that makes the required Algebra I a gatekeeper, is the teacher." Townsend further explained this perception, "We place too much emphasis on when a student learns [a skill,] and not on the fact that they have learned it. The students who get an F may learn the skill two weeks later, but it's not reflected in their end-of-course grade. I've turned this math class into more of a training ground than a testing ground." This viewpoint was presented in a School to Work conference session about Project Zero and Zap. Students were not permitted to take zeroes for grades. On Zap days, students who had not turned in homework assignments were required to spend two hours after school doing homework, even if they were missing only five problems. Towsend utilized this Zap practice in addition to the practice of allowing students to retake math tests.

Townsend believed that more emphasis should be placed on the development of thinking rather than test results. When asked about manipulatives, Townsend responded that while he did not take a strong position on the use of manipulatives, he did not use them. When further probed about the possibility of using manipulatives with low-achieving students, he stated that his students usually did not respond well to anything that looked elementary. He stated that students' lack of motivation was a result of having experienced little success. Therefore, at the beginning of the year, Townsend purposefully simplified instruction, implemented the Zap concept, and offered retests so that students could feel successful. He agreed with his colleagues' criticism that his algebra was "watered-down"; however, the outcome of motivated students justified his restructuring of the required Algebra I program. Students' comments attested to the success of Townsend's approach. "This is the first time I have ever gotten an A in math," or "I haven't passed a math course in three years." Townsend believed that both the teacher and the students share equally in the responsibility for making required Algebra I program a gateway rather than a gatekeeper. While the teacher can restructure the curriculum and thereby motivate students, the students must be willing to put forth the necessary effort. According to Townsend, algebra courses were placed on a pedestal as consumer math courses were deleted from the curriculum. As Townsend stated, "Algebra I students have no vision of what they will do after high school." When asked about the impact of the National Council of Teachers of Mathematics (NCTM) recommendations on instruction, Townsend replied that he was not familiar with the recommendations. He noted that his emphasis was on the Standards of Learning objectives.

<u>Bob Lane</u>

Teacher 12, Bob Lane, has taught algebra for four years. As Table 9 indicates, Lane scored at the nonuser Stage 0 on the Stages of Concern (SoC) Questionnaire The interview data reflected a nonuse Level 0 on the Levels of Use (LoU) focused interview. The final Algebra I grades indicated that 65% of Lane's students passed the course.

Lane, although a willing participant, asked not to be audiotaped during the observation and the interview. The observer entered just as the class had begun. The students' desks were arranged in the traditional rows. Lane's desk was located at the front of the room next to the window. There were three posters depicting travel scenes on the walls. An oversized graphing chart covered a portion of the blackboard.

Students were using consecutive integers to solve word problems. Lane reminded the students that n = the first integer, and n + 1 = the second integer. Lane asked how to solve the equation 2n + 1 = 61. Next, Lane wrote the steps stated by the student on the blackboard. Lane noted that the solution was correct and asked him if he had found the problem difficult. The student, John, responded that he found the process confusing. Lane then told the class to try example 1B. He then walked around the room monitoring students' work. Next, he asked if someone would like to solve example 1B on the board. Lynn volunteered and correctly worked out the problem on the blackboard. Lane asked the class if they had completed it correctly Most students raised their hands. Lane continued calling on students to work out problems on the blackboard for the remainder of the class. Lane reminded students that these problems required thinking, not rote memorization. Furthermore, he reviewed the distributive property and reiterated that both sides of the equation must balance. At the end of class, Lane reminded students about the upcoming quiz and handed out a worksheet for homework.

Lane demonstrated a no nonsense approach to instruction which was reflected in the short question and answer exchanges between himself and the students While most students appeared on task, students expressed little enthusiasm. Lane's classroom management style was straightforward and he needed only a few words to bring students back to task.

Lane stated that he pre-tested his Algebra I students at the beginning of the year. A letter was mailed to the parents of the students who had performed poorly on the test. The letter encouraged the parents to send their students to after-school tutorial sessions. However, Lane stated that none of the students attended the after-school sessions until the interim progress reports went home. Even then student attendance at the tutorial sessions was low and erratic. Furthermore, he noted that 60% of his class failed the last test. Lane would like to see the students who failed Algebra I at the end of the semester repeat the course during the second semester, rather than continue on in the Algebra I course. According to Lane, block scheduling was not conducive to achievement in algebra as too much material was covered during each class period. When asked about the impact of the required Algebra I program on his instruction, Lane responded that he had not changed his approach. However, he added that quizzes and tests were not as challenging, and that he had increased the amount of practice work during instruction. He also stated that he spent more time covering each topic because the required Algebra I students needed more time to develop algebraic thinking skills.

Lane perceived algebra to be a gatekeeper. He stated, "Many Algebra I students would benefit more from a consumer mathematics course to better prepare them for life after graduation." Lane believed that most students were not prepared to study algebra. He found that many students did not possess the necessary thinking skills and furthermore, were unwilling to exert the effort to succeed. When asked about the impact of the National Council of Teachers of Mathematics (NCTM) recommendations, Lane responded that he was not familiar with them. The researcher then asked specifically about the his views on problem solving. Lane felt if he spent six weeks on problem solving, students would not be successful because they were not prepared to think and apply concepts. On the topic of connections, Lane explained to students that algebra was beneficial in developing logical thinking. He stated, however, that he was unable to work in problems that reflected the connections recommendations. Lane noted that he did not stress the language of mathematics in his algebra classes. He also mentioned that he did not use manipulatives as they were time consuming, not readily available, and difficult to manage. Lane preferred not to use calculators stating that students were not ready to use them. Lane mentioned that previously he had assigned students to cooperative groups, but this year it was unmanageable due to class size. He concluded his comments by stating that his major focus was to cover the Standards of Learning objectives by test date in April.

In summary, the classroom observations did not reflect the NCTM recommendations. In the area of communicating mathematically, there was little evidence of students being probed to clarify their thinking about mathematical ideas and relationships or to discuss generalizations through investigations. In the area of making mathematical connections, there were a few examples, however, they were briefly mentioned with no attempts to discuss their relationships. In the area of becoming mathematical problem solvers, textbook word problems were presented and little was provided in the application problem solving to real-world situations. In the area of reasoning mathematically, students were not encouraged to make and test conjectures, or judge the validity of arguments.

In addition, the classroom arrangements of the 12 teachers reflected traditional rows of student desks. There was no evidence of manipulatives except for the presence of student calculators in two classrooms. Teachers' classroom management demonstrated their effectiveness in interacting with the students. Classroom instruction reflected the traditional lecture and demonstration of problems on the blackboard. The interview data further demonstrated the teachers' lack of familiarity with the National Council of Teachers of Mathematics (NCTM) recommendations.

Summary of the Research Data

The findings to the four major questions of the study are discussed in terms of the Stages of Concern (SoC) Questionnaire, the Levels of Use (LoU) focused interviews, and the narratives developed from the observation and interview data.

1. What are the concerns of Algebra I teachers regarding the implementation of the required Algebra I program?

The concerns expressed by Algebra I teachers on the Stages of Concern (SoC) Questionnaire were mainly low level, Stage 0 or Stage 1 concerns. Nine of the 12 teachers scored at Unawareness, Stage 0, which suggested that they did not perceive the required Algebra I program as a new implementation. One teacher scored at Informational, Stage 1 which suggested an interest in learning more about implementing the required Algebra I program. One teacher scored at Personal, Stage 2 which suggested uncertainty about the demands of the required Algebra I program. One teacher scored at Collaboration, Stage 5 which suggested a desire to collaborate with colleagues about the current implementation of the required Algebra I program. However, this experienced teacher's implementation of the required Algebra I program did not reflect the National Council of Teachers of Mathematics (NCTM) recommendations. None of the teachers scored at the Impact, Stage 6 which suggests a readiness to further refine the innovation in order to increase student achievement. Thus, the majority of the teachers did not perceive the required Algebra I program as an innovation. As a result, there was no perceived need to change their traditional teaching practices to better reflect contemporary algebra teaching practices. Eight of the 12 teachers, based on their scores on the Stages of Concern (SoC) Questionnaire, revealed little or no concerns regarding the implementation of the required Algebra I program. However, the Levels of Use (LoU) focused interview data did reveal seven major categories of teacher concerns.

The observation and interview data were analyzed using open, axial, and selective coding strategies. The open coding process allowed the researcher to break down, examine, compare, conceptualize, and categorize the data. Axial coding was then used to regroup the data in order to discover new relationships and make connections among the categories. The Required Algebra I Program Paradigm evolved during the process of axial coding. The selective coding process was then used to identify the core category, the implementation of the required Algebra I program. The major categories of teacher concerns emerged from the analyses of the relationships among the core categories which were further supported by the critical incidents. The seven major categories of concerns which emerged reflect the primary purpose of this investigation: the concerns of teachers implementing the required Algebra I program. Table 10 presents the major categories of concerns of the teachers regarding implementation of the required Algebra I program.

Table 10

Major Categories of Teacher Concerns

Teachers	Major Categories of Concern						
	Ill-Prepared Student	Student Behavior	Traditional Algebra Perspective	Restructure Traditional Algebra I Program	Algebra as a Gatekeeper	Content Specific Planning Time	Emphasis on Student Scores
Williams	X	X	X		X	X	X
Walker	X		X	X	X	X	X
Turner	X	X	X		X		X
Lewis	X		X		X		X
Dover	X		X		X		X
Brown	X	X				X	X
Reynolds	X	X	X	X	X	X	X

Teachers	Ill-Prepared Student	Student Behavior	Traditional Algebra Perspective	Restructure Traditional Algebra I Program	Algebra as a Gatekeeper	Content Specific Planning Time	Emphasis on Student Scores
Jones	X	X	X	X	X		X
Smith	X		X	X	X		X
White	X	X	X	X	X	X	X
Townsend	X	X	X	X	X		X
Lane	X	X	X	X	X		X

Major Categories of Teacher Concerns

The ill-prepared student. The ill-prepared student emerged as a major concern of the teachers. They were concerned that many students had not mastered basic arithmetic facts, decimals, fractions, and percents. Consequently, teachers believed that expectations for student achievement in the middle school were significantly lower than in the high school. In addition, teachers believed that students were unmotivated and lacked the necessary study skills to achieve in algebra. Teachers stated that students were not ready to work with abstract algebraic concepts. Several teachers questioned the overall capacity of their students to learn algebra.

Student behavior. Student behavior emerged as a classroom management concern of the teachers. The teachers readily worked with the students who made the effort to learn algebra. However, they assumed no responsibility to work with disinterested students. Eight of the 12 teachers were continuously challenged by students who demonstrated off-task behaviors. Teachers found themselves slowing the pace of instruction and providing more one-to-one instruction during class. A few teachers were frustrated in their attempts to work effectively with students who were bored and disruptive in the classroom. One teacher summarized, "This is not the algebra of ten years ago."

Traditional algebra perspective. The traditional algebra perspective emerged early in the study and was prevalent throughout the observations and interviews. Of particular note, was the teachers' lack of familiarity with the National Council of Teachers of Mathematics (NCTM) recommendations. Teachers implemented the required Algebra I program through the use of traditional methods: reteaching basic skills, decreasing the instructional pace, individualizing instruction, increasing student work at the blackboard, and providing after-school tutorials. Furthermore, the teachers' perceptions of algebra focused on its abstract nature. The teachers were concerned, rather, with the need to cover the curriculum objectives in preparation for the spring Algebra I Standards of Learning assessment. Teachers were unaware that the introduction to the mathematics strand of the Standards of Learning for Virginia Public Schools curriculum "... is intended to support the following four goals for students: [the four NCTM recommendations] of students becoming mathematical problem solvers, becoming mathematical problem solvers, communicating mathematically, reasoning mathematically, and making mathematical connections becoming mathematical problem solvers," (1995, p. 3). Teachers shared negative perceptions with respect to cooperative learning groups, the use of manipulatives, and problem solving activities. Student behavior precluded the effective use of cooperative learning groups. Manipulatives were perceived as nonessential to the development of algebraic concepts. Furthermore, teachers did not view problem solving within an inquiry approach but rather within a traditional procedural approach.

<u>Restructure traditional Algebra I program</u>. Teachers' views on restructuring emerged from the interview data and focused on three areas: (a) increasing student accountability for learning and behavior; (b) restructuring the required Algebra I program as a two-year program; and (c) examining the required Algebra I program in light of the Standard of Learning objectives. Teachers expressed the need to learn strategies that would better engage students. It was noted that teachers expressed the desire for administrative support in terms of curriculum modification, collaborative

planning time, and reduced emphasis on standardized test scores. Teachers noted also, that administrators were unaware of the complexity involved in implementing the required Algebra I program. However, the proposed restructuring did not include the four goals of the NCTM recommendations reflected in contemporary algebra programs.

Algebra as a gatekeeper. Algebra as a gatekeeper emerged from the expressed views of the teachers on the issue of algebra for all students. The majority of the Algebra I teachers believed that algebra was not for everyone and suggested consumer mathematics as a reasonable alternative. Algebra was perceived as a gateway for the college-bound students, but as a gatekeeper for non-college bound students. Only one of the 12 teachers viewed algebra as the foundation of mathematical literacy and therefore, essential to function in society.

Content-specific planning time. The content-specific planning time emerged from the teachers' perspectives on staff development. Teachers' comments focused on the need for collaborative planning sessions specific to the required Algebra I program. Teachers expressed discontent with previous algebra staff development sessions that focused on hands-on activities and the use of manipulatives. However, a staff development session on graphing calculators was viewed as useful by the teachers. Also, the teachers expressed a need for more communication between the middle and high school algebra teachers. As one teacher stated, "we're all inventing the same wheel." In addition, the content-specific planning time concern included greater consistency in implementing the required Algebra I program at both the building and school division level.

Emphasis on student scores. The pressure to increase student achievement emerged from the teacher interviews. Teachers experienced anxiety with teaching all the Algebra I objectives before students took the spring Standards of Learning Algebra I test (Harcourt-Brace Educational Measurement, 1996). Furthermore, data from this standardized test would impact school accreditation and graduation requirements for students. Four of the 12 teachers experienced additional administrative pressure when discontented parents blamed teachers for their children's poor algebra grades.

These major categories of concerns expressed by the teachers did not reflect a need for contemporary algebra instruction which would better meet the needs of a diverse population. The quantitative and qualitative data revealed that the required Algebra I implementation did not reflect instruction in which "... interesting problems are regularly explored using important mathematical ideas. Our premise is that what a student learns depends to a great degree on how he or she has learned it." (NCTM 1989, 5)

2. To what extent are the National Council of Teachers of Mathematics (NCTM) recommendations reflected in the required Algebra I program?

Table 11 presents the use by individual teachers of the four major recommendations by the National Council of Teachers of Mathematics (NCTM)

Table 11

Teachers' Use of NCTM Recommendations

Teachers	NCTM Recommendations			
	Communicating Mathematically	Making Connections	Becoming Mathematical Problem Solvers	Reasoning Mathematically
Williams				
Walker				
Turner				
Lewis				
Dover				
Brown		Yes		Yes
Reynolds				
Jones				
Smith		Yes		
White		Yes		
Townsend	Yes			
Lane				

Table 11 demonstrates that only four of the 12 teachers observed implemented one or two of the NCTM recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. Furthermore, the recommendations were minimally implemented within traditional algebra instruction. One teacher, Townsend, utilized the recommendation of communicating mathematically when he encouraged students to share their rationale for solutions to problems during cooperative group work. Three teachers, Brown, Smith, and White used the mathematical connections recommendation when they provided real life situations involving a ski slope, an exit ramp, and animal population growth. One teacher, Brown, utilized the reasoning mathematically recommendation by having students predict the rate of speed of model trucks in a class experiment. None of the 12 teachers demonstrated the problem solving recommendation in which require students work through real life problems resulting in multiple solutions.

3. To what extent do the Levels of Use (LoU) focused interview data support the identified teacher Stages of Concerns type, "self," "task," or "impact"?

Table 12 includes the teachers' Levels of Use (LoU) and identified Stages of Concern (SoC) types.

Table 12

Comparison of Stages of Concern (SoC) and Levels of Use (LoU)

Stages of Concern	Levels of Use						
	0	I	II	III	IV	V	VI
0	8	1					
1				1			
2		1					
3							
4							
5				1			
6							

Data obtained on the Levels of Use (LoU) focused interview clearly supported the identified teachers' Stages of Concern (SoC) Questionnaire type, "self," "task," or "impact" relative to the implementation of the required Algebra I program. Eight of the 12 Algebra I teachers who scored at the nonuse, Level 0, also scored at the unawareness, Stage 0 which indicated little or no knowledge concerning the required Algebra I program. Two of the 12 Algebra I teachers who scored at the orientation, Level I, scored at the self concern, Stages 0 and 2, which indicated uncertainty about the demands of the Algebra I program, yet indicated an interest in obtaining more information about the implementation. The teacher who scored at mechanical, Level 3, scored at self, Stage 1, which indicated a disjointed effort to implementing the required Algebra I program. The other teacher who scored at mechanical, Level 3, scored at collaboration, Stage 5 which indicated a focus on cooperating with others regarding the implementation. The findings suggested that these Algebra I teachers were unaware that the required Algebra I program was a new implementation designed to meet the needs of a diverse student population.

4. Do teachers identified by their major Stages of Concern (SoC) Questionnaire type, "self," "task," or "impact" differ in their pass rates on the required Algebra I final grades?

Table 13 presents teachers' Stages of Concern type "self," "task," or "impact" and their final Algebra I grade pass rates. "Self" includes Stages 0, 1, and 2; "task" includes Stages 3 and 4; and "impact" includes Stages 5, 6, and 7. The final grade pass rates are expressed as percentages.

Table 13

Stages of Concern and Final Algebra I Grade Pass Rates

Teacher	Stages of Concern	Stages of Concern Type	Final Algebra I Pass Rates
Joe Reynolds	0	Unawareness	51%
Ann Jones	1	Informational	88%
Bill Smith	0	Unawareness	86%
Barbara Williams	0	Unawareness	67%
Beth Walker	0	Unawareness	60%
Sharon Turner	0	Unawareness	75%
Bob Lane	0	Unawareness	65%
Donna Lewis	0	Unawareness	79%
Jane Dover	0	Unawareness	62%
Matthew Brown	2	Personal	86%
Susan White	5	Collaboration	79%
Mark Townsend	0	Unawareness	53%

The final grade pass rates were divided into two groups that ranged from 51% to 75% and 76% to 88%. The seven teachers who had final grade pass rates in the lower range of 51% to 75%, also scored at the unawareness Stage 0 on the Stages of

Concern (SoC) Questionnaire. Of the five teachers who had pass rates in the higher range of 76% to 88%, two teachers scored at the unawareness Stage 0, one teacher scored at the informational Stage 1, one teacher scored at the personal Stage 2, and one teacher scored at the collaborative Stage 5 on the Stages of Concern (SoC) Questionnaire.

Although pass rates of individual teachers differed widely with a range of 51% to 88%, teachers did not differ significantly by their Stages of Concerns types. There was little variability among the 12 teachers with nine of the teachers scoring at Stage 0 on the Stages of Concern (SoC) Questionnaire.

Summary

The findings of Chapter 4 demonstrated that nine of the 12 teachers were at Stage 0, unawareness on the Stages of Concern (SoC) Questionnaire which indicated the teachers did not perceive the required Algebra I program as a new implementation designed to meet the needs of the changing student population. Eight of the 12 teachers were at the nonuse, Level 0, which indicated the teachers' instruction did not reflect the National Council of Teachers of Mathematics (NCTM) recommendations The Stages of Concern (SoC) and the Levels of Use (LoU) findings confirmed the use of traditional instruction in the observation and interview data. Seventy percent of the students passed the required Algebra I program. In addition, the qualitative findings described in the teacher narratives support the quantitative findings with respect to teacher concerns in the implementation of the required Algebra program.

Chapter 5: Conclusions, Discussion, and Recommendations

Introduction

The purpose of this study was to determine the concerns of ninth grade teachers as they implemented the required Algebra I program. The study examined the required Algebra I program from a teacher perspective and through the lens of the National Council of Teachers of Mathematics (NCTM, 1989) recommendations for teaching mathematics. In addition, the study investigated the pass rate of students with respect to the Stages of Concerns type of each teacher.

The following limitations should be considered when interpreting the results of the study. The study was limited to the analysis of data from a sample of twelve ninth grade Algebra I teachers from four high schools in one school division in Virginia and may not be representative of all ninth grade Algebra I teachers in Virginia. Also, algebra achievement was measured by final Algebra I grades from each teacher and the Standards of Learning (Harcourt-Brace Educational Measurement, 1996) Algebra I scores from each school. These data could not be disaggregated by individual teachers

The design of the study was ex post facto. The sample consisted of twelve ninth grade Algebra I teachers. The data were collected and analyzed for the 1997-1998 school year. The quantitative findings included data obtained on the Stages of Concern (SoC) Questionnaire, the Levels of Use (LoU) focused interview, pass rates percentages on final Algebra I grades, and the individual high school pass rate percentages on the Standards of Learning (Harcourt Brace Educational Measurement,

1996) Algebra I scores. The qualitative findings included data from the observations and interviews which resulted in triangulation of the data. In addition, the Levels of Use (LoU) data further supported the identification of teachers' Stages of Concerns type: "self," "task," or "impact".

Conclusions

The primary finding of this study is that the teachers used traditional instruction in the implementation of the required Algebra I program. The NCTM recommendations of communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically were not incorporated into teachers' instructional practices. The major concern expressed by the teachers was the challenge of the "ill-prepared" student with respect to readiness, ability, motivation, behavior, and student achievement. Teachers did not perceive the changing population which included the "ill-prepared" student, as the essential part of the required Algebra I program. However, the Algebra I requirement was designed to ensure that all students learned algebra.

The study demonstrated that the teachers' identified Stages of Concern types were supported by the Levels of Use (LoU) focused interview data. The Stages of Concern (SoC) Questionnaire revealed that seven of the 12 teachers circled the numbers 5, 6, or 7 designating "very true of me now" to four critical statements pertaining to the rationale of the required Algebra I program. The statements are as follows: (3) " I don't know why the required Algebra I program is considered an innovation"; (31) " I would like to determine how to supplement, enhance or replace the required Algebra I program"; (33) " I would like to better understand my role in using the required Algebra I program"; and, (35) " I would like to know how the required Algebra I program is better than what we had before." Interestingly, in the interviews, the teachers perceived the rationale for the required Algebra I program mainly in terms of "making the school division look good if more students could take and pass algebra."

Another significant statement on the Stages of Concern (SoC) Questionnaire examined change in instructional practices. In response to statement (17), "I would like to know how my teaching or administration is supposed to change," only four of the 12 teachers indicated that this was "very true of me now." Further probing on changes in instruction during the focused interviews indicated that teachers equated the use of traditional remediation strategies with changes in instructional practices For example, teachers referred to additional student practice on the blackboard, tutoring after school, and teaching less complicated problems as new instructional practices. The teachers were unaware that significant changes in instructional practices were needed in the required Algebra I program.

Another finding of the study was the incongruence in teachers' Stages of Concern types. Eleven of the 12 teachers scored at Stages 0, 1, or 2 on the Stages of Concern (SoC) Questionnaire. This finding indicated that the required Algebra I program was not perceived as a new implementation. The final Algebra I grade pass rates, however, revealed great variability among the teachers with a range of 51% to 88%.

A major outcome of this study was the indication that Algebra I teachers examine their instructional practices. The literature review indicated that traditional algebra instruction should be replaced by contemporary algebra instruction. Furthermore, in order for a changing student population to become successful in algebra, teachers should first receive intensive training in instructional strategies similar to those recommended by the National Council of Teachers of Mathematics (NCTM). Contemporary algebra instruction was used in The Algebra Project (1989), and the University of Chicago School Mathematics Project (UCSMP (1983). These programs emphasized the teachers' and students' perceptions of algebra as an integral part of everyday life. The research noted also, that administrators should provide continuous support to teachers as new instructional strategies are incorporated.

Theory

The grounded theory method suggests that theory from the primary analyses should follow statements of relationships among the categories. The statements serve the purpose of explaining the phenomenon under study, the implementation of the required Algebra I program. The major question of this study was the concerns of ninth grade Algebra I teachers in the implementation of the required Algebra I program. Teachers' concerns on the implementation of the required Algebra I program focused on two areas: (a) student issues of readiness for algebra and classroom behavior and, (b) teacher issues of program management and accountability.

The National Council of Teachers of Mathematics (NCTM) recommendations upon which the Standards of Learning objectives are based should be familiar to all algebra teachers and be reflected in their teaching practices. However, this expectation was not realized in this research. Rather, teachers taught the required Algebra I program using traditional teaching methods while seeking to cope with a more diverse student population. The teachers focused on how to have students more fully attend to traditional algebra instruction.

The core phenomenon which emerged from the research was that teachers used traditional algebra strategies to teach the required Algebra I program which demands different strategies than required by the traditional Algebra I program. The theory which evolved from the investigation of this phenomenon highlights the critical differences between traditional and contemporary algebra. Contemporary algebra requires a deeper understanding of the underlying mathematical concepts than traditional algebra. Furthermore, contemporary algebra pedagogy differs significantly from traditional algebra pedagogy (Firestone, Mayrowetz, & Fairman, 1998). Although the ninth grade Algebra I teachers possessed strong algebra backgrounds, their traditional teaching practices did not meet the needs of a diverse population. The traditional algebra paradigm permeated all facets of the required Algebra I program. The examination of the required Algebra I implementation indicated that a significant change in the algebra instructional paradigm is required if mathematical equity is to be achieved. The tentative hypotheses that emerged from the study:

1. Traditional algebra instruction does not provide a gateway of educational and economic opportunity for a diverse population.

2. Traditional algebra teachers do not share the perception that algebra is for all students.

Discussion

The lessons learned from earlier reform efforts were two-fold: (a) the implementation of programs should not be equated with the dissemination of curriculum materials, and does not suffice for implementation, and (b) the role of the teacher is central to the implementation process. The present research suggests that the policy of simply mandating the Algebra I requirement cannot be equated to successful implementation. Firestone, Mayrowetz, and Fairman (1998) examined the impact of performance-based state assessments on teachers' implementation of required Algebra I programs. Their findings revealed that while state assessments can be powerful forces for shaping algebra instruction, the teachers' perceptions of algebra content and pedagogy are even greater forces. For example, they found that teacher implementation focused on teaching to the test and the explanation of test format procedures, rather than on significant changes to teaching practices. Corbett and Wilson (1991) shared similar findings which suggested that state assessments encouraged teachers to intensify the use of old means to address new problems.

The National Council of Teachers of Mathematics (NCTM) recommendations described a framework for instruction based on students' construction and application of knowledge. Although, informational knowledge is necessary, it is the application of this knowledge to solve a problem that makes it meaningful.

> A genuine problem is a situation in which, for the individual or group concerned, one or more appropriate solutions have yet to be developed. The situation should be complex enough to offer challenge but not so complex as to be insoluble. (NCTM 1989, 10)

Contemporary algebra instruction promotes student engagement in real-life problems that develop algebraic thinking. Contemporary algebra instruction reflects the National Council of Teachers of Mathematics (NCTM) recommendations of students communicating mathematically, making mathematical connections, becoming mathematical problem solvers, and reasoning mathematically. The teacher serves as a facilitator and discussion leader who encourages both collaboration and justification of student-generated ideas. The teachers in this study did not appear to implement instruction in this manner.

In order for teachers to adopt such contemporary algebra practices, Romagnano (1994) found that teachers needed to further develop their mathematical knowledge through authentic tasks. He also stated that the taking of more mathematics courses by teachers did not ensure a sufficient understanding of contemporary algebra and related teaching practices. In addition, Romagnano (1994) suggested that teachers must become comfortable with problem solving inquiries in which, they themselves do not know the solutions. Romagnano (1994) and Firestone, Mayrowetz, and Fairman (1998) suggested that algebra teachers create contemporary algebra classroom environments. In such environments, students are encouraged to ask questions, reason, communicate, and employ various methods to solve problems (Goodlad, 1984). Thus, creating contemporary algebra classroom environments means changing long held traditional teaching practices. As stated in the National Council of Teachers of Mathematics (NCTM, 1991) Professional Standards:

> Students, used to teachers doing most of the talking while they remain impassive, need guidance and encouragement in order to participate actively in the discourse of a collaborative community. Some students, particularly those who have been successful in more traditional mathematics classrooms, may be

resistant to talking, writing, and reasoning together about mathematics (NCTM 1991, p.35)

Recommendations

The required Algebra I program was not successfully implemented based on observations, interviews, and final grades. While Standards of Learning data was not available regarding the student performance of individual teachers, the overall pass rates listed by schools indicated low Algebra I scores ranging from 11% to 19%. The teachers used traditional teaching strategies which did not reflect the National Council of Teachers of Mathematics (NCTM) recommendations. House (1988) noted that traditional teaching strategies emphasized the acquisition of information rather than application of algebraic concepts. The major concerns identified by the teachers were increased accountability for student achievement, ill-prepared students, student disengagement, and lack of parental support. Furthermore, teachers did not believe that all students need algebra and therefore, as presently taught, the required Algebra I program is not a gateway for further educational and economic opportunities

This study suggests that for the successful implementation of the required Algebra I program, teachers must adopt the belief that all students should have access to high quality mathematics. The concerns expressed by the teachers suggest that long-term support and adequate resources be provided if teachers are to move from traditional to contemporary algebra instruction. Hord (1987) noted that the concerns of teachers must be addressed before new programs can be successfully implemented. Sparks (1994) noted that high-quality staff development is responsive to the needs of teachers as they implement new programs. Joyce and Showers (1992) stated that critical elements to successful implementation include peer coaching which allowed opportunities for feedback, reflection, discussion, and assistance. Guskey (1985) found the most significant changes in teacher attitudes and beliefs occurred when teachers observed program implementations that had resulted in increased student achievement. Staff development efforts must recognize the needs and concerns of teachers since "teachers are key figures in changing the ways in which mathematics is taught and learned in schools" (NCTM 1989, p. 2). As such, this study serves to inform educators of possible recommendations to address the implementation of the required Algebra I program.

Curriculum developers

1. Build a rigorous curriculum in grades K-8, not just algebra, based on the National Council of Teachers of Mathematics (NCTM) recommendations to better prepare students for the transition to algebra.

2. Ensure that all students, parents, teachers, and counselors understand the importance of students' early study of algebra as well as continued study of advanced mathematics.

Staff developers

1. Design staff development collaboratively with mathematics teachers that include mechanisms for sustained collegial interaction on the National Council of Teachers of Mathematics (NCTM) recommendations.

2. Provide staff development that reflects administrative support in the implementation of National Council of Teachers of Mathematics (NCTM) recommendations in classroom practice.

3. Ensure that staff development is not the one-shot, one-day model. Staff development should be ongoing and sustained.

Building administrators

1. Address the concerns of teachers as they implement the National Council of Teachers of Mathematics (NCTM) recommendations.

2. Provide support in terms of ongoing staff development, materials, and planning time for teacher collaboration in the implementation of National Council of Teachers of Mathematics (NCTM) recommendations.

Mathematics educators

1. Align teacher education programs to include the instructional paradigm needed to teach contemporary algebra.

2. Further develop the university-school connection to better inform the practitioners and mathematics educators with respect to the National Council of Teachers of Mathematics (NCTM) recommendations.

The aforementioned recommendations are based on the assumption that achieving mathematical power means engaging and providing appropriate challenges for students, and linking algebra to other subjects and contexts. Educators in Virginia are grappling with the critical issues surrounding the recent requirement that all students take algebra. In theory, the required Algebra I program should provide equity of educational and economic opportunity. However, in reality, this equity has not been demonstrated. The traditional algebra instruction has emphasized the abstract nature of algebra which precludes success for many students. The challenge remains for teachers to change their traditional algebra paradigms to reflect the contemporary algebra paradigms in implementing the required Algebra I program. It is critical that the concerns of teachers are addressed as they struggle with the necessary changes of the contemporary algebra paradigm.

Recommendations for Further Research

It is hoped that the findings of this study will serve as a catalyst for future research. Future areas of research may include:

1. Duplicate this study to determine if there is a relationship between Algebra I grades and student performance on the Standards of Learning Algebra I test.

2. Duplicate this study with elementary K-5 teachers of mathematics in the use of the National Council of Teachers of Mathematics (NCTM) recommendations.

3. Identify strategies teachers use that promote the successful teaching and learning of contemporary algebra.

4. Investigate the implementation of contemporary Algebra I programs using the Concerns Based Adoption Model (CBAM) instruments with respect to student achievement.

5. Investigate the role of the principal in the implementation of the National Council of Teachers of Mathematics (NCTM) recommendations at elementary, middle, or high school levels.

6. Examine the impact of staff development designed to increase the use of the National Council of Teachers of Mathematics (NCTM) recommendations in algebra programs.

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Appendix A

Stages of Concern (SoC) Questionnaire

0	1	2 3 4	5 6 7
Irrelevant	**Not True Of Me Now**	**Somewhat True Of Me Now**	**Very True Of Me Now**

1.	I am concerned about students' attitudes toward the required algebra program.	0 1 2 3 4 5 6 7
2.	I now know of some other materials or programs that might work better.	0 1 2 3 4 5 6 7
3.	I don't know why the required algebra program is considered an innovation.	0 1 2 3 4 5 6 7
4.	I am concerned about not having enough time to organize myself each day.	0 1 2 3 4 5 6 7
5.	I would like to help others in their use of the required algebra program.	0 1 2 3 4 5 6 7
6.	I have a very limited knowledge about providing for the individual needs of all students in the required algebra program.	0 1 2 3 4 5 6 7
7.	I would like to know the effect of reorganization on my professional status.	0 1 2 3 4 5 6 7
8.	I am concerned about conflict between my interests and my responsibilities.	0 1 2 3 4 5 6 7
9.	I am concerned about revising my use of the required algebra program.	0 1 2 3 4 5 6 7
10.	I would like to develop working relationships with both our faculty and outside faculty using the required algebra program.	0 1 2 3 4 5 6 7
11.	I am concerned about how the required algebra program affects students.	0 1 2 3 4 5 6 7

0	1	2 3 4	5 6 7
Irrelevant	**Not True Of Me Now**	**Somewhat True Of Me Now**	**Very True Of Me Now**

12.	I am not concerned about the required algebra program.	0 1 2 3 4 5 6 7
13.	I would like to know who makes the decisions concerning the required algebra requirement.	0 1 2 3 4 5 6 7
14.	I would like to discuss the use of the required algebra program.	0 1 2 3 4 5 6 7
15.	I would like to know what other resources are available to use in the required algebra program.	0 1 2 3 4 5 6 7
16.	I am concerned about my inability to manage all that the algebra program requires.	0 1 2 3 4 5 6 7
17.	I would like to know how my teaching or administration is supposed to change.	0 1 2 3 4 5 6 7
18.	I would like to familiarize other departments or persons with the progress of the required algebra program.	0 1 2 3 4 5 6 7
19.	I am concerned about evaluating my impact on students.	0 1 2 3 4 5 6 7
20.	I would like to revise the required algebra program's instructional approaches.	0 1 2 3 4 5 6 7
21.	I am completely occupied with other things.	0 1 2 3 4 5 6 7
22	I would like to modify our use of the required algebra program based on the experiences of our students.	0 1 2 3 4 5 6 7
23	I am concerned about areas of the required algebra program.	0 1 2 3 4 5 6 7
24	I would like to excite my students about their part in this program.	0 1 2 3 4 5 6 7

0	1	2 3 4	5 6 7
Irrelevant	**Not True Of Me Now**	**Somewhat True of Me Now**	**Very True Of Me Now**

25.	I am concerned about time spent working with nonacademic problems related to the required algebra program.	0 1 2 3 4 5 6 7
26.	I would like to know what the use of the required algebra program will require in the immediate future.	0 1 2 3 4 5 6 7
27.	I would like to coordinate my efforts with others to maximize the required algebra program.	0 1 2 3 4 5 6 7
28.	I would like to have more information on time and energy commitments required by the algebra program.	0 1 2 3 4 5 6 7
29.	I would like to know what other faculty are doing in this area.	0 1 2 3 4 5 6 7
30.	At this time, I am not interested in learning more about the required algebra program.	0 1 2 3 4 5 6 7
31	I would like to determine how to supplement, enhance, or replace the required algebra program.	0 1 2 3 4 5 6 7
32	I would like to use feedback from students to change the required algebra program.	0 1 2 3 4 5 6 7
33.	I would like to better understand my role in using the required algebra program.	0 1 2 3 4 5 6 7
34.	Coordination of tasks and people is taking too much of my time.	0 1 2 3 4 5 6 7
35.	I would like to know how the required algebra program is better than what we had before.	0 1 2 3 4 5 6 7

Appendix B

Levels of Use (LoU) Focused Interview

1. What are the major differences between the algebra classes that were optional and the algebra classes that are now required of all students?

2. What are the strengths of the required Algebra I program?

3. What are the weaknesses of the required Algebra I program?

4. What are the major concepts you emphasize in Algebra I?

5. What are the effects of the required Algebra I program?

6. Has the required algebra caused you to change your approach and if yes, how?

7. What is student interaction like?

8. What could be provided in terms of administrative support whether building level or central office?

9. Have you attended any conferences or participated in any staff development sessions that have been helpful for your algebra classes?

10. What kinds of grouping practices do you use?

11. Do you view algebra as a gateway or gatekeeper?

12. What do you think is the rationale for making algebra a required subject for all students?

13. Are you familiar with the National Council of Teachers of Mathematics (NCTM) recommendations? Do you agree with them and how do you incorporate them into your classroom?

14. How do you make algebra connections for students?

15. Does the algebra curriculum stress equations or problem solving?

16. How do you describe the rationale for algebra and how it relates to real life problem solving?

17. How important is the language of mathematics and is there anything you do to stress this importance?

18. What is the key to the unmotivated student?

19. How do you feel about manipulatives and how do you use them in instruction?

20. How do you feel about the use of calculators?

21. What are the different instructional strategies that you use with students?

22. What can be done to increase the success rate for students in the division taking algebra?

23. If you could design the algebra program, how would you structure it?
    a) scheduling
    b) instruction
    c) curriculum
    d) evaluation

24. Do you know of any successful models, programs or school divisions achieving a high rate of success?

25. Any last comments or thoughts about the algebra program?

26. Do you like the textbook being used?

Note. Loucks, Newlove, and Hall (1975) caution that researchers planning to use the Levels of Use Interview instrument need to be trained and certified as Levels of Use Interviewers.

Appendix C

Classroom Observation Checklist

S. Lee Winocur

Teacher____________________School____________________District__________

Observer____________________Subject____________________Date____________

Directions:
Mark an "x" in the appropriate column for each classroom behavior. If the statement is generally true of this classroom mark yes. IF the statement is generally not true of this classroom, mark no. If you are unsure, mark the third column.

Affective Disorders

	Yes	No	Unsure
1. Fosters A Climate Of Openness			
• Eye contact is frequent between teacher and students, and students and students.	____	____	____
• Teacher moves around the room.	____	____	____
• Students listen attentively to others.	____	____	____
• Teacher calls on students by name.	____	____	____
2. Encourages Student Interaction/Cooperation			
• Students work in pairs or small groups.	____	____	____
• Students respond to other students.	____	____	____
• Students help others analyze and solve problems.	____	____	____
3 Demonstrates Attitude Of Acceptance			
• Teacher accepts all valid student responses.	____	____	____
• Incorrect student responses elicit encouraging, supportive comments.	____	____	____
• Teacher acknowledges students comments with a nod or other signal.	____	____	____

	Yes	No	Unsure
Cognitive Indicators			
4. Encourages Students To Gather Information			
• Reference materials are readily available.	____	____	____
• Students use reference materials.	____	____	____
• Student mobility is allowed to obtain information.	____	____	____
• Teacher acts as facilitator.	____	____	____
• Students record data in notebooks or journals.	____	____	____
5. Encourages Students To Organize Information			
• Teacher works from organized lesson plans.	____	____	____
• Students classify and categorize data.	____	____	____
• Students take notes systematically.	____	____	____
• Teacher's presentation is logical, organized.	____	____	____
• Ideas are graphically symbolized during instruction.	____	____	____
6. Encourages Students To Justify Ideas			
• Teacher probes for correct responses.	____	____	____
• Teacher seeks evidence for stated claims.	____	____	____
• Students analyze sources of information for reliability, relevance.	____	____	____
• Teacher frequently asks, "Why do you think so?"			
• Students relate learning to past.	____	____	____
7 Encourages Students To Explore Alternatives			
Others' Points of View			
• Teacher allows time to consider alternative/ points of view.	____	____	____
• More than one student is queried for points of view/solutions.	____	____	____
• Teacher asks students to justify and explain their thoughts.	____	____	____

	Yes	No	Unsure
8. Asks Open-ended Questions			
• Teacher asks open-ended questions with multiple answers as *frequently* as single-answer questions.	____	____	____
9. Provides Visual Clues for Developing Cognitive Strategies			
• Teacher appropriately uses a variety of visual media (charts, chalkboard, maps, pictures, gestures).	____	____	____
• Teacher uses symbolic language to illustrate a point (simile, metaphor).	____	____	____
• Teacher uses outlining.	____	____	____
10. Models Reasoning Strategies			
• Teacher uses "if/then" language.	____	____	____
• Teacher poses "what if" or "suppose that" questions.	____	____	____
• Teacher uses clear examples to facilitate logical thought.	____	____	____
11. Encourages Transfer of Cognitive Skills to Everyday Life			
• Teacher encourages transfer at end of lesson with comments like, "This will help you in your everyday life in this way. . . ."	____	____	____
12. Elicits Verbalization of Student Reasoning			
• Teacher poses questions at different levels of Blooms's Taxonomy.	____	____	____
• Teacher allows at least ten seconds wait time for student answer before restating or redirecting the question.	____	____	____

- Teacher asks students to clarify and justify their responses. ____ ____ ____
- Teacher probes "I don't know" responses. ____ ____ ____
- Teacher reinforces students for responding to open-ended questions. ____ ____ ____

13. Probes Student Reasoning For Clarification

- Teacher asks questions to elicit reasoning by students. ____ ____ ____
- Teacher requires students to expand on answers. ____ ____ ____
- Teacher cues students for most logical answers. ____ ____ ____

14. Encourages Students To Ask Questions

- Teacher poses problematic situations. ____ ____ ____
- Teacher withholds "correct" responses; encourages students to explore possibilities. ____ ____ ____
- Teacher encourages students to answer other students' questions. ____ ____ ____

15. Promotes Silent Reflection Of Ideas

- Teacher allows time for reflection. ____ ____ ____

Vita

Regina Lynn Hervey

Regina Lynn Hervey was born on June 11, 1955, in Manchester, England. She is an educator with twenty-two years of teaching and instructional leadership experience. She taught fourth grade for two years, sixth grade for five years, and was a reading specialist K-5 for five years. She served as an assistant principal at the middle school level for two years. This experience was followed by a principalship at two elementary schools for a total of eight years. All of these educational endeavors occurred in the York County Public Schools in Yorktown, Virginia.

She received the following degrees: B.A. in Elementary Education from The College of Saint Benedict, Minnesota (1977); M. A. Reading Specialist Endorsement from The College of William and Mary (1981); and an Ed.S. in Educational Administration from the College of William and Mary, Virginia (1993).

Recently, she accepted a position as an Assessment and Accreditation Specialist at the Governor's Best Practice Center for the Virginia State Department of Education. Major interests include music, travel, reading, and active participation in cutting edge educational pursuits.