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An Urban Education Study: Implementing Problem-Solving Strategies in Mathematics as a Function of Teacher's Learning Styles

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AN URBAN EDUCATION STUDY: IMPLEMENTING PROBLEM-SOLVING

STRATEGIES IN MATHEMATICS AS A FUNCTION OF TEACHERS'

LEARNING STYLES

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Abstract

AN URBAN EDUCATION STUDY: IMPLEMENTING PROBLEM-SOLVING STRATEGIES IN MATHEMATICS AS A FUNCTION OF TEACHERS' LEARNING STYLES

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This qualitative research was designed to ascertain the impact of teachers' learning styles on an active teaching program. Using grounded theory procedures, the researcher explored the second-year implementation of Moretti and associates' Problem Solver Program by 67 second- through fifth-grade teachers in order to gain information on the major research question: How effective are teachers with different learning styles in implementing problem-solving strategies in mathematics that require an active teaching style? Three Concerns Based Adoption Model (CBAM) instruments were used in this study. Two quantitative instruments were used: The Stages of Concern (CBAM) to determine the degree of program implementation and the Gregorc Style Delineator to determine the teachers' learning styles. Other instruments used to gather information during the interviews and observations were the Innovation Configurations Checklist (CBAM), the Levels of Use (CBAM), and the Classroom Observation Checklist. The data showed that the ordering dimensions of the teachers' learning styles divided them into three distinct groups: sequential, random, and mixed. Data analysis revealed that the random-ordering group implemented The Problem Solver Program more effectively than did the sequential or mixed-ordering groups of teachers. These findings indicate a clear association between a teacher's learning style and the degree of success with which the

Problem Solver Program is implemented. The most significant implication from this study is that active teaching and learning programs will only become institutionalized to the extent to which the concerns of the teachers are met.

Dedication

This dissertation is dedicated to

My Husband

James J. Fogarty, who has given me twenty-seven years of happiness.

My Children and Grandchildren

Letitia and Kevin

Katie Jane, Travis, Brandon, and Lindsay, who have given me much joy.

and to the memory of

My Father

(Dec. 12, 1906--Feb. 28, 1992)

Russell Meinhold, Ph.D., who loved to learn and to teach.

My Mother

(Jan. 3, 1909--Jan. 24, 1994)

Jane Letitia Boyd Meinhold, R.N., who loved people and knew joy in laughter.

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CHAPTER 1

Introduction

Educational reform for the twenty-first century is no longer a vision for the future; it is a reality of the present in that today's seventh-graders will graduate in the year 2000. An important part of educational reform is the updating of students' mathematic reasoning and problem-solving skills to meet the demands of the technological society of today and tomorrow.

In view of this challenge, the National Council of Teachers of Mathematics (NCTM) published An Agenda For Action (1980), which stated many of the objectives that were again emphasized nearly a decade later in both their Curriculum and Evaluation Standards for School Mathematics (1989) and Professional Standards for Teaching Mathematics (1991). For example, students should be encouraged to question, experiment, estimate, explore, and suggest explanations. In addition, they should be given opportunities to confront problem situations in a greater variety of forms than provided by the traditional verbal formats alone. De Blanc's (1977, p. 18) observation that the process problem was "fast becoming recognized as an important vehicle for teaching problem solving

in the near future" has been confirmed; that is, the process problems of the 1970s are the non-routine problems of today.

Even though the rationale, the content, and the strategies for such an approach to mathematics education have been made known and encouraged for some time, teaching practices have for the most part continued to be traditional. Classrooms are characterized by grouping students according to ability and having students regularly work on problems from textbooks and worksheets (National Assessment of Educational Progress [NAEP], 1991). Moreover, present teaching practices reflect an apparent lack of commitment to such active teaching and learning practices as, for example, hands-on activities and other strategies which promote student discovery and group interaction. The question mathematics educators must ask is this: Why have mathematics teachers continued to teach mainly traditional word problems instead of following the recommendations for problem solving and the active teaching and learning practices set forth by NCTM in various publications?

Ironically, the philosophy of teaching for understanding as the purpose of education espoused by Socrates and Aristotle, through Rousseau and Jefferson, and on to Dewey (Elmore, 1991) continues as the rallying cry for reform in the 1990s. Dewey (1933) wrote of "reflective thinking" in mathematics and everyday situations and, in this regard, foreshadowed Polya's (1966/1981) heuristic with its emphasis on the art of discovery in modern day problem solving. Further, Polya (1981) argued that students must be taught how to think and suggested the

judicious use of non-routine problems to that end. In a more recent approach to problem solving, based on the application of the constructivist learning theory, problem solving is viewed not as a discovery but as an "invention" whereby students actively construct their own knowledge (Kamii, 1990).

An assumption that teaching for understanding is taking place cannot be made at the present time when classrooms are operating according to the truism that "teaching is telling, knowledge is facts, and learning is recall" (Cohen, 1988). Unfortunately, such practices reflect the norm rather than the exception in classrooms across the nation (Goodlad, 1984). The assumption of student engagement cannot be made either; research indicates that American schools have done a poor job of engaging most students in serious learning of academic content (Goodlad, 1984; Sedlak, 1986; Sizer, 1984). Considering students' inadequate understanding of subject matter and inadequate engagement with subject matter, it is not surprising that the reform movement of the 1990s has stressed the need for change in both <u>what</u> teachers teach and <u>how</u> they teach (Elmore, 1991).

Significance of the Study

An exploration of how teachers with different learning styles experience <u>active</u> teaching when using process word problems in mathematics instruction was undertaken to provide insight into the impact, if any, that teachers' learning styles may have on active teaching programs. The results of this study will contribute to

the validation of the hypothesis: When teachers' learning styles and new programs share a similar philosophical base, the likelihood of successful program implementation is greatly increased. Also significant is the potential contribution this study makes to theory building on the nature of teacher resistance to an active teaching plan of action--in this case, a program called The Problem Solver Program (Moretti, Stephens, Goodnow, & Hoogeboom, 1987).

According to the National Assessment of Educational Progress [NAEP], 1991, our students' lack of problem-solving skills is reflected nationwide in the standardized test scores in which problem solving continues to be the weakest area of mathematics achievement. The lack of problem-solving ability is critical among urban minority students of low socio-economic background, especially in the southeastern region of the United States (NAEP, 1991). If teaching practices do not change to meet the needs of these "at-risk" students in mathematics, they will find even less economic opportunity in the future as problem-solving skills are increasingly valued in the workplace.

Teachers' continued resistance to using a discovery approach in teaching word problems is evident in the findings of the NCTM's Curriculum and Evaluation Standards for School Mathematics, 1989. Silver (1985) and Polya (1981) note the lack of a problem-solving atmosphere in our classrooms. For over fifty years, Polya stressed the importance of engaging students in meaningful learning, specifically in solving complex word problems in order to develop mathematical thinking skills. A recent review of the education abstracts listed in the Dissertation Abstracts International from 1991 to 1993 reveals an increase in the number of

studies investigating curricula implementations and the role of the teacher. Suggestions for further research on implementation of curricula continue to focus on the personal motives and beliefs of teachers, indicating the possibility that opposition to active teaching may lie within teachers' beliefs about learning and teaching.

This study was approved by and conducted in the York County Public School System, which is located in a rapidly developing urban area of southeastern Virginia. The importance of making necessary changes in the schools to meet the needs of the students is strongly upheld by the school system, which has a vested interest in the findings. Knowledge of teachers' learning styles, the extent of implementation of The Problem Solver Program, and the kinds of staff development teachers desire on non-routine story problems will aid the mathematics specialist in planning county-wide staff development.

This study investigates teachers' concerns with a specific program, The Problem Solver (Moretti et al., 1987), during its second year of implementation, as viewed through the lens of teachers' learning styles. The rationale for the study lies in the need for research on the concerns of teachers during the implementation of programs (Lewis, 1988), combined with recognition that educational reform will be determined by the degree to which new programs move from introduction to implementation in classroom practice. Furthermore, research on learning styles (Gregorc, 1979) and on problem solving in mathematics (Steffe, 1990) strongly supports "knowing who we are" and "where we are coming from"

as educators with respect to teaching behaviors and the ability to adapt to new curricula requirements.

Conceptual Framework

This study describes the current teaching practices in the implementation of The Problem Solver Program by elementary mathematics teachers in the York County Public Schools. By documenting teachers' feelings about the program, their knowledge of the program content and instruction, and the use of The Problem Solver Program by teachers with different learning styles, it was possible to gain information relating to the following questions: What are teachers greatest concerns with the program? Are the concerns more about instruction or student achievement? Do teachers know how to use The Problem Solver Program strategies? Do teachers use active teaching with the program? How do teachers fit the program in with other mathematics instruction?

This study focuses on the ordering dimension of teachers' learning styles. Dimension refers to a particular aspect or mind quality used on learning style instruments. The perspectives taken by developers of learning style instruments determine which dimensions are used to identify learning styles.

The decision to investigate the ordering dimension of learning style stemmed from the often heard reference to individuals as being either random or sequential. Furthermore, the decision to form ordering groups based on individuals' ordering dimension of learning style was premised on the supposition

that ordering preferences are easily recognizable in behavior and are task specific; for instance, random thinking is emphasized over sequential thinking in process-problem solving.

The Gregorc Style Delineator (1985b) combines ordering (Sequential and Random) and reality (Abstract and Concrete) dimensions to form four distinct learning styles: Concrete/Sequential (CS), Abstract/Sequential (AS), Abstract/Random (AR), and Concrete/Random (CR). For the purpose of this study, the researcher created three main ordering groups of sequential, random, and mixed as follows: Sequential: those teachers demonstrating a preference(s) for sequential ordering combined with a perception of reality that is abstract and/or concrete. Random: those teachers demonstrating a preference(s) for random ordering combined with a perception of reality that is abstract and/or concrete. Mixed: those teachers demonstrating a preference(s) for sequential ordering combined with a perception of reality that is abstract and/or concrete **and** a preference for random ordering combined with a perception of reality that is abstract and/or concrete. The three main ordering groups allowed the researcher to relate traditional and active teaching practices to ordering preferences of teachers.

Statement of the Problem

Major Question

How effective are teachers with different learning styles in implementing problem-solving strategies in mathematics that require an active teaching style?

Subsidiary Questions

1. What are the expressed opinions on the worth of The Problem Solver Program among teachers with different learning styles?

2. Are teachers' learning styles evident in in-depth interviews and observations of The Problem Solver Program lessons?

3. How do teachers express their resistance to use of The Problem Solver Program?

4. Does the extent to which The Problem Solver Program is used vary among teachers with different learning styles?

Definition of Terms

Learning style: a phenomenological construct indicative of personal philosophy--an individual's usual way of interpreting reality cognitively and affectively.

Teaching style: a phenomenological construct indicative of teaching philosophy--a teacher's distinctive classroom behavior reflecting attitudes towards students and subject matter.

Active teaching: instructional methods characterized by the facilitator role of the teacher in a classroom atmosphere promoting students to think aloud, challenge,

experiment, and problem solve, while using developmentally appropriate activities to construct knowledge.

Traditional teaching: instructional methods characterized by the authoritarian role of the teacher in a classroom atmosphere promoting students to passively follow directions, while using activities designed to foster the recall of facts.

The Problem Solver: an instructional program developed by Moretti, Stephens, Goodnow, and Hoogeboom (1987), consisting of problem-solving strategies and numerous process-word (story) problems designed to promote problem-solving skills (see Appendix A).

Limitations

This study was limited in scope, examining one school system and, within that system, only those elementary teachers using The Problem Solver Program. The uneven distribution of teachers across Gregorc's four learning style groups and the researcher's three ordering groups precluded the use of parametric statistics. However, the findings clearly reflect the concerns of the teachers as they implemented The Problem Solver Program and the degree of that implementation. Further, the qualitative research strategies provided insight on an active teaching program from the perspective of the teachers.

Overview of the Study

This chapter has shown the significance of studying the role of the teacher in the implementation of active teaching programs. Past reform efforts have failed to bring about the desired active teaching in process-word problem instruction, and the key to understanding this phenomenon may lie with teachers--especially in light of recent research that suggests that teachers' learning styles share a philosophical base with either active teaching methods or traditional teaching methods (Wakefield, 1992).

The remaining chapters examine how teachers with different learning styles interact with process-word problem instruction. Chapter 2 provides a review of the literature on word problems and the process-word problem in particular. The origins of the term learning style and the application of learning style to education are also discussed. Chapter 3 describes the research design, with emphasis on the grounded theory method, sampling procedures, and instrumentation. Chapter 4 presents the findings on the teachers' learning styles and the implementation of The Problem Solver Program. Conclusions and recommendations for future research are addressed in chapter 5.

CHAPTER 2

Literature Review

Why traditional practices continue to prevail in spite of the educational reform efforts of the 1960s, 1970s, and 1980s becomes clearer if some findings from two areas of research conducted during the past twenty years are examined: program implementation (Doyle & Ponder, 1977; Hord, 1987) and learning styles (Gephajart, Strother, & Duchett, 1980; Gregorc, 1979; MacNeil, 1980; McDaniel, 1982). Such an examination reveals that, first, early reforms were based on the incorrect assumption that delivery of new programs into teachers' hands could be equated with use of the programs as intended by the developers (Hall & Hord, 1987). Second, teachers' resistance to change must be addressed in order to successfully implement reform in curricula (Joyce & Showers, 1982). Third, the recognition of potential dissonance between teachers' preferred learning styles and the teaching style required to implement particular curricula must be taken into account (Gregorc, 1979, 1985a; Wakefield, 1992). This third finding becomes even more important in light of the great differences between traditional or passive curricula and the active curricula advocated by the reform movement of the 1990s.

Word Problems in Mathematics

Word problems in mathematics have a long history. They date back to recreational type problems found on ancient Egyptian papyrus and, in more recent times, appear as practice or applied-type problems in textbooks published from the late nineteenth century into the present (Stanic & Kilpatrick, 1988). The problem-solving skills used in any given period tend to reflect societal needs of that particular time. For example, Stanic (1984, 1986) points out that most youth of the early 20th century needed only sixth-grade mathematics skills, which included the traditional approach to solving word problems.

Today's youth, however, living in a more complex and technologically-oriented world, need to view the whole mathematics curricula from a problem-solving perspective (NCTM, Curriculum and Evaluation Standards for School Mathematics, 1989). This is especially true in the study of word problems, where the NCTM Standards advocate increased communication, questioning, and justification of reasoning on the part of students.

The need to develop improved problem-solving skills received public attention in A Nation at Risk (National Commission on Excellence in Education, 1983), which called for reform in the teaching and learning of mathematics and cited the poor problem-solving ability of our students. More recently, in the fall of 1989, President George Bush and the governors of all fifty states met for a historic education summit in Charlottesville, Virginia. The purpose of this Governors' Conference was to establish a set of national educational goals to prepare our

students for active participation in the world's affairs. Significantly, the need for American educators to teach students to become better problem solvers was reiterated. Yet, mathematics educators have been reluctant to change the instruction and learning of problem solving in the elementary schools, preferring instead to cling to traditional methods, especially in the area of word problems. For this reason the writers of The State of Mathematics Achievement (National Assessment of Educational Progress, 1990) have expressed concern about reaching the goals for the twenty-first century set forth by the president.

Furthermore, the National Assessment of Educational Progress (1990) specifies changes in content and emphasis in the area of problem solving by calling for, on the one hand, decreased attention to the use of clue words to determine which operation to use and, on the other hand, increased attention to variety in the structure of word problems along with the use of other problem-solving strategies. The current position of the National Council of Teachers of Mathematics (1991) supports active learning of problem solving through communication and engagement of students in finding their own solutions to problems. This approach to problem solving is shared by the psychologist, Lauren Resnick (1988) and many mathematics educators (Kamii, 1990; Steffe, 1990; Cobb, Yackel, & Wood, 1985) who support the application of Piagetian constructivist theory to how children learn mathematics. This perspective is compatible with the notion that skill in problem solving is both an art and a science (Dewey, 1933; Polya, 1981; Brownell, 1942). If the concepts and principles of mathematics are not viewed as representing static-bound knowledge, the pursuit

of understanding through mathematical reasoning clearly justifies the time and effort required to solve problems.

However, neither the knowledge of how children learn nor the availability of appropriate curricula can guarantee change in problem-solving instruction. Traditional teaching methods "die hard" (Elmore, 1991), especially when change from an authority role to a facilitator role is required on the part of the teacher. At the same time, the atmosphere of the classroom itself must change from one that reflects student submission and acceptance to one that reflects questioning and challenge on the part of both students and teacher. The goal is what Silver (1985) called a "problem solving atmosphere." In the past, process problems were used mainly with the more able students seeking the challenge offered by these problems (Stanic & Kilpatrick, 1988). A review of the literature on problem solving, however, shows that all students, regardless of their computational skill, need to develop problem-solving skills using multi-strategies in a learning environment that promotes both understanding and engagement.

The review of the literature on problem solving was guided by a search for the historical background of word problems in curricula, with particular attention given to non-routine or process-story problems as are emphasized in the present reform movement with its stress on active learning. The significant finding relative to this research is that, although the National Council of Teachers of Mathematics has been urging non-routine problem-solving instruction since the late 1970s, the widespread use of non-routine problems has not taken place.

The Process-Word Problem

The recognition that mathematics should be taught as an active endeavor would promote the notion that students should approach mathematics with the mind-set of mathematicians in which guessing, estimating, and formulating possible outcomes occur in everyday practice (Lave, Smith, & Butler, 1988). Such an approach is the antithesis of the traditional or passive approach with its emphasis on the application of pre-determined mathematical rules and principles.

Nevertheless, process-word problems or non-routine problems have not been widely used over the past fifteen years. Thus, the reform efforts of the 1990s are emphasizing the importance of including process-word problems in mathematics curricula. Polya (1966) and Silver (1985) provide several reasons for utilizing such problems to engage students in mathematical-thinking. First, process-word problems require patience and persistence to solve. Second, process-word problems invite collaborative efforts which result in reflective thinking. Third, process-word problems develop critical thinking skills through experimentation and practice in using various problem-solving strategies. Fourth, process-word problems promote understanding through the examination of errors and validation of solutions. Fifth, process-problem solving may increase metacognitive awareness among students as they consider how they think in comparison to their peers.

It is important to keep in mind the difference between process-word problems and the traditional word problems which focus primarily on the

identification of clue words for solution. A program designed specifically to provide instruction and practice in the use of multi-strategies to solve non-routine problems has been developed by Moretti and her associates (1987). Called The Problem Solver, this program uses a four-step method:

Step 1. Find Out what the problem means and what question must be answered to solve it.

Step 2. Choose a Strategy or strategies which will help the most to solve the problem.

Step 3. Solve It by working through the problem until the answer is found. Record work to see what is completed. If the strategy is not helpful consider another strategy.

Step 4. Look Back by rereading the problem to check the solution to see that it meets stated conditions and answers the question: Is the answer logical and reasonable?

Moretti and her associates included, for display in the classroom, a chart listing the ten strategies to help solve process-word problems (see Table 1).

The teacher models each of the strategies and provides practice in applying them to various problems. The teacher's guide indicates by number which problems exemplify each of the ten strategies. The teacher determines the number of strategies taught and the amount of practice on each strategy based on the needs of the students. Over time students develop an understanding of how to use the strategies and when to apply them in various problems.

Table 1

The Problem Solver Strategies

1. Use or make a table
2. Make an organized list
3. Act out or use objects
4. Use or look for a pattern
5. Make a picture or a diagram
6. Guess and check
7. Work backwards
8. Use logical reasoning
9. Make it simpler
10. Brainstorm

Note. From The Problem Solver 5 (Supplementary Chart) by G. Moretti, M. Stephens, J. Goodnow, and S. Hoogeboom, 1987, Palo Alto: Creative Publications. Copyright 1987 by Creative Publications. Reprinted with permission.

The four-step approach to problem solving and the ten strategies are similar to those found in journal articles advocating teaching students various problem solving strategies, for instance, Silver (1985). (See Appendix A for sample problems from The Problem Solver 5.)

The role of the teacher in using the process-word problems is that of facilitator. The teacher provides practice in using a strategy on the problems

provided in the program following initial instruction on the strategy. Students are encouraged to share their thinking out loud to develop reflective thinking, collaboration, and consensus on the solution(s) to problems. The teacher promotes use of the strategies by asking, "What if" questions to help make the strategies more relevant to real-life problems encountered both inside and outside of school.

Student engagement is fostered in the classroom where groups of two or more students work together. Moreover, students may move freely from group to group as they challenge the strategies used, as well as the solutions arrived at, by their peers. An expected outcome is a problem-solving atmosphere reflected in the enthusiasm of the students and teacher as they explore the process of problem solving.

Evaluation of students' problem-solving abilities may be formal and informal as the classroom allows for "knowledge-in-action." The atmosphere created when thinking is shared and valued by one's peers and teacher is less threatening than that typically found during traditional-word problem lessons. A major concern of this study was to ascertain how teachers implemented the problem-solving strategies in The Problem Solver Program and to discover whether their personal learning styles affected that implementation.

Learning Style Theory and Models

Learning style theory evolved from the desire of human beings to understand themselves and others. Wilson (1991) notes that individuals have tried down through the centuries to understand the human perspective in diverse ways: through for example, palmistry, physiognomy, heredity, phrenology, astrology, birth order, auras, and graphology. Moreover, the application of scientific research methods to the study of human nature by sociologists and psychologists during the past fifty years, has produced numerous cognitive processing models reflecting a wide variety of research perspectives that inform our present-day understanding of learning styles.

In her review of the literature on learning styles, Guild (1980) discusses three main perspectives: cognitive processes, learner behaviors, and a combination of cognitive processes and learner behaviors. Wolfe (1983) credits German psychologists at the turn of the century with the early work on cognitive processes research; such research explores thinking--how the brain takes in, manipulates, uses, and stores information.

Gordon Allport, an experimental psychologist, coined the term <u>cognitive style</u> (Guild, 1980). Allport (1937) used cognitive style to describe how individuals view and adapt to the demands of life. Allport's major interest lay in developing a psychology of personality based on personality traits, and the influence of distinctive personality types on cognitive style was part of this work. At the time, many other psychologists viewed the study of personality from a Freudian or

situationist position and thus considered Allport to be a maverick (Ryckman, 1985). Allport (1961) defined personality as "the dynamic organization within the individual of those psychophysical systems that determine his characteristic behavior and thought" (p.28). The work of Allport and others who studied personality traits contributed significantly to the emerging learning style concept.

The definition of cognitive styles provided by Messick (1976) exemplifies the cognitive process perspective as information-processing habits reflecting the learner's typical mode of perceiving, thinking, problem solving, and remembering. Guild (1980) notes that several researchers define cognitive processes in terms of perception, acquisition of knowledge, and conceptualization. Witkin, the most noted researcher in cognitive psychological style during the 1940s and 1950s, worked with the concept of field independent (analytic style) and field dependent (global style). Field dependent people view situations as a whole, whereas field independent people view them as discrete parts (Kirby, 1979). In the classroom, field dependent students want to see the "whole picture" as provided in thematic units. In contrast, field independent students prefer to learn separate facts and integrate them into the whole concept later. Witkin, Moore, Goodenough, and Cox (1977) therefore divided learners into two broad groups based on their preferred approach to learning, emphasizing either the whole or parts.

Kagan (1965), another researcher in cognitive processes, looked at conceptual tempo, an outgrowth of his work on analytic styles of thinking. Conceptual tempo is concerned with the systematic examination of new information. Deliberation in decision making is referred to as reflective behavior,

while immediate reaction is sometimes referred to as impulsive behavior. Kagan contends that some adults and children consistently reflect before responding to a problem while others make impulsive responses.

Kirby's (1979) summary of nineteen cognitive style models published primarily in the 1960s supports Guild's (1980) and Wolfe's (1983) research of the historical development of the learning style concept from its early beginnings in cognitive processes research.

Research on cognitive processes as applied to education suggests that many students benefit from the support provided by instruction which guides student thinking in understanding and relating concepts. However, the widespread use of instructional methods based on cognitive-process research is hindered by (a) a lack of awareness among teachers and administrators of cognitive-instructional strategies, (b) a lack of curricula and materials matched to cognitive-instructional strategies, and (c) a lack of trained personnel capable of providing supervisory support to teachers. Moreover, Pressley et al. (1989) mention the necessity for explicit [and extensive] training required by teachers to effectively use cognitive strategies as the major barrier to use of the strategies.

Developers of instructional strategy manuals based on cognitive processing (Fulton, 1989; Marzano, 1992) contend such instruction promotes learning in two major ways: (a) the mastery of basic skills, and (b) the procedure or "know how" ability to use skills again as needed, that is, as procedural knowledge. For example, Fulton (1989), director of the Developmental Skills Institute (DSI), has designed several guide books for teachers to use in teaching skills as strategies.

Fulton discusses school curricula objectives which students must perform as competencies or new behaviors. Furthermore, "Any objective stated as a noun can be taught as a competency, for example, insect, clock, or city" (p. 2-1). Fulton's Cognitive Process of Instruction (CPOI) is based on seven steps. The first four steps are teacher-directed and the last three steps are student-directed. Fulton outlined the seven-step process as follows:

1. Teacher guides the grouping of examples of the objective, for example, insect.

2. Teacher guides the construction of a learning visual. The learning visual is a "picture" of the objective. It shows the parts of one example of the objective.

3. Teacher guides the use of the learning visual to draw, label, and describe two examples of the objective.

4. Teacher guides the comparison of two examples. Teacher asks two questions: What is the same about the two examples? What is different about the two examples?

5. Teacher provides practice tasks consisting of examples of the objective. Students use their descriptions of the objective to perform the tasks.

6. Teacher provides application tasks that require students to produce their own examples of the objective. Students use their descriptions of the objectives to perform the task.

7. Teacher assesses mastery of the objective. Can students describe the objective and perform it as a competency? (p. 2-5)

This approach to teaching emphasizes the presenting of a skill as a whole, followed by each separate part in a sequential way; it is based on cognitive processes research that has demonstrated the effective use of normal brain functions. The success of The Cognitive Process of Instruction strategies designed by Joan Fulton is attested in the following summary by Pendarvis and Howley (1988):

> The Developmental Teaching program has shown extraordinary success in improving students' achievement. It seems to be especially successful with those students whom teachers often find difficult to instruct: low achievers. Moreover, these students, who typically dislike school, seem to enjoy learning when they are taught using the strategies employed in this competency-based program. (p. 1)

Despite this success, many barriers to cognitive process instructional strategies usage remain due to "the large number of strategies, the lack of evaluation data for many strategies, and the inaccessibility to practitioners of existing research that is normally published in academic journals" (Pressley et al., 1990, p. 19).

Wolfe (1983) found significant differences between the early cognitive style research and the later learning style research that emerged in the 1970s. Basically, according to Kirby (1979), there was a shift in emphasis from the thinking-process perception of learning style to the more "action-oriented" applications for the classroom. Kirby noted, however, that if the cognitive style [processes] underlie learning style, then they also have practical applications.

Guild (1980) has pointed out that, in the literature, the term cognitive style in time became synonymous with "learning style" and "life-style."

The learner behavior perspective of the learning style concept is most directly influenced by the contribution of personality theory. Especially significant is the work of Carl Jung who developed analytical psychology, which emphasizes examining the roles of the conscious and unconscious as they influence behavior. According to Ryckman (1985), Jung was "obsessed with understanding both sides of his [own] personality, that is, the inner world of subjective experience and the unconscious and the outer world of contact with other people and material objects" (p. 62). Jungian influence is reflected in both learning style theory and in many of the instruments used to measure learning styles. Jung referred to one's total personality as the psyche. Psychic energy manifests itself in an individual's feelings, thoughts, and behaviors. The psychic energy is an outcome of the conflict of forces within the psyche, which operates according to the principle of opposites. Jung believed that archetypes or universal themes--such as the major attributes of introversion and extroversion--affect behavior.

Ryckman (1985) notes that Jungian analysts developed a personality inventory which was replaced in 1943 by the Myers-Briggs Type Indicator (MBTI), a highly valid and reliable measure consisting of 166 items with a forced-choice format to identify introverts and extroverts. The format of the (MBTI) became the prototype for the learning style inventories developed over the next four decades. The research of Dunn and Dunn (1978) and Renzulli and Smith (1978) exemplifies the learner behavior perspective based on students' preferred instructional

strategies and environment. Their research is discussed later in the literature review section titled Learning Style Application and Student Achievement.

Guild (1980) identifies one perspective of learning style as comprehensive; that is, it includes elements from both the cognitive processes and learner behavior perspectives. Among researchers using this inclusive perspective are Gregorc (1985a), Hill (1969), and Kolb (1983). Learning styles in this comprehensive definition emphasize that people have individual, characteristic patterns of learning which are pervasive and consistent. These patterns proceed from the gestalt of an individual's way of looking at, interpreting, and reacting to the world (Gregorc, 1985a).

Wolfe (1983) discusses the work of Hill and associates at Wayne State University on ways to identify college students' cognitive [learning] style, research that resulted in cognitive style mapping. In 1968 Hill, president of Oakland Community College located outside of Detroit, tested the concept of cognitive mapping extensively. The rationale for the testing was to provide students with an understanding of their personal cognitive style to enable them to better plan their own learning. According to Wolfe, Hill attempted to integrate the earlier work on cognitive styles from both psychology and education. In all, seven educational sciences or areas were analyzed: (a) symbols and their meanings; (b) cultural determinants; (c) modalities of inference; (d) educational memory; (e) cognitive style; (f) teaching, administrative, and counseling style; and (g) systematic analytic decision making. The students' responses were processed through a computer, thereby producing a profile or map of cognitive traits for each individual. The data

thus obtained are similar to that provided by other research instruments with a focus on a comprehensive perspective of learning style. However, because the model or mapping requires "interpretation" of the data obtained, it is not considered valid by some researchers in the scientific community (Kirby, 1979).

Kolb's (1977) model reflects the influence of Jung in that he uses dualities in his experiential learning model. Interestingly, Kolb comes from an organizational and management background. Kolb suggests four kinds of abilities: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). Kolb perceives learning to be situation specific in that the learner is required to choose which set of abilities to use in a given instance. In the learning situation, the learner is in a constant state of tension between action and observation, and between involvement and reflection. Kolb believes an individual's strengths and weakness within the four kinds of abilities affect the learning outcome. Moreover, he contends that individuals develop learning styles that emphasize some learning abilities over others (Guild, 1980). In addition, as Guild notes, Kolb's model uses such educational terminology as observation, reflection, concrete experience, and other education-specific terms even though his model was developed and tested with business managers. It is interesting that McCarthy (1986) uses Kolb's model as the basis for a program of open-ended teaching methods, The 4Mat System, to aid teachers in their efforts to understand and teach to the learning styles of the various students in their classes.

Gregorc (1979, 1982, 1985), like Kolb, comes from the comprehensive learning style perspective in which the instruments to determine learning style are

usually administered to adults. For example, the Gregorc Style Delineator measures two dimensions: perception of reality (Abstract or Concrete) and preference in ordering (Sequential or Random). Four distinct learning styles result from combining the two dimensions: Concrete/Sequential, Abstract/Sequential, Abstract/Random, and Concrete/Random. The following discussion considers the attributes of the four learning styles in terms of the world of reality, ordering ability, and approach to change (Gregorc, 1982).

The Concrete/Sequential individual's reality is based in the concrete, physical, objective world. According to Gregorc, for the Concrete/Sequential individual, the "What is," is solely dependent on that which is detected through the senses of sight, sound, touch, taste, and, smell. The Concrete/Sequential individual approaches experiences in an ordered, sequential, linear manner which finds expression in such terms as "deadlines" and "bottom lines." Change is difficult for the Concrete/Sequential individual because it constitutes a break from the normal routine. Moreover, such an individual does not generally adapt well to new conditions or environments.

The Abstract/Sequential individual's reality is the abstract world of thoughts and mental constructions. "As I think, so I am," summarizes such a person's world view. The Abstract/Sequential person is a precise two-dimensional thinker who is theoretical, evaluative and determined.

Moreover, the Abstract/Sequential individual, while not adverse to change, is slow in making deliberations due to the laborious weighing and debating of all the pertinent data.

The Abstract/Random individual's reality is based in the world of feelings, emotions, and imagination. Gregorc uses the words of Antoine DeSaint-Exupery to describe the Abstract/Random person: "It is only with the heart that one can see rightly; what is essential is invisible to the eye" (p. 29). The Abstract/Random person orders reality by holistically "tuning in" to experiences. Gregorc likens this approach to what Carl Jung called "synchronicity." Furthermore, the Abstract/Random individual's approach to change is subject to current emotional attitude and intensity of interest.

The Concrete/Random individual's reality is the concrete physical world. The Concrete/Random person uses intuition to understand and relate to the world. Gregorc uses a statement by Albert Einstein to describe the Concrete/Random individual: "The most incomprehensible thing about our world is that it is comprehensible." The Concrete/Random individual sees events occurring in a linear order but is open to outside variables, an outlook which Gregorc believes results in a "stream of consciousness." Thus, the Concrete/Random person has the potential for viewing the world from "out in left field." Change is viewed as natural to the Concrete/Random individual, who Gregorc notes, may be the "trouble shooter" in an organization due to the flexibility required in redesigning and restructuring organizations. The Concrete/Random individual is his or her own person who thrives on changes which require challenge.

The Gregorc Style Delineator presents ten sets of four words (reflecting each of the four learning styles) to the individual to rank from 1 to 4 by preference relative to self (see Appendix B). A composite score is obtained for each of the

four learning channels by adding the scores across the rows and then down the columns.

Similar to other instruments, Gregorc's style Delineator (1985b) uses two cut-off points. Each of the four mediation channels receives a score. An individual's preferred or strong learning style is indicated by a cumulative score of 27 or above and a non-preferred or weak learning style is indicated by a cumulative score of 15 or below. Scores falling between the two cut-off values, 16 to 26, indicate neither a strength nor a weakness in using a particular learning style. Individuals indicating no strong or weak learning styles may be comfortable in situations which require them to make changes in conducting "business as usual." Furthermore, a lack of preference may indicate a flexibility toward change not found in individuals indicating high strengths or weakness in any of the learning styles.

Importantly, while a person with a strong preference for a particular learning style is unlikely to develop a strong preference for another style, the adapted or increased use of a less favored style is possible and at times required. The research suggests that an individual's learning style may be incompatible with the demands of a particular job or the learning styles of other individuals (Sternberg, 1990; Guild, 1980; Laffey, 1983). This does not mean, however, that, in the comprehensive approach, learning styles are considered to be so rigidly fixed that no adaptability is possible.

Those who embrace the comprehensive learning-style viewpoint do concede that individuals can be helped to flex or bridge learning styles in order

to perform necessary tasks. At the same time, Gregorc (1985a) notes that individuals with very dominant styles may be too inflexible to change their perceptions and, hence, their attitudes or behaviors. Adherents of the combined learning style perspective emphasize that knowledge of one's personal learning style increases self-understanding and sensitivity to the learning styles of others. Further, personality, culture, and life experience all appear to be factors in learning style. A major point is that, while the ability to use all learning styles resides within each individual, most people favor one or possibly two learning styles (Gregorc, 1979).

For the purposes of this study the following definition of learning style will be used: Learning style is a hypothetical construct having attributes which include, minimally, cognitive and affective dimensions. These dimensions describe a mind set, that is, the usual way in which an individual interacts with the world (Gregorc, 1979). Furthermore, the Gregorc Style Delineator is based on this comprehensive definition which allows the researcher to investigate the mediation or learning channels using perception of reality and ordering dimensions which, as noted in chapter 1, are critical to this study.

The present day learning style research which combines cognitive and affective dimensions of individuals is reflected in the learning style instruments of Canfield and Lafferty (1970), French (1975), Hagberg and Leider (1978), Hill (1969), Kolb (1977), Ramirez and Castaneda (1974), Dunn and Dunn (1978), and Gregorc (1985b). The later learning style instruments include more of the affective variables. Moreover, the work of Dunn and Dunn (1978), in particular, is

associated with individual preferences relative to environmental, emotional, physical, and sociological stimuli.

Learning Style Application and Student Achievement

The decade of the 1960s was a time of constructing and validating learning style instruments (Wakefield, 1992). It was not until the late 1970s that learning style research appeared in major educational journals. The articles reflect different views on the nature and value of the learning style concept and its application to actual classroom settings (Curry, 1990). While some researchers suggest that the knowledge and use of learning styles is essential for effective instruction (Sternberg, 1990; Kuchinskas, 1979), other researchers suggest that a concise definition of the term learning style precludes serious implications for curricula change based on learning style data (Friedman and Stritter, 1976). Fischer and Fischer (1979) question whether instruments which require students' responses are valid or reliable given the immaturity of the youngsters.

The renewed interest in learning styles is a logical consequence of the mandate to educators to meet the needs of students in active teaching and learning environments. The development of strategies which utilize learning style modalities allows for practical application in the classroom. Teachers' manuals, such as The 4Mat System (McCarthy, 1986), provide the rationale and the means by which teachers are able to implement learning style research. Teachers may come to find these manuals invaluable in their efforts to restructure curricula to

include more integrated learning experiences and to develop alternate ways to assess these experiences. The models provide the basic "how to" strategies for incorporating the various learning styles of students within curricula. Teachers may be more comfortable with some of the strategies than with others. Furthermore, efforts to raise the awareness of teachers to the differences in the learning styles of students may promote the use of alternative teaching strategies.

The conception of learning style as learner behaviors is the basis for the research of Dunn and Dunn (1978) and Renzulli and Smith (1978). These researchers perceive learning style to consist of distinct patterns of student preferences rather than the thinking processes described by the cognitive psychologists. Dunn and Dunn (1978) developed a Learning Style Inventory (LSI) to measure 18 different traits of third-grade through twelfth-grade students and includes the influences of sound, light, temperature, and time. For instance, a student may prefer low lighting with a moderately high noise level while he or she interacts with several other students. Matching of students to their preferred learning environment (including type of instruction and materials) results in significant student achievement (Dunn, 1990).

Beginning in the early 1970s, all school systems were required to provide special programs for gifted students. Renzulli and Smith's research (1981) focused on the learning styles of gifted students and provided data to support offering stimulating learning materials and environments for them. The programs designed for gifted students placed special emphasis on the development of critical thinking and problem-solving skills. However, the realization that all

students benefit from instruction in critical thinking and problem-solving skills and therefore should be provided such instruction is a relatively recent occurrence. This realization, combined with the reform efforts utilizing active teaching, supports accommodating the various learning styles of all students.

Efforts to apply learning style research to student achievement peaked in the late 1970s and early 1980s. The interest in learning styles coincided with attempts to individualize instruction and to better meet the needs of special education students who were beginning to be main-streamed into regular classrooms during the 1970s (Wolfe, 1983).

While attempts to individualize classroom instruction did not prove feasible in most instances, learning style research continues to support adapting instruction to meet diverse learning styles of students (Sternberg, 1990; Guild, 1980). Several studies, particularly the research of Dunn and Dunn (1978), note that matching instruction to students' preferred learning styles results in significant achievement gains. Nevertheless, most classroom teachers are unaware of these studies as they have been rarely mentioned in education courses or in the journals generally read by teachers (Wolfe, 1983).

As recently as ten years ago most teachers discussed learning style solely in terms of how special education children learned best: auditorily, or visually and/or kinesthetically (Wolfe, 1983). The regular classroom teacher, faced with adapting instruction to meet the needs of a special education child, frequently gave tests orally or, depending on the child, called on him or her to read from the

board more frequently than the other children. Therefore, attempts to adapt curricula to meet the needs of all children because of their differing learning styles is a relatively new idea, particularly in the upper elementary grades. Efforts to accommodate the different learning styles of students are often combined with the need to use developmentally appropriate practices in the development of thematic units, the major curricula structure in the reform of elementary education.

In summary, application of learning style research to student achievement ranges from efforts to teach students to think more effectively and efficiently, to efforts to accommodate students' environmental and instructional preferences. Even though the research on student learning styles over the past thirty years yields the consensus that students learn better when their learning preferences are considered, thus providing the rationale for eclectic teaching in general and in elementary school mathematics in particular (Rowan & Cetorelli, 1990), there remains a vagueness as to the precise definition of learning style and its practical application for the classroom teacher (O'Neil, 1990). And it must be acknowledged that, while some researchers have reported significant achievement gains in student learning when students have been matched by learning styles to instructional methods and environmental preferences, other researchers have failed to find significant results in similar studies (Curry, 1990).

While much remains to be studied about student learning styles and student achievement, there is sufficient data to support the idea that student achievement is effected by how students learn.

Learning Style of the Teacher

The "teacher-proof" curricula packages of the sixties and seventies attested to the once-held notion that teachers' influence on instruction could and should be minimized. Ironically, instead of facilitating reform in classrooms, these "packages" that devalued teachers' influence may have hindered reform as teachers resisted pre-packaged instruction (Hord, 1987). Thus, present reform in education, informed by past failures to change teaching practices, stresses the importance of the teacher--not the innovation--as the primary change agent. This recent emphasis on the role of the teacher has spurred an interest in teachers' learning styles in current literature (Wakefield, 1990, 1992; Sternberg, 1990; Brandt, 1990).

Lester (1988) notes that teachers' beliefs, affects, and knowledge of problem solving can strongly influence the nature and effectiveness of instruction. While the idea that teachers' knowledge of subject matter (such as problem solving) influences instruction appears obvious, <u>how</u> teachers' beliefs and affects influence instruction is not so obvious.

Gregorc (1985a) suggests that, because style indicates personal philosophy, it may be at odds with the philosophy of a teaching approach; for example, the Back to Basics programs of the 1970s would most likely appeal to sequential, step-by-step thinkers. When teachers are required to use curricula that differ greatly from curricula they prefer or are comfortable with, either of two outcomes may occur: dissonance resulting in teacher burn-out (Gregorc, 1985a) or resistance to implementation of certain programs (Wakefield, 1992).

A recent interest in learning styles is taking place as teachers become familiar with the Myer-Briggs Type Indicator, Gregorc Style Delineator, or other learning style instruments in education classes or staff development sessions. Administrators are seeking to increase teachers' knowledge of learning styles in order to sensitize them to differences in learning styles among themselves and in their students. In turn, this increased awareness may result in a greater willingness on the part of teachers to use thematic units, whole language, and other curricula approaches which support reform in education. Unfortunately, however, the significance of their personal learning style is not usually made clear to teachers, with the result that most teachers are unaware of the impact that their learning styles have in the classroom.

Therefore, more research needs to be focused upon the learning styles of teachers. Most germane to this study is the research of Kuchinskas (1979) that identified teacher learning style as the most influential factor in first-grade student reading achievement, more so than instructional methods or learning styles of the students. Further, Kuchinskas' contention that the teacher's learning style "permeates everything and everybody" in the classroom supports Sternberg's (1990) observation that teachers may [unknowingly] exploit their own learning styles in classroom management, types of assignments, and methods of assessment. Furthermore, Sternberg (1990) contends that learning styles are as important as levels of ability and that educators disregard learning styles (their own and students') at their "own peril."

Combs (1982) stated, "No matter how promising a strategy for reform, if it is not incorporated into teachers' personal belief systems it will be unlikely to affect behavior in the desired directions" (p. 38). Wakefield (1992) suggested that teachers may be willing to use a less preferred learning style when they are intellectually challenged to examine the rationale for changing their beliefs and strategies concerning teaching and learning. This is possible when teachers are instructed in techniques in how to "stretch" or "bridge" from one learning style to another. Educational reform requires teachers to change what and how they teach. Providing a rationale and support system based on learning style theory may aid in fostering the desired changes. The willingness to see "beyond one's own perspective" may be a critical factor in reforming a traditional educational system consisting, for the most part,of teachers who are sequential learners themselves. Wolfe (1983) has pointed out that teachers do not teach the way they were taught so much as they teach the way they learned.

Reform in education requires teachers to be open to change. The issue is one of flexibility. Are random web-like thinkers, for example, more likely to feel comfortable with active teaching curricula such as thematic units, innovative spelling, whole language, or process-problem solving than are the sequential step-by-step thinkers? Presently, it is accepted practice to recognize and accommodate the different learning styles of students. Now, the important question to be investigated is this: Do the learning styles of teachers foster or hinder reform in the classroom?

Chapter 2 has provided a review of the literature on word problems and the process-word problem in particular. The origins of the term learning style and the application of learning style theory to education have been discussed. Chapter 3 includes a discussion of the research design, grounded theory method, the research plan schedule, pilot study, methodology, instrumentation, data gathering procedures, and data analysis.

CHAPTER 3

Methods

The primary task of this research was to investigate the impact of teachers' learning styles on an active teaching program. The study explored how teachers with different learning styles experience active teaching in the instruction of process-word problems in mathematics. The research also sought to validate the hypothesis: When teachers' learning styles and new programs share a similar philosophical base, the likelihood of successful program implementation is greatly increased.

Research Design

The following major and subsidiary questions were used to guide the research:

Major Question

How effective are teachers with different learning styles in implementing problem-solving strategies in mathematics that require an active teaching style?

Subsidiary Questions:

1. What are the expressed opinions on the worth of The Problem Solver Program among teachers with different learning styles?

2. Are teachers' learning styles evident in in-depth interviews and observations of The Problem Solver Program lessons?

3. How do teachers express their resistance to use of The Problem Solver Program?

4. Does the extent to which The Problem Solver Program is used vary among teachers with different learning styles?

The following discussions support, first, the utilization of qualitative methods to investigate the research questions, and second, the selection of the grounded theory method in particular. Also included is a description of the set of procedures which were used in this grounded theory research.

Qualitative Research Methods

Patton (1987) provides a substantive rationale for using qualitative methods:

> The philosophical roots of qualitative methods emphasize the importance of understanding the meanings of human behavior and the social-cultural context of social interaction. This includes developing empathetic understanding based on subjective experience, and understanding the connections between personal perceptions and behavior. (p. 20)

The characteristics of qualitative research are commonly accepted by researchers in the various disciplines who employ the naturalistic inquiry perspective (Borg & Gall, 1989; Lincoln & Guba, 1985; Burgess, 1985). Perhaps

the two characteristics of qualitative research which most readily distinguish it from quantitative research are (a) that it is "grounded in the data" and (b) that it uses inductive analysis procedures. However, the decision to use a particular qualitative research method--for instance, grounded theory, ethnography, case study, life history, or conversational analysis--is determined by the nature and purposes of the research investigation.

Furthermore, Wax (1967) notes the sharp contrast between the qualitative researcher's use of the process of *verstehen,* or interpretive understanding, to appreciate the worlds and concerns of participants, and the quantitative researcher's use of positivist procedures. Erickson, Florio, and Buschman (1980) suggest that qualitative methods are best in seeking answers to (a) What's happening in the field setting? and (b) What do the happenings mean to the people involved in them? These two questions are critical to this study, a major component of which is the investigation of teachers' perspectives on the implementation of an active teaching program.

Merriam (1988) discusses the qualitative researcher's ability to explore the multiple realities of teachers' behaviors and beliefs in different ways. The qualitative researcher is able to "discover important questions, processes, and relationships" (Marshall & Rossman, 1988, p. 43). Furthermore, theory validation and theory building are suited to qualitative methods and are particularly appropriate in the educational setting, for as Borg and Gall (1989) note:

> 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 collaboration of two sociologists, Anselm L. Strauss and Barney G. Glaser. Strauss, trained in the qualitative research tradition of the University of Chicago, and Glaser, trained in the quantitative research of Columbia, utilized their combined research perspectives. Glaser and Strauss (1967) recognized the need to develop 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)

Thus, the grounded theory approach resulted as a response to a need for a method to use in the building of theory. "The grounded theory approach is a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (Strauss & Corbin, 1990, p. 24). The following discussion describes the systematic set of procedures required in the utilization of the grounded theory method. Examples showing the application of these procedures to the present study are located in chapter 4. Also included is a discussion of theoretical sensitivity and a description of how the

researcher developed and applied this ability in the research. Moreover, two conditional paradigms are noted in the discussion with accompanying page references in chapter 4. A discussion of the problem of the study relative to the wide scope of organization levels is presented in the conclusions section of chapter 5.

According to Strauss and Corbin (1990) doing analysis is, in reality, making interpretations. Diesing (1971) shares a similar view in discussing the products of analysis: "Concepts, hypotheses, and theories are not found ready-made in reality but must be constructed" (p. 14).

The grounded theory method, often referred to as the "constant comparative method of analysis," emphasizes two basic analytic procedures: (a) asking questions about the data and (b) making comparisons for similarities and differences between each incident concerning the phenomena being studied (Glaser & Strauss, 1967). Theoretical sensitivity is a personal quality or ability of questioning beyond the who, what, when, where, and how of a phenomenon in order to gain deeper insights into the real meaning behind words and behaviors. Strauss and Corbin (1990) suggest several techniques to enable the researcher to become increasing sensitive to what he or she perceives, which include using the following background sources: (a) literature, (b) professional experiences, and (c) personal experiences. Additionally, the analytic processes become a source of theoretical sensitivity. Strauss and Corbin (1990) summarize the quality: "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). Furthermore, Strauss and Corbin provide a sound rationale for developing theoretical sensitivity:

> 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)

The researcher endeavored to develop theoretical sensitivity by reflecting on her own experiences, both positive and negative, with various types of curricula implementations. Additionally, the review of the literature conducted for this study provided insight into why programs were not successfully implemented during past periods of educational reform. However, the researcher came to understand the importance of theoretical sensitivity while listening to the three teachers selected for the pilot study who openly shared, on the one hand, their enthusiasm or, on the other hand, their frustration with The Problem Solver Program.

Other qualities important to the grounded theory researcher include flexibility in thinking, creativity, and perseverance, all of which are needed for the analytic data processes. Coding is the main set of procedures upon which grounded theory is based. Coding refers to the analytic processes or operations by which the data are broken down, conceptualized, and put back together in new ways. According to Strauss and Corbin (1990) the analytic processes are designed to accomplish the following goals:

1. Build rather than only test theory.
2. Give the research process the rigor necessary to make the theory "good" science.

3. Help the analyst to break through the biases and assumptions brought to, and that can develop during, the research process.

4. 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)

Analysis in grounded theory is composed of three types of coding processes: open coding, axial coding, and selective coding. Specific directives apply to each of the three processes. Open coding is the introductory step into the first of many analyses of the data.

Open coding is the process of breaking down, examining, comparing, conceptualizing, and categorizing data" (Strauss & Corbin, 1990, p. 61). In the process of studying the data, the researcher identifies and labels concepts which denote discrete happenings, events, and other instances of phenomena. The identified concepts are then compared and grouped together under a more abstract concept, referred to as a category. Each of the categories is then analyzed in terms of its properties, that is, attributes or characteristics pertaining to that category. The properties of the categories are then dimensionalized, that is, placed on a continuum. The categories which emerged during the open coding process in the early stages of this study are found in chapter 4.

The second type of coding, axial coding, regroups the data which was "opened up" during open coding in order to discover new relationships by making connections between the categories. This is accomplished through the construction of a paradigm which, in this study, defined The Problem Solver Program in terms of its conditions, context, action/interaction strategies, and

consequences. The Problem Solver Program paradigm which resulted from the application of the axial coding procedure to the data appears in Table 5 in chapter 4.

Selective coding is the analytic process whereby the core category or central phenomenon is selected and systematically related to the other categories. The story line is a descriptive narrative about the central phenomenon of the study. In this research, the central phenomenon is the teacher as the creator of the problem-solving atmosphere. The Problem-Solving Atmosphere Creator paradigm presented as Figure 1 in chapter 4, depicts the relationships between the categories supporting the central phenomenon.

The story line is explored in the narrative presentations of the six teachers selected for the study. Several transcriptions of large segments of observed lessons are included to preserve the "big picture" of the interactions between the teacher and students. Such a comprehensive view is critical in determining the nature of a problem-solving atmosphere. A discussion based on the Problem-Solving Atmosphere Creator paradigm follows the narrative presentation of each of the three ordering-style groups to show how the emerging theory was grounded in the critical incidents identified during the data collection phases of the study.

The research plan schedule which follows provides an overview of the entire research endeavor, including the collection of baseline data, the pilot study, and the actual study. The stages of the study format is used in the Data Gathering Procedures section of this chapter also.

Research Plan Schedule

Stage One

1. Arranged for principals to administer the Gregorc Style Delineator and Stages of Concern Questionnaire (first time) to ninety-two teachers in the school system using The Problem Solver Program.

2. Analyzed the teachers' Gregorc Style Delineator and Stages of Concern Questionnaire data.

3. Created ordering groups based on the teachers learning style preferences: (a) sequential, (b) random, and (c) mixed.

Stage Two

1. Conducted pilot study using three teachers, one from each of the three ordering-style groups, to validate the worth of conducting the study and to provide practice for the researcher in conducting open-ended and focused interviews and classroom observations.

2. Arranged for the administration of Stages of Concern Questionnaire (second time) to the seventy-two teachers using The Problem Solver Program who completed and returned the Stages of Concern Questionnaire and the Gregorc Style Delineator administered in the fall.

3. Analyzed the teachers' Stages of Concern Questionnaire data.

Stage Three

1. Trained two independent observers in the use of the Observation Checklist and Innovation Configurations Checklist and in the techniques used in focused and open-ended interviews.

2. Contacted six teachers, randomly selected for the study by an administrator on the basis of their Gregorc Style Delineator scores, to serve as examples of the three distinct ordering groups: (a) sequential, (b) random, and (c) mixed.

3. Arranged interview and observation times with independent observers and teachers.

4. Collected interview and observation data from the observers.

5. Transcribed, categorized, and coded data while examining data for trends and emergent themes.

6. Analyzed data using critical incident approach within the grounded theory method to explore relationships and describe findings.

Baseline Data

The data from seventy-two teachers on the Stages of Concern Questionnaire and the Gregorc Style Delineator were obtained in September of 1992 during the stage one phase of the research schedule. These baseline data were used to select three teachers for the pilot study. A summary of the data analysis resulting from that first administration of the Stages of Concern Questionnaire and from the Gregorc Style Delineator follows:

Seventy-two of the ninety-two (78%) teachers who were asked to respond to the instruments returned the Gregorc Style Delineators and the Stages of Concern Questionnaires. In this larger sample, the teachers' learning style data were grouped to indicate those teachers having one learning style preference, those teachers having two learning style preferences with the same ordering preference (sequential or random), and those teachers having two learning style preferences with different ordering preferences (sequential and random). The numbers of teachers in each category follows:

1. Teachers indicating only <u>one</u> learning style preference: Concrete/Sequential (24), Abstract/Sequential (3), Abstract/Random (9), and Concrete/Random (5).

2. Teachers indicating <u>two</u> learning style preferences with the <u>same</u> ordering preference: Concrete/Sequential and Abstract/Sequential (5), Abstract/Random and Concrete/Random (12).

3. Teachers indicating two learning style preferences with <u>different</u> ordering preferences: <u>one</u> random and <u>one</u> sequential learning style preference: Abstract/Random and Concrete/Sequential (10), Concrete/Random and Concrete/Sequential (4).

Reducing the data by combining teachers with similar ordering preferences resulted in the following percentages of teachers in each of the ordering groups: random 36.1%; sequential 44.4%; and mixed 19.4%.

A school administrator randomly selected one teacher from each of the three ordering groups to be participants in the pilot study.

Pilot Study

The pilot study was undertaken for several reasons. First, it provided a way to validate the learning styles of the three teachers selected for the pilot study through classroom observations and interviews. Second, it provided the means to obtain samples of data from the several sources being considered for the actual study: Gregorc Style Delineator, Stages of Concern Questionnaire, Innovation Configurations Checklist, Classroom Observation Checklist, and Levels of Use and open-ended interviews. Third, the researcher was able to gain field experience in conducting open-ended and focused interviews, along with making any necessary revisions in any of the questions. Fourth, the pilot study provided the opportunity for the researcher to practice observation skills with teachers who use The Problem Solver Program and thus to plan the training sessions for the two independent observers who would conduct the observations and interviews for the actual study. Because of the pilot study, the researcher was able to anticipate the types of concerns the observers would have before they made initial contact with the teachers.

Each of the three teachers who were selected for the pilot study represented one of the three major ordering groups: random, sequential, or mixed. Individuals with random ordering preferences tend to approach life's problems from a number of perspectives, while individuals with sequential ordering preferences look for more linear approaches. Individuals who demonstrate no strong ordering preference may use a random or a sequential approach

depending on the situation. A discussion of how the teachers' learning styles were determined using the Gregorc Style Delineator appears in chapter 2 (see Appendix B).

The information gathered during the pilot study from the interviews and observations suggests there are distinct differences among the three groups of teachers--especially between the random and sequential groups. The random teacher was enthusiastic about using The Problem Solver Program; the sequential teacher was very frustrated with The Problem Solver Program; and the mixed teacher appeared to "take it in stride," seeing no problem with The Problem Solver Program.

This view was supported in the baseline data obtained in the fall on the Stages of Concern Questionnaires of the three teachers who piloted the study. The Stages of Concern Questionnaires indicated that the random teacher was implementing the program to the greatest degree and the sequential teacher to the least degree. The mixed teacher was between the random and the sequential teachers as to degree of program implementation. Based on the baseline data obtained on the larger sample of teachers and the pilot study, the researcher was able to conceptualize better the relationship between teachers' learning styles and their implementation of The Problem Solver Program. The research became more meaningful in light of the experiences and feelings shared by the three pilot study teachers implementing The Problem Solver Program. After conducting the pilot study and examining all the data, the researcher decided that ordering preference was indeed a factor worthy of study.

Method

Participants

Sixty-seven of the ninety-two second- through fifth- grade teachers using The Problem Solver Program in the York County Public Schools responded to the Gregorc Style Delineator and to both the fall and spring administrations of the Stages of Concern Questionnaire. Three ordering preference groups (sequential, random, and mixed) were formed, based on the learning style data. Six teachers, two from each of the three ordering groups, were randomly selected by a school administrator as participants for this study. The teachers selected represented the full range of socioeconomic populations found within the school division. The six teachers had five or more years of teaching experience before using The Problem Solver Program.

Wax (1967) emphasizes the importance of establishing reciprocal relationships when access to naturalistic settings is needed. Moreover, Patton (1987) states that the reciprocity model of gaining entry to the research site "assumes that one can find some reason for participants to cooperate in the evaluation and that some kind of mutual exchange can occur" (p. 98). In view of this consideration, the six teachers were offered funds, classroom release, and/or help in research endeavors such as providing data sources for thematic units. Two of the six teachers accepted the offer of help in research endeavors. The other four teachers said they would not think of taking any form of "payback." The primary concern of the six teachers was the assurance of anonymity as to person

and school. The teachers agreed to candidly share their concerns with The Problem Solver Program only after it was made clear that their perceptions would not be shared with other teachers and especially administrators. The interest on the part of the teachers in knowing their learning styles provided the opportunity for the researcher to validate each teacher's learning style. Validation occurs when individuals agree with the findings of the Gregorc Style Delineator. Invalidation may occur when individuals attempt to choose the "correct" responses. The six teachers selected for the study validated their learning styles.

Instrumentation

In grounded theory studies, as in other types of qualitative research, the researcher is the primary instrument in gathering, analyzing, and interpreting data. (Borg & Gall, 1989). This study employed the primary investigative tools of observations and interviews (open-ended and focused) to obtain the necessary data. In addition, the study required the use of two quantitative measures to determine the learning styles of the teachers and the degree to which they had implemented The Problem Solver Program.

The Stages of Concern Questionnaire was selected for use in this study because the items (questions) reflect concerns the teachers are having with an implementation. With the exception of two or three questions, teachers are unable to choose the "correct response" unlike many of the questions on the instruments

used to gather implementation data in the past. However, the responses do in fact, indicate the implementation progress made by teachers.

The first instrument used in this study was The Stages of Concern Questionnaire (CBAM) (Hall, George, & Rutherford, 1979), which measures the degree to which a program has been implemented based on the areas of greatest concern to the teacher. The Stages of Concern Questionnaire (CBAM) (see Appendix C) measures seven different stages of concern about an innovation that is being implemented: 1) awareness, 2) informational, 3) personal, 4) management, 5) consequences, 6) collaboration, and 7) refocusing. The measure consists of a thirty-five item questionnaire concerning the innovation; responses range from (0) "irrelevant" to (7) "very true of me now." The Concerns Based Adoption Model Stages of Concern Questionnaire takes approximately fifteen minutes to complete.

<u>Reliability</u>: Stages of Concern score correlations ranged from .65 to .86 with four of the seven correlations being above .80.

<u>Validity</u>: Alpha coefficients ranged from .64 to .83 with six of the seven coefficients being above .70.

The second quantitative measure used in this study was the Gregorc Style Delineator (Gregorc, 1985b) which measures learning style based on the cognitive and affective dimensions of ordering (random or sequential) and perception of reality (abstract or concrete). The Gregorc Style Delineator (see Appendix B) is a self-analysis tool used for identifying four basic channels through which a person receives and expresses information. The channels, labeled Concrete/Sequential

(CS), Abstract/Sequential (AS), Abstract/Random (AR), and Concrete/Random (CR) are revealed through characteristics popularly called "style." The responses are made by numbering (1) least to (4) most words which best reflect the individual being tested. The Gregorc Style Delineator is a self-administered instrument that takes five to seven minutes to complete. The Gregorc Style Delineator was selected because the data obtained reflect ordering preferences (sequential versus random) which were of interest in this study

Reliability: Standardized alphas were 0.92 and 0.92 for the Concrete/Sequential scale; 0.89 and 0.92 for the Abstract/Sequential scale; 0.93 and 0.92 for the Abstract/Random scale; and 0.91 and 0.91 for the Concrete/Random scale.

Validity: Correlations between style delineator scores and ratings of attributes were 0.68 and 0.70 for the Concrete/Sequential scale; 0.68 and 0.76 for the Abstract/Sequential scale; 0.61 and 0.60 for the Abstract/Random scale; and 0.55 and 0.68 for the Concrete/Random scale.

Two informal instruments were used to collect observational data in this study. The first, the Innovation Configurations Checklist (Stiegelbauer, Hall, & Loucks, 1981) is one of the three Concerns Based Adoption Model (CBAM) instruments used to measure where teachers are in the change process. The Innovation Configurations Checklist provides an indication of what the implementation looks like based on identified components. An adaptation of the Innovation Configurations Checklist was constructed by the researcher, following the guidelines of the developers, to reflect the essential characteristics of The

Problem Solver Program which include (a) the arrangement of the desks, (b) the indication that mathematics is integrated into other subject areas, (c) the indication that The Problem Solver Program is being used as intended, (d) the types of questions asked by the teacher relative to promoting student thinking, and (e) the involvement of the students in the learning process. The researcher adapted the format to use a Likert-type scale that provided the observers with a continuum rather than just the three categories of ideal, acceptable or unacceptable used by the developers of the checklist (see Appendix D).

The Classroom Observation Checklist (Winocur, 1983) uses affective and cognitive descriptors indicative of a teacher's facilitator role. The Classroom Observation Checklist (see Appendix E) was used during the observations of The Problem Solver Program lessons and skills lessons in mathematics to assess teaching behaviors. This instrument focuses on the cognitive and affective behaviors of the teacher which are critical to the role of the teacher as the creator of the problem-solver atmosphere. This instrument consists of thirty-two statements of teachers' classroom behaviors. The observer marks an "x" in the appropriate column for each behavior under the headings, yes, no, or unsure. The findings are used to substantiate interview data and observations notes for each teacher.

Two instruments were used to collect interview data. The Levels of Use (CBAM) (Loucks, Newlove, and Hall, 1975) focused interview format was used to gain specific information on <u>how</u> the teachers were implementing the program. The Levels of Use (CBAM) (see Appendix F) focused interview questions were

constructed by the researcher according to the guidelines provided by the instrument developer. The interview format directs the teacher to discuss questions which evoke responses that are critical to understanding the teacher's perceptions of what the implementation consists of and how he or she is implementing it. The focused interview is an important tool in providing data that teachers may not otherwise think to mention or which they may choose to avoid discussing in an open-ended interview.

In two open-ended interviews, teachers were asked to share their thoughts on what influences their decisions on how to teach a skills mathematics lesson and a Problem Solver Program lesson. The following questions were used as probes:

1. To what extent does staff development, graduate classes, availability of manipulatives, the curriculum, testing, or discussions with other teachers affect how you teach this lesson?

2. What was the most important factor in deciding your teaching strategy for this particular lesson?

The interviews were conducted after the classroom observations so that the interview questions would not affect the lessons.

Data Gathering Procedures

Stage One

The researcher called the school principals to request permission to conduct the study in their schools. The principals who granted the requested

permission, agreed to distribute and later return the completed materials to the researcher.

Teachers using The Problem Solver Program in second through fifth grade were asked to respond to the Gregorc Style Delineator and the Stages of Concern Questionnaire early in September of 1992. The school principals distributed the instruments. After the completed materials were mailed to the researcher, the researcher wrote follow-up notes to each teacher whose materials had not been returned by the first due date. When only sixty-two questionnaires were returned after the follow-up notes were sent, the researcher was given permission by Joan Byrne, the director of research for the York County Public Schools, to speak to the teachers about this research and to request that they fill out and return the instruments at a division-wide staff development. As a result of this plea, ten teachers returned the instruments bringing the total to seventy-two of the ninety-two teachers who returned the materials.

Stage Two

The researcher conducted the pilot study with the three teachers randomly selected by an administrator. Data were gathered from observations and interviews on the instruments described previously. The data gathering procedures for the six teachers were similar to those discussed in Stage three for the actual study.

During this second stage of the study, the researcher also arranged for the second administration of the Stages of Concern Questionnaire. In late April of 1993, seventy-two teachers were asked to respond to the Stages of Concern

Questionnaire again and to confirm their learning styles as determined by the Gregorc Style Delineator. Eight of the teachers returned the instrument after they were called at their respective schools when the materials were not returned by the first due date. Sixty-seven of the seventy-two teachers who responded on the fall instruments returned Stages of Concern Questionnaire administered in the spring. The researcher's analysis of the data appears on Tables 2, 3, and 4 in chapter 4.

Stage Three

The two observers who conducted the observations and interviews were somewhat familiar to the six teachers studied because the observers have taught in the York County School System, one while the study was being conducted and the other, the previous year. One of the observers is a special education teacher who works with severely-handicapped young children. The other observer is a doctoral candidate in administration and gifted education at the College of William and Mary. Both observers hold master's degrees in education. Both observers had prior training with observational and interviewing instruments and, as a result, displayed no concerns after "practicing" one observation, one focused interview, and one open-ended interview in preparation for this study. The observers discussed with the researcher the observations, interviews and the notations they had made on the data sheets. The researcher typed the transcriptions of these trial sessions to gain practice in that aspect of the study. The operation of the audio-tape recorder was the only concern expressed by either of the observers.

Each of the six teachers selected to represent the three ordering groups, random, sequential, or mixed, completed two Stages of Concern questionnaires

(early September and late April) and the Gregorc Style Delineator. Each of these teachers participated in two open-ended interviews, one focused interview, and two classroom observations. The observations and interviews were audio-tape recorded.

The two classroom observations consisted of one lesson from The Problem Solver Program and one skills lesson from the regular mathematics curriculum. The skills lesson provided a contrast lesson in which the content does not prescribe an active teaching style as it does for The Problem Solver Program lesson. As expected, the skills lessons reflected the teachers' natural teaching style without the demands of active teaching inherent in a Problem Solver Program lesson.

Each of the thirty minute skills lessons was followed by an open-ended interview designed to encourage the teachers to share their beliefs about learning and teaching mathematics relative to the observed lesson. Each of the thirty minute lessons from The Problem Solver Program was followed by a focused interview (Levels of Use) designed to obtain specifics about the teacher's understanding of the program and how it is being implemented. The third and last interview was an open-ended interview which took place three to five days after The Problem Solver Program lesson in order to allow the teacher time to distance herself from the lesson. The intent of this later interview was to increase the likelihood that the teacher would candidly share her perspective on The Problem Solver Program as a whole. After two interviews, a decision based on the data obtained was made to decrease the structure of the open-ended questions. The

teachers appeared less inhibited in expressing their concerns in teaching The Problem Solver Program and skills lessons using the revised open-ended questions.

Data Analysis

Data on teachers in each of the four learning style groups and their respective percentages is provided in Tables 2, 3, and 4 in chapter 4 to indicate (a) teachers with one or two learning styles, (b) the resultant ordering-type groups, and (c) the progress of the ordering-type groups in implementing The Problem Solver Program.

The data obtained on the fall and spring administrations of the Stages of Concern Questionnaire on The Problem Solver Program from the sixty-seven of the ninety-two teachers who returned the instruments is presented on the Large Sample Stages of Concern Graph (see Appendix G). The data obtained on the Stages of Concern Questionnaire on The Problem Solver Program for the six teachers selected for in-depth study is presented on graphs as well (see Appendixes H-M). In addition Table 4 summarizes the learning style data obtained on the Gregorc Style Delineator and the implementation data obtained on the Stages of Concern questionnaire for the sixty-seven teachers.

The qualitative data obtained from the Levels of Use focused interviews, the open-ended interviews, and the classroom observations provided the grounding for this research. The interview and observation data were transcribed and

entered into a qualitative data base. The coding processes described earlier were used to analyze the data. In addition, critical incidents, which are statements or other behaviors significant to an investigation, were identified in the transcripts of collected data and examined for emergent themes. In this study, critical incidents reflected passive and active teaching behaviors of teachers. For example, statements in the transcripts that "all teachers should use the discovery approach" and that "the program is just an extra thing for us to fit in" were considered critical incidents. These research procedures are consistent with the critical incident method (Copas, 1984) and the principles of grounded theory research (Bogdan & Biklen, 1982; Miles & Huberman, 1984).

A profile of each of the six teachers selected for in-depth study was developed by combining demographic, observation, and interview data, with quantitative data discussed previously. In addition, the specifics of data analysis evolved as patterns emerged in the data. This type of constant comparative analysis is congruent with the grounded theory approach (Patton, 1980). The study adhered to the coding procedures for grounded theory research set forth by Strauss and Corbin (1990).

The findings of the study emerged in the following manner: first, as concepts and then as categories in the coding stages of the transcribed data; second, as paradigms that were substantiated in the teachers' narratives; third, as themes derived through analyses of the relationships between the categories; and fourth, as hypotheses which emerged during the analyses and interpretation of the data within and across the ordering groups of teachers. All of the findings are

included in chapter 4 except for the themes and hypotheses, which are presented in chapter 5.

This qualitative study utilized both qualitative and quantitative research techniques. The instruments used to collect and/or analyze the data were discussed in the instrumentation section of this chapter. Furthermore, the research gained validity by triangulation of methods: questionnaires, interviews, and observations. According to Borg and Gall (1989), a "triangulation is simply a form of replication that contributes greatly to our confidence in the research findings" (p. 393).

Personnel

Two independent observers observed the lessons and made notations on the Classroom Observation Checklists. The observers also made notations on the Levels of Use focused-interview format sheets. Written notations were not made of the responses to the open-ended questions in order to create an informal atmosphere. However, all observations and interviews were audio-tape recorded. The coded data derived from the interviews and observations were open to inspection by an independent researcher as to the "fit" of data into particular categories and emerging themes. These procedures were followed in order to reduce threats to the validity and reliability of the study.

The researcher collected and analyzed the data from the interviews, observations, and questionnaires. She is an experienced educator, who has taught at the elementary and junior high levels and supervised many student teachers. As a specialist in the Cognitive Process of Instruction, she has designed and conducted staff development in instructional methods at several schools. Her competence in conducting focused interviews and using the Concerns Based Adoption Model (CBAM) instruments is a result of specialized training during the summer of 1992 in preparation for this study.

In conclusion, after much consideration, the researcher determined that the grounded theory method best supported the purposes of this study which were to gain insight into how teachers with different learning styles perceive their implementation of a problem solving program and how that perception compares to the implementation as envisioned by The Problem Solver Program developers. Furthermore, the grounded theory method was compatible with the requirements of this study which were to validate one hypothesis and develop other hypotheses on the impact of teachers' learning styles on an active curriculum.

This chapter has outlined the research method employed to investigate how effective teachers with different learning styles are in implementing problem-solving strategies in mathematics that require an active teaching style. The research design, qualitative research, the grounded theory method, research plan schedule, pilot study, method, instrumentation, data gathering procedures, and data analyses were discussed. The results of the quantitative and qualitative analyses are discussed in chapter 4.

CHAPTER 4

Analysis of the Data

Quantitative and qualitative methods were used to validate and develop hypotheses on the impact of teachers' learning styles on the implementation of an active teaching program. Grounded theory methodology guided the collection and analysis of the data on the primary research question: How effective are teachers with different learning styles in implementing process-word problems in mathematics?

Quantitative Findings

The Stages of Concern Questionnaire and the Gregorc Style Delineator were administered to the teachers to obtain data on their implementation of The Problem Solver Program and learning styles.

The Gregorc Style Delineator, learning style groups, and ordering groups were discussed thoroughly in previous sections. The Stages of Concern Questionnaire stages are reviewed here to ensure that they are clearly understood before the data pertaining to them are discussed.

The Stages of Concern Questionnaire (Hall et al., 1979) is based on the seven stages of concern expressed by individuals implementing new programs. As Hord, Rutherford, Huling-Austin, and Hall (1987) point out:

> While the seven Stages of Concern are distinctive, they are not mutually exclusive. An individual is likely to have some degree of concern at all stages at any given time, yet our studies have documented that the stage or stages where concerns are more (and less) intense will vary as the implementation of change progresses. These variations in intensity mark the developmental nature of individual concerns. The developmental nature of concerns is further reflected in the three dimensions--self, task, and impact--into which the seven stages may be grouped. (p. 30)

Hord et al. (1987) note that self-concerns (stage 1, informational; stage 2, personal) relate to individuals' desire to know more about an implementation, that is, how it is similar and different from what they are already using, while task concerns (stage 3, management) relate to individuals' desire to know how to use the implementation in terms of time, concepts to be taught, organization of materials, and interactions with students.

Impact concerns (stage 4, consequence; stage 5, collaboration; stage 6 refocusing) relate to the effects of an innovation on students and efforts to improve the effectiveness of the program. Hord et al., 1987, contend that many teachers never experience intense stage 5 or stage 6 concerns. Moreover, school systems may consider that when the majority of the teachers are at a stage 4 level, the program has been successfully implemented (Hall, George, & Rutherford, 1979).

The present study, based on the preceding discussion, considers teachers who are at the stage 4 or higher stage to be successfully implementing The Problem Solver Program. The data suggest that teachers who remained at the

stage 3 level and did not progress from lower stages during the year may be resisting the implementation. However, all teachers at stage 3 at the end of the school year need support to overcome their management concerns in order to effect student success in solving process problems. The data obtained on the first and second administrations of the Stages of Concern Questionnaire are discussed and presented in Tables 2, 3, and 4.

The Problem Solver Program stage 4 reflects mechanical usage or consequence concerns. Teachers at a stage 4 or higher are successfully implementing the program. Teachers at the lower stages are not yet successfully implementing the program. Table 2 shows the data on teachers with one learning style preference and teachers with two learning styles preferences and their progress in the implementation of The Problem Solver Program to stage 4.

In summary, fifty-five percent of the teachers have only one learning style preference, and roughly forty-five percent of the teachers have two learning style preferences. The data on teachers with one learning style preference show that the Abstract/Random and Concrete/Random teachers have progressed further than the Concrete/Sequential and Abstract/Sequential teachers in their implementation of The Problem Solver Program.

The data on teachers with two learning style preferences show that teachers with two random learning style preferences are further along in The Problem Solver Program implementation than teachers with either two sequential learning style preferences or one sequential and one random learning style preference.

Table 2

Teachers' Learning Styles and Implementation of The Problem Solver Program

One Style Preference	N	%	Stage 4 N	%
Concrete/Sequential	22	(32.8)	6	(27.2)
Abstract/Sequential	2	(02.9)	0	(00.0)
Abstract/Random	9	(13.4)	4	(44.4)
Concrete/Random	4	(05.9)	4	(100.0)
Totals	37	(55.2)	14	(37.8)

Two Style Preferences	N	%	Stage 4 N	%
Both Sequential	5	(07.4)	2	(40.0)
Both Random	12	(17.9)	7	(58.3)
Random & Sequential	13	(19.4)	4	(30.7)
Totals	30	(44.7)	13	(43.3)

Table 3 summarizes the data obtained by combining teachers with one and two learning style preferences into ordering groups based on the ordering dimension of each learning style preference. The table includes data on the implementation of The Problem Solver Program at stage 4 for the ordering groups.

Table 3 indicates that only forty percent of all the teachers are at stage 4, the mechanical level of use of The Problem Solver Program. The percentages of teachers in the sequential and the mixed ordering groups are quite similar for the stage 4 use of The Problem Solver Program. The percentage of teachers in the random ordering group is considerably greater than the other two groups for the stage 4 use of The Problem Solver Program.

Table 3

Teachers' Ordering Groups and Implementation of The Problem Solver Program

Ordering Preferences	N	%	Stage 4 N	%
Sequential	29	(43.2)	8	(27.5)
Random	25	(37.3)	15	(60.0)
Mixed	13	(19.4)	4	(30.7)
Totals	67	(99.9)	27	(40.2)

The data discussed above were obtained from the Stages of Concern Questionnaire which was administered (second time) to the teachers in the spring of 1993. The same group of teachers had responded to the Stages of Concern Questionnaire (first time) in the fall of 1992. A comparison of the data from the two sets of questionnaires indicates implementation progress made by the teachers from the beginning to the end of the school year. Table 4 data show the progress during the second year of The Problem Solver Program implementation. Advancement indicates movement to a stage of greater implementation. Remained Stationary indicates no change in the stage of implementation. Teachers at stage 4 in the fall were already at the mechanical stage of use and, therefore, a remained stationary classification in the spring may reflect refinement of the program to further meet the needs of students. Stage 4 teachers have very different concerns from those teachers who remained stationary at a stage lower than stage 4 or whose advancement was to a stage lower than 4.

Table 4

Teachers' Ordering Groups and Second Year Implementation Progress

Ordering Groups	N	Advanced N	%	Remained Stationary N	%
Sequential	29	16	(55.1)	13	(44.8)
Random	25	17	(68.0)	8	(32.0)
Mixed	13	8	(61.5)	5	(38.4)
Totals	67	41	(61.1)	26	(38.8)

The data show that the random ordering group has progressed the most of the three ordering groups of teachers. A closer examination of the advanced and remained stationary data reveals the following:

Out of the sequential ordering group, four teachers advanced to stage 4 and four teachers remained stationary at stage 4, bringing the total to eight teachers (27.5%) at stage 4 of the implementation. Among the random ordering group, eleven teachers advanced to stage 4 and four teachers remained stationary at stage 4 for a total of fifteen teachers (60%) at stage 4 of the implementation. And in the mixed ordering group, three teachers advanced to stage 4 and one teacher remained stationary at stage 4, resulting in a total of four teachers (30.7%) at stage 4 of the implementation. Thus, the random ordering group of teachers have progressed further in the implementation than the sequential or mixed ordering groups of teachers based on the numbers of teachers at stage 4 in the fall and the numbers of teachers who progressed to stage 4 by late spring.

Qualitative Findings

The qualitative findings of this study resulted from the application of the techniques and methods for grounded theory research described by Strauss and Corbin (1990). The concepts which emerged during the analytic coding processes were developed according to the set of procedures used to develop an inductively derived grounded theory. These concepts were defined in chapter 3 and are discussed further with accompanying examples in this chapter. The findings consist of the coding data including the two paradigms and The Problem Solver Program implementation narrative of the six teachers.

Open coding is used to identify concepts in the grounded theory method. The researcher examines the transcripts of the observations, interviews, and the questionnaires for incidents critical to the phenomenon being studied. Concepts that are derived from the incidents are placed in categories according to their properties. The properties of the categories are dimensionalized and used to develop the research story. Two sets of categories emerged from the data. The first category set pertains to The Problem Solver Program within the implementation framework; the second category set pertains to the beliefs and behaviors the teachers demonstrated during the implementation of the program.

The original categories emerged during open coding in response to the researcher's asking herself, as she read the transcripts of the interviews and observations, What is the teacher doing? Answers to that question suggested the following categories for describing the teacher's role: (a) Lesson Director, (b)

Behavior Modifier, (c) Information Gatherer, (d) Atmosphere Regulator, (e) Problem Solver Program Activity Provider, and (f) Appraiser of The Problem Solver Program. The characteristics of each category help to define it:

1. The Lesson Director presents the lesson, reviews steps and strategies, builds on prior knowledge, and links learning to other knowledge.

2. The Behavior Modifier arranges seating, responds to students' ideas, and decides the amount and type of information to share with students.

3. The Information Gatherer studies The Problem Solver Program, attends conferences, uses staff development suggestions, and confers with colleagues.

4. The Atmosphere Controller interacts with students, uses the materials, sets expectations, and allows students to interact.

5. The Problem Solver Program Activity Provider uses lessons (determining frequency and duration), models strategies, and supplies students with manipulatives.

6. The Appraiser of The Problem Solver Program evaluates the content and thinking required, fits the program into the mathematics curriculum, and uses words and body language that express approval or disapproval in discussing the program.

Each of the qualities pertaining to the categories was dimensionalized along a continuum from least to greatest. For example, arranges seating examined the seating arrangement which could range from traditional rows to a variety of groupings with desks or tables. Another continuum on arranges seating,

examined the degree of movement allowed in the classroom during a lesson. The following excerpts taken from classroom observation and interview transcripts demonstrate each of the six categories:

The Teacher as Lesson Director: "I have confidence that you are going to do a good job. For example, remember the problem-solver example you did with animals playing cards?"

The Teacher as Behavior Modifier: "Do you remember the last time when we worked with the animals around the stump, we drew a diagram?"

The Teacher as Information Gatherer: "It depends on the staff development. I really like some of it a lot. It depends on what is out there and what you're offered."

The Teacher as Atmosphere Controller: "Did I ask you anything? This may be on a test."

The Teacher as Problem Solver Program Activity Provider: "I guess they are there (indicates the resource box) but I don't have time to figure out how to use them."

The Teacher as Appraiser of The Problem Solver Program: "I need it and I think it is important. I wish I had been taught to think like that 'cause it helps me now as an adult, and I look back and say, 'Hey, that is kind of a neat way to approach it.'"

In axial coding, the data obtained during open coding is organized by making connections between the categories. A coding paradigm is utilized to show the relationships among the conditions, context,

action/interaction strategies and consequences. Categories of The Problem Solver Program within the implementation framework were used to construct the paradigm presented in Table 5.

During selective coding the core category is selected, systematically related to the other categories, and used to validate the relationships among them. This process requires the researcher to conceptualize the research question as a core category to better examine its conditions and processes. The story line evolves from the core category and integrates the data that emerged during the coding processes. The core category of this study is the teacher as the creator of the problem-solving atmosphere. The second set of category data which emerged during the open coding process was further refined during the selective coding process to substantiate the core category. These categories are specific to the role of the teacher: child learning theorist, information gatherer, thinking mediator, affective motivator, activity provider, and Problem Solver Program assessor.

Theoretical sampling is the procedure of selecting incidents indicative of the categories which emerged during the coding processes discussed earlier. In this study incidents reflecting the teachers' beliefs and behaviors were selected to provide sufficient density for each category. The following incidents are taken directly from the transcripts of classroom observations of The Problem Solver Program. "Erase all that work right now!" is an inappropriate response in terms of the teacher's being a thinking mediator. Another incident--"Boy, I like the fact that this group came up with four different ways to work the problem"--exemplifies

Table 5

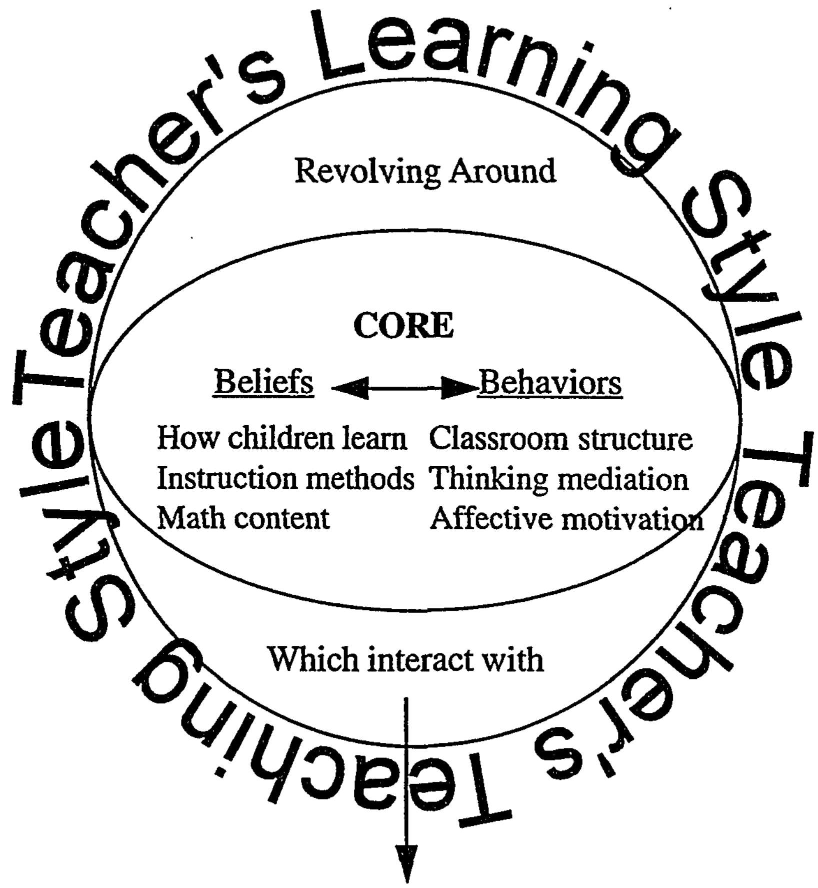
The Problem Solver Program

Basic Elements	Action and Description
Phenomenon	The Problem Solver Program Implementation
Casual condition	Requirement to implement The Problem Solver Program in fall of 1991
Properties of The Problem Solver Program Implementation	Statement of purpose of PSP guide, rationale for using process problems in an active learning setting, four steps, ten strategies, instructional problems, practice problems
Dimensions	Teachers' awareness of rational and statement of purpose, knowledge of content and management, frequency of use, method of teaching
Implementation Support Context	Building level staff development with teachers grouped dynamics, teachers grouped to work on PSP problems, math facilitator from school board office, grade level staff development with teachers working in pairs or small groups on "hands-on" math activities
Intervening Conditions	Quarterly tests containing process problems, teaching style used in implementing The Problem Solver Program, peer coaching (observations), availability of manipulatives, teachers' perceptions of the program, additional innovations (such as creation of thematic units, assessment portfolios, and inclusion practices)
Strategies to Manage The Problem Solver Program Implementation	Teacher confers with grade level teachers about The Problem Solver Program, attends workshops and conferences on problem solving and/or cooperative learning, increases time using The Problem Solver Program
Consequences	Creation or non-creation of a problem-solving atmosphere, differential progress in the implementation process of The Problem Solver Program

an affective-motivator response which would reinforce students' trying alternative solutions to process problems.

The Problem-Solving Atmosphere Creator Paradigm, which represents the central problem of the study, provides the conceptual framework for the implementation narrative of the six teachers (see Figure 1). The continuous interplay between the beliefs and behaviors of the teacher is significant. While the teaching style of the teacher suggests receptivity to particular teaching behaviors, teaching behaviors in turn impact the beliefs the teacher holds about teaching and curriculum content. Moreover, the beliefs and behaviors impact on the teacher's knowledge and understanding of The Problem Solver Program which, in turn, determine whether or not a problem-solving atmosphere is created. How effective the teacher is in using The Problem Solver Program directly impacts on the process-problem solving ability of the students.

Figure 1. The Problem-Solving Atmosphere Creator Paradigm



INFORMATION OBTAINED ON PROBLEM SOLVER PROGRAM

↓

KNOWLEDGE AND UNDERSTANDING OF PROBLEM SOLVER PROGRAM

↓

DEGREE OF PROBLEM SOLVING ATMOSPHERE CREATED

↓

EFFECTIVE OR INEFFECTIVE USE OF PROBLEM SOLVER PROGRAM

A problem-solving atmosphere is realized when students are intently engaged in the process of learning to use the strategies or in actually using the strategies to solve process problems. Students freely confer and challenge each other's strategies before coming to a consensus on one or more solutions. As needed, the teacher guides student thinking by his or her questions and responses. The creative thinking that is promoted in this atmosphere is encouraged and valued by the teacher and the students alike. The National Council of Teachers of Mathematics supports this kind of environment for process-problem instruction. When traditional, that is, applied word problems, are considered in terms of creating a problem-solving atmosphere, it becomes clear that the nature of the traditional word problem precludes the creation of a problem-solving atmosphere. The sharp contrast in the types of thinking required for applied and process problems is evident in the following discussion. The teacher-constructed applied word problems are reproduced with the permission of the author, Kathy Faron, a fifth grade teacher in the York County School System. The process problems from The Problem Solver 5 are reproduced with the permission of Moretti et al. (1987).

Grade 5 Traditional Problems

1. Paige took 2 rolls of film to camp. She could take 36 pictures on each roll. During the first day she took 29 pictures. How many more could she take?

2. For the three-day float trip, an adult's ticket costs $32.50 and a child's ticket costs $18.75. How much did 2 adults' tickets and 2 children's tickets cost?

3. Everyone wanted to go down Rapid River in a raft. If the 5 rafts hold 205 people, how many people could each raft carry?

Examples 1 and 2 are two-step word problems. In example 1, the clue word more indicates the use of the process of subtraction. In example 2, the clue word for the process of addition, altogether is not given, but implied. In example 3, the clue word each indicates the process of division.

Grade 5 Process Problems

1. Maria is taking a picture of the dogs that won ribbons at the neighborhood dog show. As Maria aims her camera, the black mutt is to the right of the golden retriever, and behind the poodle. The Irish setter is in front of the golden retriever, and to the left of the german shepherd. The labrador is between the golden retriever and the black mutt. How were the dogs arranged for their picture? (p. 15)

2. Kelly counted all the bags of recyclable trash piled up at the curb, as she walked to her friend's house. There were half as many bags of colored glass as there were bags of newspaper; there were four times as many bags of newspaper as there were bags of aluminum cans; and there were two more bags of clear glass than bags of newspaper. If there were 35 bags altogether in front of the houses, how many bags of each recyclable item were there? (p. 16)

3. The Flying Wannabees, a trapeze act, are trying to improve their safety record. They have designed a new safety net, which they put together wherever they perform. With their net, each supporting pole is connected to every other supporting pole with heavy rope. If their safety net has 13 supporting poles, how many separate pieces of rope must be used to connect all the poles? (p.34)

In example 1, the act out or use objects strategy is used to determine a solution requiring organization of objects. Pieces of paper are labeled and manipulated in place of objects. In example 2, the guess and check strategy is used because of the lack of information. Incorrect guessing provides information to improve the guessing technique leading to the solution. In example 3, the make it simpler strategy is used to simplify complex problems by looking first at a smaller number of objects and then constructing a table and perhaps a diagram in order to "see" the solution.

The active learning evident in a problem-solving atmosphere is not present during the traditional problem-solving instruction in which the whole class is engaged in following the teacher's directives concerning the identification of clue words, the problem set-up, and the labeling of the answer. Moreover, in the traditional atmosphere, the emphasis is on following a stated procedure and presentation of the answer to a problem. The teacher directs the thinking and determines if the answer is correct. This passive teaching style reflects the didactic teaching of word problems used in many classrooms. What happens when teachers are asked to change from passive teaching to active teaching to create a problem-solving atmosphere is described in the implementation narrative.

Narrative

The narrative is presented in two parts. The first part contains transcriptions of classroom lessons which provide the "big picture" of the interactions between

the students and the teacher. Each teacher's response, when asked if she would be willing to be observed teaching a Problem Solver lesson, is included as a critical incident reflecting her level of comfort in using the program. The second part of the narrative includes: (a) the staff development provided for The Problem Solver Program, (b) the philosophies behind The Problem Solver Program, and (c) the whole language curriculum. Furthermore, the structure (description and organization of materials and seating arrangements) provides details on the classroom setting that are critical in discussing both teaching style and a problem-solving atmosphere.

Additionally, the second part of the narrative considers the two teachers representing each of the three ordering groups in terms of their effectiveness in implementing The Problem Solver Program, that is, in establishing a problem-solving atmosphere (refer back to Figure 1).

Grounded theory research findings are usually presented in a narrative form, thereby reflecting the substantive nature of the research and at the same time providing insight into the evolution of the explanatory theories. Glaser and Strauss (1967) note two important aspects needed to establish credibility in theory discovery or building. First is the establishment of the theoretical framework, represented by The Problem-Solving Atmosphere Creator Paradigm in this research. Second is the vivid description of the data of the social world so that the reader "can almost literally see and hear its people--but always in relation to the theory" (p. 228). The observational lesson data is first presented as a whole in order to preserve the "reality," as much as possible, of the problem-solving

atmosphere. Each lesson presentation is followed by a discussion designed to demonstrate the relationships between the categories.

A major consideration of this study was to find out how three distinct ordering groups of teachers perceived their implementation of The Problem Solver Program. The story line weaves the personal accounts of the teachers together with observation and other data in an effort to portray the everyday reality of the implementation. In order to protect the anonymity of the teachers, neither their names nor grade levels were used; instead, fictitious teacher names and a general indicator of teaching level--primary (pr) for second and third grade teachers, and upper (up) for fourth and fifth grade teachers. The ordering group for each teacher is designated by (S) sequential,(R) random, or (M) mixed. The identifying data follows the name of each teacher: Susan Edwards (S-up), Frances Morgan (S-pr); Glenda Feldman (R-up), Mary Ann Bostich (R-pr); Cathy Proctor (M-up), Louisa Sullivan (M-pr).

Background

Before the introduction of The Problem Solver Program into the school system in the fall of 1991, problem-solving instruction consisted, for the most part, of the traditional word problems found in the textbooks used throughout the schools. Staff development on problem solving consisted mainly of presentations designed to improve students' ability to identify clue words in order to determine which operation to use. Teachers usually received hand-outs of word problems to supplement the textbook problems at these meetings.

Previous changes to the mathematics curricula, based on teacher input, focused on changing the placement or number of skills in various levels of instruction. Mathematics placement test results were used to group students in their appropriate instructional level groups. Level tests were used to determine student mastery of the mathematics skills and advancement to the next level. While minimum promotion levels were established for each grade, rate of movement through the levels was determined by the students' achievement on the level tests. The levels necessitated daily instruction of at least two, or as many as four, mathematics groups.

Two major changes occurred in the mathematics curricula for the 1991-1992 school year. First, the level system was replaced with grade-level instruction and quarterly tests on basic skills and problem solving. Whole class instruction replaced the small level groups. Class and homework assignments were modified to meet the individual needs of the students. These modifications were usually in the amount or difficulty of the work. Second, The Problem Solver Program was adopted to increase students' problem-solving ability. While the teachers welcomed the change to whole class mathematics instruction requiring less planning, student assessment, and paper work, many of them expressed concern about using The Problem Solver Program because they were unsure about how to solve process problems themselves. While the mathematics texts used in the classrooms included several pages of process problems, the level tests used previously assessed only applied problem-solving ability. Therefore, for the most part, the process-word problems were overlooked because students were not

tested on them. As a result, process-problem instruction was viewed as a new content area for many of the teachers.

In the introductory section of the program, Moretti et al. (1987) suggest that teachers "develop an atmosphere in which the students feel comfortable expressing themselves. Let them know it's okay to make mistakes. In this setting, your students will become enthusiastic problem solvers and will begin to see problems as interesting challenges" (p. vii). The teachers in the second through fifth grade were given the opportunity to provide such an atmosphere. They each received The Problem Solver Program, a three-ring notebook binder containing the teacher's guide and several pages of practice process problems. It was now up to them to meet the challenge.

Sequential Ordering Group

Forty-three percent (29) of the teachers who participated in this study fell into the sequential ordering group. Two of these teachers were selected for in-depth study to gain insight into how they implemented The Problem Solver Program. The teachers were randomly but purposefully selected because of the high degree of sequentialness reflected in their scores on the Gregorc Style Delineator.

Susan Edwards (S-up) has taught elementary grades for twenty-two years, the last fifteen for the York County School Division. When asked to participate in the study, she responded with a tone of indifference, "Well, okay." Sensing that Edwards might be concerned about the interviews and observations, the researcher reassured her that the findings would be strictly confidential as to

teacher and school. The observation of The Problem Solver lesson took place two weeks later.

Although the observer arrived a few minutes early, the lesson was already in progress. The observer's first impression of the classroom was that of a highly organized learning environment. Papers and books were neatly arranged on shelves and desks. The students' backpacks and supplies were stored out of the way by the back wall. Colorful bulletin boards reflected current student work in science and art. However, there was no evidence of students' mathematics work. The Problem Solver Strategies Chart listing the ten strategies was taped to the wall next to the front chalkboard. Twenty-four students were seated in desks grouped by fours and arranged so that two students faced two other students. The atmosphere of the classroom was reflected in the interactions of the teacher with the students as they worked one of the problems using the make it simpler strategy. The make it simpler strategy is used to make complex problems easier to solve by reducing either large numbers or the number of items given in a problem. The simpler representation of the problem may reveal a pattern that can be used to solve the problem (Moretti et al., 1987). Edwards's teaching style and management concerns with The Problem Solver Program are clearly evident in the following transcription:

> Teacher: If we can figure out a pattern we'll be all right. Thirty-one. What an odd number, but we'll solve it. [Observer's note: The students are talking among themselves.]
>
> Student: Just guess something.

Teacher: No, we're not going to just guess something. Is that problem solving? Okay, we'll leave it there and go on to the next one.

Student: You said this one was just a little bit harder than that one.

Teacher: Well, you're right, but let's go on to 71. Would you read it for us Jake. [Observer's note: It is about placing chairs around tables.]

Teacher: Remember that your first strategy is to figure out what your question is. Look at your question again. How many tables are they going to set up in a row? How many chairs on each side of the table?

Teacher: Okay, let's look at 71. You're doing it in the wrong place. Don't draw all 8 tables. Is that the way we discussed the strategy?

Student [talking to himself]: Well, you could.

Teacher: How many tables do you need to draw? About 2 or 3 to get the pattern. Once you've figured out the pattern, like what Diane is doing, figure it out from the list. First of all figure out how many people can fit at 1 table. Then write 1 equals. You and Travis are doing the wrong thing. We are using the strategy make it simple.

Student: But could you do it?

Teacher: No. It is not the strategy we are learning. Hey, everybody, you're not supposed to be drawing all 8 tables.

Student: But I already did.

Teacher: I want you to erase it. You need to make a list of information in a list. [Observer's note: Students are getting noisy.] One table. Nine people do not sit at 1 table. Nine is not correct. [Observer's note: Students begin to discuss ideas in their groups.]

Student: What if we get it wrong? Three and 3, that's 6.

Teacher: Nine is not right. Shh! [Observer's note: There is a lot of confusion among the students as to what to do.]

Teacher: Looks like we made a mistake at the very beginning by not having one table.

Teacher: Erase that third table. That goes on the side. Erase all of it. How many can sit at 1 table? Erase all of this. You have it wrong. Your mistake in your strategy was that you all started drawing a bunch of tables. That is not what we learned. The first thing you always do is draw 1 table. How many can sit at 1 table? One equals 12. Now draw a second table. Did I ask you anything? Terease, how many at 2 tables? Not 21. Eighteen can sit at the tables. You need to count. What about the people on the end? You're counting wrong. You don't squish them, Mike. Now have you answered the question? [Observer's note: The children are trying to copy each other and asking if they have the correct answer.]

Teacher: These people are done because they answered the question. It is not answered until you write the answer down. Three tables is not 26. [Observer's note: The students give a variety of answers.]

Teacher: What happens with a lot of people is they do the list and at the end--they just quit. They find a number but don't answer the question. This is not correct. You added wrong. Tom, sit down and answer the question. We have to stop now and get ready for art.

As the observer was leaving, Edwards remarked, "This is not a typical day. This is the absolutely worst they have ever behaved. It's one of those days I guess."

Several of the interactions in the lesson suggest that when the teacher does not understand the problem-solving strategies, she is unable to serve as either a cognitive mediator or an affective motivator. For instance, Edwards's insistence that the students follow her directions denied them the opportunity to explore and share their thinking, thereby suggesting that she does not feel confident enough to consider alternative strategies that they might propose--strategies other than the

one provided in the teacher's guide. This incident indicates that she is unaware of cognitive mediating, a teaching strategy that is central to active teaching. Furthermore, Edwards's frustration with the students' confusion caused her to respond negatively to their efforts--"Erase, start over," and "That's wrong." Such responses are incompatible with the role of the teacher as an affective motivator, that is, someone who responds to students in ways that show support, encouragement, and acceptance of them as problem solvers. The role of the teacher as a facilitator was not realized. Rather Edwards's performance exemplified the role of the authoritarian usually associated with the passive teaching approach used with applied problem-solving instruction. The lesson was directed by the teacher's questions, most of which she asked and answered herself. She appeared to be unaware that students need engagement time to discover mathematical relationships for themselves. Although the students were allowed to converse in their groups, none of them left their seats to get manipulatives or to talk to students in other groups. The teaching style observed during this lesson was incompatible with the suggestions made by the program authors and the National Council of Teachers of Mathematics. The lesson demonstrated that a problem-solving atmosphere is not created when process-problem instruction is used with traditional or passive teaching.

Edwards (S-up) appraised the lesson by how inefficiently the students solved the problem and on their behavior which, in fact, was understandable given their state of confusion about how to use the strategy. During the interviews, Edwards expressed her frustration with the program and the lack of time to use

it. She had many manipulatives, such as counting tiles, chips, beans, and so on that she had collected over the years; however, she was unfamiliar with the manipulatives supplied with the new mathematics curriculum. Pointing to the resource box, she said, "I guess they are there, but I don't have time to figure out how to use them."

When asked her opinion on the staff development provided on The Problem Solver Program she replied:

> They [math facilitator and lead math teacher] need to show me how to use the program for my grade level step by step--not generic-stuff staff development. I want to know what pertains to me. Show us [the teachers] problem by problem. Don't just give us the answers, show us.

In an open-ended interview she shared that she felt strongly that "Brain Teasers" should be reserved for the middle school. "We are still teaching the basics. We are trying to master many different areas in math. To me, it [The Problem Solver Program] is an extended activity."

When asked if she believed The Problem Solver Program shared a common philosophical base with the whole language philosophy, she replied, "No" during two interviews separated by several months.

Edwards's (S-up) style of teaching was reflected in the teacher style traits of Concrete/Sequential teachers who, as Butler (1987) has pointed out, "rely on traditional procedures and patterns; expect the class to be teacher-directed; tend not to change prepared lesson plans" and "run an orderly classroom; finish work on time, and do not look for change without cause" (p. 70).

The management level of concern indicated by Edwards on the Stages of Concern Questionnaire was apparent during the lesson. The fall and spring Stages of Concern Questionnaire data showed high intensity management concerns and a refocusing of attention to other matters, all of which were collaborated in the interviews.

Butler's description of the Concrete/Sequential (CS) teachers aptly summarizes Edwards's (S-up) teaching technique:

> CS teachers like learning to fall on target the first time around, and want students to correct their mistakes promptly and move on. They have a tendency to apply rather than discuss, to see detail rather than generalize, to work at a steady pace from one stage to the next, and to require right answers rather than favor process outcomes (p. 72).

Frances Morgan (S-pr), the other sequential teacher studied, has taught in the same school in the York County School Division for twenty years. When asked if she would be willing to participate in the study she said, "Oh, sure, just let me know when someone is coming so I can be ready." She seemed pleased to be asked but said, "I don't know if you will see what you're looking for." The observer witnessed a Problem Solver Program lesson in her classroom a few days later. The following observations reflect a sequential orientation to teaching and management concerns in using The Problem Solver Program.

The children were working on a Problem Solver Program worksheet when the observer arrived. The observer noted that the bulletin board displays looked rather tired, as though they had been unchanged for some time. Piles of books and papers were spread on the counters and table tops. Even the teacher's desk was covered with papers--test papers, teacher magazines, and office memoranda.

There was little student work visible on the walls and counters and nothing to indicate work in mathematics. The Problem Solver Strategies Chart was attached to the bulletin board at the front of the room. Twenty-two students were sitting in traditional classroom rows. The following transcription is illustrative of her approach to teaching.

> Teacher: We had 48 legs to start off, right? It is right on the sheet. We had 2 equal groups. That's why we divided by 2, right? When we divided by 2 into 48 and we had 24. Then they gave us some clues. They said the tree had 6 legs so we had to think of a number that can go into what? [Response was not recorded on the tape.]
>
> Teacher: Yes, that's how we got it. There is no other way to do it.
>
> Student: Will we get credit for this?
>
> Teacher: We'll have these problems on a test and you need to know how to figure them out, right?
>
> Teacher: Let's look at the next one. It gives you a hint. They said the little critter had 6 legs. You've got to think how many times 6 can go into 24. The other little critter had 8 legs. So, we had to divide 8 into 24. And I was just showing you that division is the opposite of times.

Morgan (S-pr) continued to ask the students questions to guide them in matching the animals in the problem to the correct locations. She cautioned one student, "You have to make a wise choice. Sometimes your friend's choice is not always the best choice." [observer's note: Many students call out the answer to the next question.]

> Teacher: Why did you choose that one?
>
> Student: Because the others don't have the bird in them.
>
> Teacher: By the process of elimination; that's right.

Student: Do we have to turn these in?

Teacher: No one asked you anything. And you don't know if it's right. Go back and check over it. I'm not going to tell you. Figure it out for yourself, if you think you know how to do it.

Morgan (S-pr) then read off the answers and the students checked to see if their matching was correct.

The teacher expressed mixed feelings as to the value of The Problem Solver Program. She sees the program as a way to develop higher level thinking skills for the average and high ability students; however, she believes that the low achievers "don't have a clue" when it comes to using the strategies to solve the problems.

Morgan admitted that she has trouble using the strategies herself. Interestingly, while she noted that a major difficulty with The Problem Solver Program is that some of her students are unable to read the words in the process problems, she shared how she is able to work around that barrier: "Reading is a big problem. I group some students according to need, that is, reading comprehension. Sometimes when one child explains it, the other child gets it better than when I try to explain it."

Although Morgan (S-pr) feels manipulatives help students in counting, she did not discuss other uses for them. She did express pleasure at having "finally gotten some manipulatives." While no manipulatives were in evidence on the counters or open shelves, she commented that some of the staff development on problem solving which involved using manipulatives was interesting. "I like to get new ideas to try out; it keeps the lessons from getting so boring."

She expressed frustration in not having time to really understand the strategies before she actually started using the program. "Sometimes it is hard for me to figure out," she commented, "but you always have that shining star you can send to the board. Some of the problems they can work out but others you have to tell them how [to work out] because the information given is so confusing."

Further, she stated that she feels, "pulled in so many directions." As an aside to the observer she mentioned that she has seen so many new things come and go that it doesn't pay to take it [The Problem Solver Program] too seriously. Morgan (S-pr) felt that process-word problems have a place in the curriculum but that "only time will tell if the school system will continue to emphasize their use." She concluded one interview with the remark, "In the past, a new curriculum concept would quietly be set aside after a year or two and other curriculum areas would receive the attention." In summary, Morgan (S-pr) evaluated the program in terms of students' ability to use it, the conditional status placed on all new curriculum programs by the administrators, and by how it fits with what she felt students need to learn.

While a problem-solving atmosphere was not realized in Morgan's classroom, she did understand the problem strategy; and the students were able to use it following her instructions. Like Edwards (S-up), Morgan (S-pr) appeared to be unaware that students need engagement time to interact socially and intellectually with the other students. There was no evidence in her questioning or responses that higher level thinking skills were probed or that students were motivated by the way she interacted with them. During one of the interviews she

stated that she saw little difference in how she teaches process problems from the way she teaches traditional word problems. This perception was supported during the lesson observations and in the interviews.

When asked if she believed that The Problem Solver Program and the whole language philosophy shared a common base, Morgan (S-pr), referring to The Problem Solver Program, stated, "No, it's different all by itself." But at a later interview she said, "Yes, they both use varied experiences and different situations."

Morgan is an Abstract/Sequential teacher, a member of a learning style group that is characterized, according to Butler (1987) by the following teaching traits: a desire for "consistent and reliable rules and procedures," a preference for traditional classrooms; and a need for "time to think through ideas, organize materials, and plan approaches" (p. 78).

On the fall and spring Stages of Concern Questionnaires, both Edwards (S-up) and Morgan (S-pr) marked two of the questions as being of great concern: Number 8 (I am concerned about conflict between my interests and my responsibilities) and Number 16 (I am concerned about my inability to manage all The Problem Solver Program requires). Also, they both indicated that they would like staff development specific to their grade level but felt that their use of the program was adequate. The Stages of Concern instrument indicated that management concerns remained high for both teachers over the course of the year and that they were refocusing their concerns to other matters.

Random Ordering Group

Thirty-seven percent (25) of the teachers who participated in this study represent the random ordering group. Interestingly, one of the two teachers selected for study from this ordering group appears to be successfully implementing The Problem Solving Program while the other teacher remains at the management level of concern. A high degree of randomness was reflected in the scores of both teachers on the Gregorc Style Delineator.

Glenda Feldman (R-up) has taught elementary school for seventeen years, the last four in the York County School Division. She enthusiastically welcomed the chance to share her teaching of The Problem Solver Program with the researcher. " Come any day," she said and proceeded to set a date for the observation to take place the following week.

The observer was a few minutes late in arriving at Feldman's room. Although the room was darkened because the over-head projector was in use, piles of books, papers, and magazines, all in great disarray, appeared to cover every available surface. Feldman (R-up), with a sweeping arm gesture, welcomed the observer with a warm, "This is the way it is!" The students were seated in three horizontal rows with six students in each row.

The teacher stated in an interview that her main focus is to make problem solving fun as she thoroughly enjoys working on problems and feels that "in order to hold the students' interest, you have to entertain them."

Student: If we figure out a pattern, we'll be all right.

Teacher: Okay, we have five boys and five dogs. We need to find out who belongs where.

She called on different students to provide clues given in the problem and wrote them on the overhead which appeared as a chart on the blackboard that the students had copied and were filling in. "Now don't be too quick about this." She asked if there is any more information and used the students' responses to mark the chart. The students were enthusiastically looking for the clues and could be heard conferring with students on either side of them.

Teacher: We still haven't figured out what kind of dog is what, only who owns the dogs. Okay, let's try this again.

Feldman (R-up) modeled thinking aloud when she said, "This is where you go back to the beginning again and try to figure it out." She continued to muse aloud, "Eric does not own...." Students offered suggestions: "Ralph does not own a terrier. So that means Rover cannot be Bower. Spot cannot be.... Let's put down that Bernard goes with Spot." [Observer's note: One of the students explains his thinking to the teacher.]

> Teacher: Oh, I understand. Because Eric is not, Rover cannot...so we know Fido cannot be a poodle. Let's back up. That left one square open because it had one circle. We haven't done Rover yet.[Observer's note: The students are offering her their explanations which she listens to intently.]

> Teacher: Is that how you do it? Wait a minute, Kevin show us how you did it. Oh, Why can't Bob be a spaniel?

Everyone was working on the solution together. They were treating each other like fellow problem solvers. The teacher was clearly not the font of knowledge.

A problem-solving atmosphere was created as the students were thoroughly engaged in thinking through which dog belonged to which master and marking

it on the charts in their notebooks. The teacher was caught up in the excitement and asked a student, "Where did you get that idea?" The students and the teacher became peers in the quest for the solution. Suddenly there was a change in the discourse when Feldman announced excitedly, "This is where I told you I got mixed up. Now Eric owns Rover. Wait a minute, back off."

The general impression obtained from the audio-taped lesson and the observer's notes was that these students have worked with problem solving before and enjoy the lessons. The teacher appeared to be more involved with the problem solving than some of the students. For instance, "This is where I told you I got mixed up. Now Eric owns Rover. Wait a minute, back off." Nevertheless, Feldman's enthusiasm was contagious.

With the lights turned on, the observer was able to see The Problem Solver Strategies Chart taped to the front wall and several graphs depicting the number of casualties on both sides during the Civil War. The students had constructed original line drawings using coordinates they had worked out. These covered a large section of one wall. There were three "guesstimate" jars on the bookshelf. A bar graph showed who was in the lead in home reading. Of the 6 classrooms visited, this one proved to be the most mathematically oriented.

Feldman (R-up) stated that she spends 33% of her mathematics time using The Problem Solver Program and feels its strength lies in the refocusing of the work through the suggested strategies. She sees the effect of the program as increasing the students' awareness that "problems are more than computation and they help them think."

The Stages of Concern Questionnaires indicate that she was at a stage 4 level of use in the fall and progressed to the stage 5 or collaboration level in the spring. She rated question Number 24 the highest of the 35 questions: (I would like to excite my students about their part in this approach.) The observations and interviews indicate that she creates a problem-solving atmosphere out of her total involvement with the process problems.

Feldman said that she believed The Problem Solver Program to be a discovery approach and that she has always taught that way. She does feel that there is more interaction of the students with process problems than with the story problems used previously.

The Concrete/Random teaching style described by Butler (1987) was apparent in Feldman's lesson:

> Concrete/Randoms learn by experience. Such learners like to frame out the whole picture, then let others fill in the details. As a result, teachers of this style tend to provide materials and techniques that encourage students to consider broad implications and applications. CR teachers like to generate many different interpretations and outcomes, and regard the process of learning as more valuable than the final product. (p. 98).

When asked if she thought The Problem Solver Program shared a common philosophical base with the whole language approach, Feldman (R-up) replied at the first interview:

> No, problem solving is a discovery approach. The main focus for me is to get kids thinking and not give up. There is no right answer. In whole language there is discovery, but I don't see where it gets people to think. I think whole language will be gone in ten years but not problem solving.

Several months later she responded to the same question: "Yes, both [philosophies] emphasize process and the love of learning and how to learn."

Mary Ann Bostich (R-pr) has taught in the York County School Division for 11 of her 15 years of teaching. She indicated two learning style preferences on the Gregorc style delineator: Abstract/Random and Concrete/Random. Unlike Feldman (R-up), Bostich (R-pr) is having difficulty managing the program, the difficulty having shown up in the fall and spring Stages of Concern Questionnaire data and in the classroom observation and interview data.

She said an observer was welcome to watch her teach a Problem Solver Program lesson but that she only used The Problem Solver Program about once every two weeks or so. She spoke freely of her use of the program once she was assured that her identity would remain anonymous. A Problem Solver Program observation time was set for the following week.

Bostich's (R-pr) classroom conveyed a sense of fun and activity. Students' social studies and art projects covered the walls, counters, and much of the floor space. Rich colors and textures abounded. Books and papers appeared to be randomly spread around the projects. Shortly after the observer arrived, Bostich distributed little wooden cubes to help the children understand a make it simpler problem. The teacher directed the students to count the sides of one of the cubes.

> Students: I don't think this is fair. [Observer's note: Some students have more blocks than other students.] I don't understand this.
>
> Teacher: I drew one on the board to show you. Someone said their cube had 4 sides. Your wooden cube has 3 dimensions. It

has width and height and depth. Now the important thing is not knowing how to draw it.

Teacher: Quit talking. I'm going to count to 3, and then I want to get this class back. Keep your little blocks together. Each block has how many sides?

Student: Six.

Teacher: It has your regular 4 sides plus a top and a bottom. All right. Look at your problem. Let's read it. This is one of the strategies we are going to use to work one of the problems. At the end of the grading period you know how we have the test and they always have the tricky couple of problems at the end. Read it, Deanna.

Student: Ron and Rebecca Robot worked in a factory. Ron produced six blocks together in a row on a table and Rebecca sprayed paint on the blocks. Every block has six sides. The sides that touch the table or sides of the blocks don't get painted. How many sides of the blocks in a row get painted?

Teacher: That was a long story problem, wasn't it? Did you all read along with her and keep up? Were you thinking about it? Let me ask you a few questions. What is the question you have to answer here? The last sentence there. What is the question, Marie?

Student: How many blocks are in a row?

Teacher: No, it's the last sentence in the paragraph. Clinton, you're not looking either. I need to see your hand if you want to answer. Clinton, let's hear it.

Student: How many sides of the blocks in a row get painted?

[Observer's note: The teacher held up a row of blocks and pointed to the sides that would be painted. She elicited answers from the students that indicated that the bottom of the row of blocks and the touching sides would not be painted.]

Teacher: Now, how are we going to find out how many sides are to be painted?

Students: Eighteen! Twenty! Seven!

Teacher: Wait a second. Don't be shouting out the answers. I want to have a system for getting to this answer. How many blocks are in each row? You know there are 6. Are the blocks touching or not touching?

Students: Touching.

That Bostich (R-pr) did not understand the strategy was evident when she said, "All right. At the top of your page here, one of the skills they want me to help you learn is make it simpler. I thought I could make it simpler by letting you see this; then you can see what we are doing."

[Observer's note: Students are noisy--playing with blocks and not paying attention.] She told them to start with 1 block and then 2 to figure out the problem before working with all 6 blocks.

She gave the following directions: "Use the back of this paper. You may not consult in groups. I want you to work by yourself. Show me the answers."

The students started shouting out widely divergent answers. Finally, Bostich (R-pr) said, "Some of you may find a way to multiply." Several students started calling out that they didn't get it. Bostich became very agitated and said, "I want an answer. You're going to get a grade on this. I mean if this was on a math test. Put the answer down. I will come around and look at your work."

Student: I got it. I got it.

The student did have the correct answer and was able to tell the other students how he worked it out. The lesson time was almost over when Bostich remarked to the class, "Some of you are acting like you're defeated before you try,

and I thought you'd think this was fun." Two more students showed how they figured out the problem by adding the number of sides.

> Teacher: Who knows a short-cut for addition that we could have used?
>
> Student: Divide.
>
> Teacher: Are you listening up here? You know the reason you don't understand is, you're not tuned in. You would rather play with those blocks than think about them.
>
> Teacher: I need you to look up here as you obviously don't understand this. Look at how Matthew did his. Matthew thinks differently. He knew he had five fours. On second thought, I don't want to confuse us any more. Let me see what you did wrong. Turn your papers in and line up for music.

The observation data reflected the teacher's management concerns with The Problem Solver Program and provided insight into why she uses the program infrequently and only when she "feels in the mood to teach it." While the atmosphere of the classroom stimulated the visual senses and aroused the interest of the observer, the lesson was reminiscent of the traditional work-on-your-own type utilized with the traditional-word problems. The critical incidents in this part of the narrative reflected the frustrations of a teacher who values process problem instruction and realizes she is inadequately implementing the program.

When asked if she thought the program had any particular strengths or weakness, she responded:

> I need it and I think it is important. I wish I had been taught to think like that 'cause it helps me as an adult, and I look back and say, Hey, that is kind of a neat way to approach it. Just from more than one angle or this is how you do it.

Concerning weaknesses of the program, she replied:

> I don't think there is any weaknesses. I just think it is one additional thing to do if you feel like it. You've got to feel like it's an extra, but we shouldn't treat it like an extra. It's an extra thing to do. You feel responsible to do it.

When asked whether she felt The Problem Solver Program shared a common philosophy with whole language, Bostich (R-pr) answered, "Maybe, they [the philosophies] are going toward the same direction," while earlier she had stated that she did not think they shared a similar philosophy.

When asked if she ever discusses the program with other teachers, she said:

> I tell them I wish I had more time. That's really what I need, more time to handle things. But that's been since the beginning of time, and I'm not going to get more time--so it's one of those things.

Butler's (1987) Concrete/Random classroom description aptly describes Bostich's (R-pr) room which was rich in color and full of all kinds of things pertaining to thematic units. Butler notes that, under stress, "the Abstract/Random teacher may turn flexibility into chaos, and compensate by overstructuring time and tasks" (p. 91). This flexibility-into-chaos appeared to be the case in the observed lesson. Bostich's statement that, "I teach The Problem Solver Program as individual work to my students" was supported by the classroom observation data in which the students were directed not to talk among themselves.

Bostich related that much of her instruction in other curriculum areas utilizes groups of children to work on projects together and that she is always on the lookout for interesting places to take them on field trips. Moreover, she stated that

she likes to be involved with her students in most of the learning which takes place in her classroom.

Surprisingly, Bostich (R-pr) seemed unaware that students should be working in groups as they learn and apply the strategies. This lack of awareness, combined with her lack of understanding of the strategy used in the lesson, hindered the creation of a problem-solving atmosphere. Six months later, in passing, she mentioned to the researcher that she doesn't use the program any more at all but instead uses only the problem-a-day notebook provided with the new mathematics textbooks.

Both Bostich (R-pr) and Feldman (R-up) represent the random ordering group. Feldman expressed a strong desire to attend mathematics workshops and to create new manipulatives while Bostich, who appeared to value process-problem instruction, expressed frustration with the time and effort necessary to be knowledgeable in the use of the strategies. Bostich (R-pr) rated question Number 24 (I would like to excite my students about their part in this approach.) as of high concern. Both teachers rated question Number 20 highly (I would like to know what other faculty are doing in this area.).

Mixed Ordering Group

Nineteen percent (13) of the teachers who participated in this study represent the mixed ordering group. Cathy Proctor (M-pr) has taught in the York County School Division for the last two of her twelve years of teaching. She agreed to participate in the study and set a Problem Solver Program observation date for later in the week that she was asked.

Proctor has two learning style strengths: Concrete/Sequential and Abstract/Random. Of interest in this part of the narrative is, Which of the two strengths is reflected in her teaching style? Given the nature of The Problem Solver Program and the bi-polar learning styles she possesses, the researcher was unsure of what to expect.

When the observer arrived at her classroom, Proctor (M-pr) was telling the students to clear their desks in preparation for their math lesson. While there was no sign of student mathematics work, projects from the current science unit filled the counters and bulletin boards. Books and papers were neatly piled on desks and shelving, giving the room a tidy appearance. The Problem Solver Strategies Chart was stapled to a bulletin board at the front of the room. Several cardboard boxes were clearly marked as to the type of mathematics manipulatives they contained: beans, tiles, straws, sticks, dice, rods, and squares. These boxes were open and looked easily accessible to the students.

Twenty-six students sat in groups of four or five desks. Proctor (M-pr) began the lesson by having the students read the problem on a Problem Solver Program sheet to themselves. The following transcription portrays the classroom scene as it presented itself to the observer.

> Teacher: Are you ready? How many animals did they look at altogether? What do you suppose could be a way we could solve this problem?
>
> Student: Add.
>
> Teacher: Okay, how many people agree with Jay? [Four students raise their hands.] Well, good guess but not right.

Teacher: Starting at the end of the problem and working your way through. Now we know we have how many of what animal?

Student: puppies

Teacher: Okay, we know we have puppies. How many do we have?

Student: Thirty-six.

Teacher: We know we have 36 puppies. Now with that information we can work our way back. Now read the sentence right here.How are we going to figure out how many kittens there are?

Student: Thirty-six divided by 3.

Teacher: Okay, and how many kittens would we have for the problem? Think very carefully.

Student: Three into 36.

Teacher: Three into 3 on the top and 3 into 6 on the top. So how many kittens do we have? [Class says 12.]

Teacher: All right, we figured out kittens and now we're ready to move up to the next one. It says there are half as many kittens as birds. Mike, what are we going to do?

Student: Take half of it. Half of 12 would be 6, okay.

Proctor (M-pr) wrote all the information on the board during the discussion. The lesson moved along in the same manner. The teacher told the students they have to put all the numbers in a straight line and add them altogether. She assigned a new problem in which all group members were to discuss how they would solve the problem. She said, "Discuss what strategies you would use for this one." Then, in an aside to the observer, "I am not a problem solver but I'm better than last year." The students freely shared their ideas and challenged each others' answers. The observation time ended while the students were still working.

Proctor's sequential strength was more evident than her random strength during the lesson. Although she did encourage group discussion, her role was more of a director than a facilitator. While it appeared that manipulatives might have added interest and clarity to the lesson, they were not used. The Concrete/Sequential traits used to describe Edwards (S-up) appear to describe the teaching style demonstrated in this lesson also.

The Stages of Concern Questionnaires for the fall and spring indicate that Proctor (M-pr) is at the management stage 3 level. The spring data show an increased intensity of concern at this stage and a refocusing of interest to other matters. Several comments made by Proctor support these findings. She stated that she is using the program for about 20% of her total mathematics time, which she equated to one problem every day for ten minutes. She believed her use of The Problem Solver Program steps is going along satisfactorily but not the strategies. She finds the make it simpler strategy difficult and mentioned that it was only a fluke that she was able to figure out one of the problems using it. She did note, however, that she uses the making a table strategy in other curricula areas such as reading. When asked what she focused on in her lessons, she jokingly remarked, "Getting them to get the right answer to pass the test." Then she said, "No particular thing, just to follow the strategy. When you're teaching the strategy, that is what you do."

She definitely viewed process-problem instruction as different from the traditional story problems: "These are extra. I don't have time to do it." and "The slow kids could spend days and not get it." She added that there was some value

to The Problem Solver Program: "The group work seems to reduce the dread of problem solving that they have when they have to do it on their own." Also, "Some [of the students] seem to learn from each other. I can see the light bulb go off when they use the strategies."

Proctor (M-pr) did not think that The Problem Solver Program shared a similar philosophical base with whole language. She responded negatively to the question during two interviews held several months apart.

Patricia Sullivan (M-up) has taught in the York County School Division for four of her seven years of teaching. When the researcher asked her to participate in the study, she said, "Oh, dear, I hate to be tape-recorded." Nevertheless she agreed to a Problem Solver Program lesson observation for the following week. Sullivan (M-up) shares a similar learning style with Proctor (M-pr), Concrete/Sequential and Abstract/Random. While both favor highly structured lessons, Sullivan stated that she feels duty-bound to teach practically every single problem in the book and more besides. She mentioned that she attends every available conference and spends much of her own money to buy and make manipulatives. That observation supported her commitment to using the program and her enthusiasm for her students and their work.

The observer arrived at Sullivan's classroom just before the start of the lesson. Several colorful bulletin boards reflected the current thematic unit: whales. Numerous library books on whales were displayed on a table. Several graphs comparing the lengths of various kinds of whales and their migration patterns

covered one large bulletin board. Large plastic boxes containing numerous manipulatives, all clearly marked, were neatly arranged on a large table.

> Teacher: Ladies and gentlemen we are getting ready to do a problem-solving activity. Get everything else off your desk. Thank you. We are going to review a problem-solving skill we had earlier. You had lots of fun with it and I feel like you will again today.

For the first few minutes the teacher reminded them of how they worked on a similar problem in which they drew a diagram. They were to work with their math buddies on a new problem. She allowed them several minutes to read and discuss the problem. The room was buzzing with students deep in thought. Sullivan (M-up) asked if every group was about done.

> Teacher: Thumbs up. I would like someone to share how he did the problem and came up with the solution. [Observer's note: A student steps forward and draws his diagram on the board. The students compare it with their diagrams. Some of the students nod their heads in agreement.] Did any group come up with more than one solution? [Observer's note: One group had four solutions.]

> Teacher: I am especially pleased, Nathan, that people in your group double-checked with the information.

At the end of the lesson, she said, "Thumbs up if you think this class did a great job. I agree."

In summary, there was very little teacher direction; the students engaged themselves in the problem-solving process within the behavior and academic structure she had established in her room. The general impression noted by the observer was that Sullivan (M-up) understood the strategies, used lots of encouragement, and expected good behavior. Her enthusiasm for The Problem

Solver Program was expressed in her answer to the question, Do you think this is a worthwhile program? She replied:

> To me it is. I was a poor math student in school. Had they taught me to draw diagrams and manipulate objects, guess and check, I know I would have been a more competent math student; so naturally I'm hoping my students will benefit from it, too. Research keeps telling us problem solving is what we need to make sure the kids can do; but I'm old school [enough] that I'm working on computation, too, which is stress--trying to do it all.

Sullivan (M-up) stated that staff development affects her use of manipulatives. "And more than staff development, particularly Susan Lusk's (math facilitator for the school division) workshops are wonderful. She tries to encourage us to bring in things to share that are problem solving. Very, very good." Sullivan noted that if she feels weak in a particular strategy, she would be less enthusiastic. "I'm afraid to try it. That is why I am working so much on [getting] staff development." She responded positively to the new mathematics tests saying, "I think it's awesome that we get to give partial credit for the students' work even if the answer is not totally correct."

Sullivan was at the management stage 3 level in the fall and at the mechanical stage 4 level in the spring. She is thoroughly committed to using the program and continued to refine her use of it even though the school division had adopted a new mathematics series which contains process problems.

When asked whether she felt whether The Problem Solver Program shared a common philosophical base with whole language she replied:

> Yes, I do and it bothers me, really bothers me. I'm basing this on one child from last year who came in second quarter from a school that was totally whole-language based who was way behind what we are doing here.

At a later interview her initial response to the question was simply, "No." But then she said:

> I don't look at thematic units as a discovery type thing. They could be, but it depends largely on how the teacher organizes the thematic unit. She has literature and other subject areas. With The Problem Solver Program you are just doing thinking skills basically. There is some math involved but not a whole heck of a lot. It is mostly thinking skills in my opinion.

In summary, while Proctor (M-pr) and Sullivan (M-up) share learning style strengths, Sullivan appeared more likely to fully implement The Problem Solver Program than Proctor because she has made herself knowledgeable, believes that her students benefit significantly from the process-problem instruction, and is committed to using the program.

Learning Styles and Curriculum Philosophy

The final consideration of this study was validation of the hypothesis that when teachers' learning styles share a common philosophical base with curriculum, the likelihood of implementation is greatly increased.

The whole language approach advocates the use of only authentic experiences, such as writing letters and mailing them, as opposed to just practicing a letter-writing format. However, it shares some important philosophical elements with The Problem Solving Program in that it is based on the active learning that is at the core of constructivist philosophy. Instruction based on discovery approaches in science and social studies shares this common active learning element. What are the commonalties? There is the emphasis on the communication of ideas in classrooms in which developmentally appropriate activities serve as vehicles for children to use basic academic skills. Process-

problem strategies, like language rules, are the tools which students learn to use as they interact with one another and the teacher to solve problems. There is the student-centeredness of the learning environment in which students are encouraged to explore their own ideas as well as those of their peers. There is the emphasis on the joy of learning--the "Aha" experience--which is more likely to occur when teachers create learning situations that reward risk-taking. Lastly, there is the emphasis on teacher behaviors which reflect on her as a thinking mediator and as an affective motivator.

The teachers were asked if they thought The Problem Solver Program shared a common philosophy with the whole language approach to determine whether they would identify active teaching and active learning as common to both approaches. Of the six teachers queried on whether or not they felt The Problem Solver Program shared a similar base to whole language, only two teachers replied in the negative and maintained that view over a period of several months. Interestingly, three of the other four teachers replied, "No" during one interview and responded with a qualified "Yes" at a later interview. Only one teacher replied, "Yes" at the first interview and a qualified "No" at a later time. The major emphasis on integrating the curricula areas in county-wide staff development during the last year may have influenced the teachers to respond differently in the later interviews.

Findings

Three major findings emerged from this study which addressed how effective teachers with different learning styles are in implementing The Problem Solver Program. First, teachers' understanding of the steps and strategies of the program is of critical importance. Second, teachers' provision for social and cognitive interactions of students with each other and with the teacher is essential for the creation of a problem-solving atmosphere. And third, teachers' use of the traditional teaching style used in the instruction of traditional word-problems hinders the creation of a problem-solving atmosphere. Commitment to use the program evolved as a function of teacher involvement with it. Teachers who made extensive use of the program pointed out that their students really enjoyed and were successful in learning and using the process-problem strategies. This perception appeared to strengthen their belief that children can think at higher levels and solve problems given ample opportunity and guidance.

This chapter presented the quantitative and qualitative findings of the study. The quantitative data indicate that the random-ordering group teachers are implementing The Problem Solver Program more effectively than are the sequential or mixed-ordering group teachers. In addition, a comparison of the fall and spring Stages of Concern data shows that management concerns with The Problem Solver Program remained uppermost in the minds of teachers throughout the second year of the implementation. The data suggest that teachers continue to need support in order (a) to increase their understanding of the process-problem

strategies, (b) to realize the importance of creating a problem-solving atmosphere, and (c) to value process-problem instruction as a significant part of an active-learning mathematics curriculum. The quantitative data were presented in three tables. The data indicated the relationship between the learning style and ordering groups of teachers and their stages of The Problem Solver Program implementation.

The stages at which teachers are found have important implications for further implementation of The Problem Solver Program. On the one hand, teachers at stage 4 or higher are most likely to continue teaching process-problem solving and using additional resources along with The Problem Solver Program to increase student achievement. Moreover, level 4 teachers appear to value process-problem instruction over the more traditional word-problem instruction. In the implementation process, these teachers are at the impact level on student achievement, which suggests that their commitment to provide process-problem instruction is not solely dependent on administrative support for its continued use.

On the other hand, teachers at stage 3 or lower appear to be uncomfortable using the process-problem strategies. These teachers are at the management level in the implementation process and, in all likelihood (unless administrators place a renewed emphasis on process-problem instruction), will emphasize other areas of the mathematics curriculum, resulting in a minimum of process-problem instruction. It is at this juncture in the implementation process that administrative decisions must be made as to whether process-problem instruction is essential to the stakeholders--parents, teachers, students, and the local community.

Implications based on the findings of this study for the more global environment are discussed in the summary section of chapter 5.

The research data reported here have shown that the qualitative findings support the quantitative findings. The data analysis followed the set of procedures required for grounded theory research: open coding, axial coding, selective coding, and core category identification. Critical incidents were used to substantiate the findings presented in the implementation narrative of the six teachers. The utilization of these techniques provided the researcher with the theoretical sensitivity necessary to see and interpret the relationships between the main concepts in the study.

Analysis of the relationships between the categories resulted in identifiable patterns or themes, which were then interpreted in light of other research findings and the researcher's personal experiences. The data were revisited several times to ensure that the themes which emerged faithfully reflected the teachers' perceptions of The Problem Solver Program. The themes pointed to further analyses of the data which resulted in the validation and development of hypotheses which explain how teachers' learning styles impact on process-problem instruction. The findings were then discussed in terms of implications for further implementation of The Problem Solver Program.

Chapter 5 presents the themes and theories which emerged during and as a result of the research. Also discussed are the implications of the study for reform in education, along with suggestions for teachers, math facilitators and

administrators, and developers of process-problem programs. Suggestions for further research are included as well.

CHAPTER 5

Discussion, Summary, and Recommendations

There exists much confusion over the meaning, the value, and the place of active learning in the minds of many teachers. Active learning results from active teaching practices--for instance, discovery or hands-on approaches--which are designed to promote student engagement in problem solving in all curriculum areas. The constructivist philosophy that learning becomes meaningful as it is constructed by the student himself or herself supports the rationale for providing active learning experiences. A classroom setting that encourages students to think aloud, share, and challenge each other's ideas empowers students to become problem solvers. The leaders in the mathematics education reform efforts of the 1990s strongly endorse active teaching and learning practices by proclaiming that the schools must change to meet the needs of the student, not the student to meet the demands of the school. The challenge to administrators is to move the active teaching and learning reform forward.

Discussion

In the urban elementary and middle school, active teaching and learning are critical to the urban child's achievement. The most critical determinant in educational reform is the teacher. Each individual teacher's learning style impacts the philosophy behind how he or she teaches. The review of the literature suggested that how teachers learned when they were students strongly influences how they teach their own classes. This present study suggests that resistance to implementing The Problem Solver Program is a function of teachers' personal learning style. The idea that resistance to innovations is not born out of laziness or uncooperativeness but resides deep within an individual's personal learning style has significant implications for mathematics education reform. Moreover, in the urban school these implications must be considered. This insight underscores the importance of providing teachers with a substantive rationale for active teaching and learning. Only when teachers come to the full realization of how active teaching and learning affect student achievement will they become risk-takers and make the changes necessary for effective instruction. For the urban child, active teaching and learning become critical to his/her academic success.

The present mathematics education reform requires radical changes in curricula--both in content selection and teaching style. In the urban school, this curriculum and instructional reform must be coupled with an appropriate definitive model for the education of the urban child. While the major objective of research is to inform educational practice, a caveat should be heeded. Experienced

teachers have seen many innovations in curriculum come and go. Frequently what "research says" is greeted with skepticism among teachers who recall that research at one time or another advocated homogeneous and even individualized instruction, both of which emphasized the instruction of basic skills within a spiraling framework. Now teachers are asked to discard many traditional instructional methods in favor of such innovative practices as inclusion and whole class instruction. Furthermore, teachers are asked to embrace the whole language philosophy and similar philosophies supporting the discovery approach and stressing an integrated curriculum. Recalling that earlier practices also claimed to "meet the needs of the students," many teachers have come to question their own educational expertise and look to administrators for clarity on what constitutes good instructional practice. This is especially true for the education of the urban child.

The Case For Constructivist Classrooms (Brooks & Brooks, 1993) provides instruction on how to apply the active teaching and learning paradigm in the classroom setting. This is one of many recent resources available to educators that describe the practical application of constructivist theory. Teachers need to realize that although passive teaching served many students well in the past, the continuance of such instruction is incongruous with what society wants for today's youth, namely, the development of thinking skills to empower students to become problem-solvers. Process-problem solving instruction exemplifies the change in problem-solving instruction reflected across many levels of a conditional matrix. At the global level, improved problem-solving strategies are viewed as critical to

maintain competitiveness in the world marketplace. The United States, which has fallen behind many other countries in producing students with strong mathematical reasoning skills, is keenly aware that students from such countries are being offered lucrative American jobs. The ability to apply mathematical reasoning skills in the face of change is apparent as the military and related industries continue to downsize and job opportunities become more scarce. As the workplace--the urban centers in particular--changes for economic survival, a new generation of workers must be prepared to assume positions that demand creative and competent thinking skills not provided by traditional schooling. Until recently, many teachers of mathematics remained unaware or chose to ignore the suggestions for problem-solving instruction advocated by the National Council of Teachers of Mathematics since the early 1980s. National recognition of the need to improve problem-solving skills has created a renewed interest and commitment to this area of mathematics instruction.

As the nation is increasing overwhelmed with the problems of poverty and unemployment, it looks more fervently to the schools for help. Presidential and gubernatorial mandates to emphasize problem solving in mathematics have resulted in school divisions committed to changing classroom instruction particularly in the urban areas. At the building level, principals, math facilitators, and lead math teachers have joined forces to support teachers in their struggle to change teaching practices. Whether or not teachers create problem-solving atmospheres will depend largely on their commitment to using active teaching practices.

Summary

The investigation of the major research question resulted in the identification and study of five main areas germane to the role of the teacher as the creator of a problem-solving atmosphere. These are (a) knowledge of content (steps and strategies), (b) classroom structure (seating arrangement and availability of manipulatives), (c) communication (cognitive and affective) between students and the teacher, (d) beliefs of teachers about how students learn, and (e) the value placed on process-problem instruction by teachers.

The findings presented in chapter 4 suggest that the effectiveness of teachers in implementing The Problem Solver Program is based on the degree to which they create a problem-solving atmosphere in their classrooms. Moreover, the findings suggest that the random-style group of teachers implement the program more fully than the sequential or mixed-style groups of teachers. The implication from the findings is that teachers' success in implementing The Problem Solver Program is a function of their personal learning styles.

Although the researcher made no reference to the National Council of Teachers of Mathematics, nor to cooperative learning, learning styles, constructivism, alternative assessment, integrated curriculum, and facilitator to prevent biasing teachers' responses to questions asked in the focused and open-ended interviews, these are the current buzzwords in educational reform. The infrequent usage of this terminology by teachers to describe their teaching

practices may suggest that they do not view these concepts as central to their teaching. Active teaching, however, is expressed in these terms.

It was evident from the research that many of the teachers considered The Problem Solver Program to be an "add on," the importance of which they determined by the attention paid to it by school administrators. Accountability for teaching The Problem Solver Program both in terms of student achievement and expected teacher behavior was often viewed as conditional: An updated version of the program would be forthcoming or other programs would soon supersede it in importance. Teachers have learned not to expend too much time and effort in constructing materials that may soon become obsolete. The notion of continuous change as an essential part of educational reform is not yet recognized by many teachers.

Finally, the possibility exists that active teaching programs such as the process-problem implementations of the 1990s, like the ones of the 1980s, will go largely unimplemented unless administrators consider curricula innovations in terms of cognitive and affective effects on the teachers as well as the students. It appears that programs selected on the basis of how students are believed to learn best, without consideration of how teachers naturally teach, can be counterproductive. The most significant implication from this study is that active teaching and learning programs will only become institutionalized to the degree to which the concerns of the teachers are met. When teachers' lower level implementation concerns are left unresolved, further implementation is not realized.

Reform in education must look first to the teachers who are the primary change agents.

The following themes emerged during the study as the data were repeatedly compared and contrasted.

Themes

1. Teachers' competency in using the program was the critical factor in whether their instruction hindered or fostered the creation of a problem-solving atmosphere.

2. Sequential teachers evaluate their instruction and the worth of the program on the basis of whether or not the students stayed on task, paid attention, followed directions and obtained the correct answers.

3. Random teachers evaluate their instruction and worth of the program on the basis of whether or not the students understand the strategies and use creative thinking in applying them. The processes used to find solutions are valued more than the solutions.

4. Sequential and mixed teachers may provide for some social and intellectual involvement of students during process-problem solving; however, random teachers purposefully provide for such involvement.

5. Random teachers are more effective in implementing The Problem Solving Program than are teachers in the sequential or mixed ordering groups as a result of their commitment and total involvement in the program.

6. Random teachers perceive staff development on problem solving to be more beneficial than do sequential or mixed ordering group teachers.

7. Teachers' future implementation of The Problem Solver Program is likely to be based on their perception of its value for their students and by their perception of the importance placed on it by administrators.

A major goal of grounded theory research is the development of theories that explain phenomena. In this study, teachers' learning styles and the implementation of an active teaching curriculum, The Problem Solver Program, was investigated. The following theories evolved from the study.

Theories

1. Teachers in the random ordering group are more likely to create a problem-solving atmosphere because their teaching philosophy is congruent with the philosophy of process-problem instruction.

2. Teachers in the sequential ordering group are largely unaware of the disparity of their teaching style with how children construct knowledge. Therefore, they are unlikely to move toward more active teaching practices without supportive staff development.

3. Teachers in the mixed ordering group are more likely to create a problem-solving atmosphere than sequential ordering group teachers, provided they understand the process-problem strategies and the rationale for active teaching.

4. Staff development that is designed to meet the learning style needs of all teachers in process-problem instruction may increase the likelihood that teachers will more fully implement process-problem instruction in their classrooms.

An important consideration of this study was the validation of the hypothesis that when teachers' personal learning styles and program innovations share a similar philosophical base, the likelihood that the innovation will be implemented is greatly increased. The findings of this study indicate that The Problem Solver Program, which requires active teaching, shares many common characteristics displayed by teachers with random learning styles. Thus, it was more successfully implemented by those teachers than by the teachers in the sequential or mixed ordering groups.

The findings of this study suggest the following recommendations to educators and researchers.

Recommendations

Recommendations for Teachers

It is imperative that teachers give serious attention to the importance of learning styles: both their own and those of others. This study especially highlights the impact that teachers' personal learning styles have on classroom instruction, and teachers need to be aware of this fact. Increasing their knowledge of learning styles should also help them better understand the needs of colleagues and students whose learning styles differ from their own.

In addition to increasing their knowledge about learning styles, teachers would find it beneficial to explore the philosophy of constructivism. Constructivist theory undergirds and provides the rationale for many of the curriculum innovations that are being implemented as part of the reform of the 1990s. Thus, teachers should take every opportunity to understand constructivism and its application to their work as educators.

A third suggestion is that teachers be encouraged to utilize peer coaching in order to observe how the process-problem implementations are taking place. In this way, teachers can both share their successes (and difficulties) and gain valuable insights into the nature of a problem-solving atmosphere.

Recommendations for Mathematics Facilitators and Administrators

Those responsible for designing staff development programs must be encouraged to recognize that teachers' learning styles are likely to affect the rate and extent of program implementations. Therefore, staff development should be designed to meet the needs of teachers with different learning styles, especially those in the sequential and mixed ordering categories, to better insure that active learning programs will be implemented. At the same time, it is suggested that mathematics facilitators and administrators provide specific instruction on process-problem strategies for each grade level to aid teachers in their task.

Recommendations to the Developers of Process-Problem Programs

Three suggestions are offered that would increase the likelihood of student engagement with process problems and teacher use of process-problems instructions. First, process problems should be constructed within situational

contexts that are meaningful and relevant to students. Second, such process problems should yield strategy applications to real life situations. And third, the teacher's answer key should include all alternative strategies for solving each of the process problems in the program.

Recommended Questions for Future Research

It is hoped that the findings of this study will serve as a catalyst for future research. Among questions calling for further investigation are these:

1. How do teachers' learning styles impact on other curricula areas requiring active teaching?

2. How do teachers' learning styles affect team teaching of process-problem instruction?

3. What is the nature of engagement time during process-problem instruction?

4. How do teachers' learning styles affect their receptivity to staff development?

5. Is there a relationship between teachers' learning styles and the utilization of integrated curricula practices?

6. What are the effects of teachers' learning styles in team building of school faculty?

References

Allport, G. W. (1937). A psychological interpretation. New York: Holt.

Allport, G. W. (1961). Pattern and growth in personality. New York: Holt, Rinehart and Winston.

Bogdan, R., & Bilken, S. K. (1982). Qualitative research for education. Boston: Allyn & Bacon.

Brooks, J., & Brooks, M. (1993). The case for constructivist classrooms. Alexandria, VA: Association for Supervision and Curriculum Development.

Borg, W. R., & Gall, M. D. (1989). Educational research: An introduction (5th ed.). NY: Longman.

Brandt, R. (1990). On learning styles: A conversation with Pat Guild. Educational Leadership, 48(2), 10-13.

Brownell, W. A. (1942). Problem solving. In Psychology of learning, Forty-first yearbook of the national society for the study of education, Pt. 2, (pp. 415-443). Chicago: The Society.

Burgess, R. G. (Ed.). (1985). Strategies of educational research: Qualitative methods. Philadelphia: Falmer.

Butler, K. A. (1987). Learning and teaching style in theory and practice (2nd ed.). Columbia, CT: The Learner's Dimension.

Canfield, A. A., & Lafferty, J. C. (1970). Learning styles inventory. Detroit, MI: Humanics Media (Liberty Drawer).

Cobb, P., Wood, T., & Yackel, E. (1985). Curriculum and teacher development: Psychological and anthropological perspectives. In E. Fennema, T. Carpenter & S. Lamon (Eds.), Integrating research on teaching and learning mathematics. Madison: Wisconsin Center for Education Research.

Cohen, D. (1988). Teaching practice: Plus ca change...Issue Paper 88-3. East Lansing, MI: National Center for Research on Teacher Education, Michigan State University.

Combs, A. W. (1982). A personal approach to teaching: Beliefs that make a difference. Boston: Allyn and Bacon.

Copas, E. (1984). Critical requirements for cooperating teachers. Journal of Teacher Education, 25(6), 49-53.

Curry, L. (1990). A critique of the research on learning styles. Educational Leadership, 48(2), 50-56.

De Blanc, J. F. (1977). You can teach problem solving. Arithmetic Teacher, 25(2), 16-21.

Dewey, J. (1933). How we think: A restatement of the relation of reflective thinking to the educative process. Boston: Heath.

Diesing, P. (1971). Patterns of discovery in the social sciences. Chicago: Aldine.

Doyle, W., & Ponder, G. (1977). The practical ethic and teacher decision-making. Interchange, 8(3), 1-12.

Dunn, R. (1990). Rita Dunn answers questions of learning styles. Educational Leadership, 48(2), 15-18.

Dunn, R., & Dunn, K. (1978). Teaching students through their individual learning styles: A practical approach. Reston, VA: Reston Publishing.

Elmore, R. E., & Associates. (1991). Restructuring schools: The next generation of educational reform. San Francisco: Jossey-Bass.

Erickson, F., Florio, S., & Buschman, J. (1980). Field work in educational research. East Lansing, MI: State University, Institute for Research on Teaching (ED 196 882)

Fischer, B., & Fischer, L. (1979). Styles in teaching and learning. Educational Leadership, 36(4), 245-54.

French, R. L. (1975). Teaching strategies and learning processes. Educational Considerations, 3, 27-28.

Friedman, C. P., & Stritter, F. T. (1976, November). An empirical inventory comparing instructional preferences of medical and other professional students. Research in Medical Education Proceeding 15th Annual Conference (pp. 85-90) San Francisco.

Fulton, J. L. (1989). Complete guide to the cognitive process of instruction. Richmond, VA: Developmental Skills Institute.

Gephajart, W., Strother, D., & Duchett, W. (1980). On mixing and matching of teaching and learning styles. Practical Applications of Research. Bloomington, IN: Phi Delta Kappa.

Glaser, B., & Strauss, A. (1967). The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine.

Goodlad, J. (1984). A place called school. New York: McGraw-Hill.

Gregorc, A. (1979). Learning/teaching styles: Their nature and effects. In Student learning styles: Diagnosing and prescribing programs. Reston, VA: National Association of Secondary School Principals, 19-26.

Gregorc, A. (1982). An adult's guide to style. Columbia, CT: Gregorc Associates, Inc.

Gregorc, A. (1985a). Inside styles: Beyond the basics. Maynard, MA: Gabriel Systems.

Gregorc, A. (1985b). Learning style delineator: A self-assessment instrument for adults. Columbia, CT: Gregorc Associates, Inc.

Guild, P. O. B. (1980). Learning styles: Knowledge, issues and applications for classroom teachers. Dissertation Abstracts International, 41, 1033A. (University Microfilms No. 80-19, 462)

Hagberg, J. O., & Leider, R. J. (1978). The inventurers: Excursions in life and career renewal. Reading, PA: Addison-Wesley.

Hall, G. E., George, A. A., & Rutherford, W. L. (1979). Measuring stages of concern about the innovation: A manual for use of the SoC Questionnaire. (Report No. 3032). Austin: The University of Texas at Austin, Research and Development Center for Teacher Education. (ERIC document Reproduction No. ED 1473 42)

Hall, G. E., & Hord, S. M. (1987). Change in schools: Facilitating the process. NY: State University of New York Press, Albany.

Heck, S., Stiegelbauer, S. M., Hall, G. E., & Loucks, S. F. (1981). Measuring innovation configurations: procedures and applications. (Report No. 3108). Austin: The University of Texas at Austin, Research and Development Center for Teacher Education.

Hill, J. E. (1969). The educational sciences. Detroit: Oakland Community College.

Hord, S. M. (1987). Evaluating educational innovation. London: Croom Helm.

Hord, S. M., Rutherford, W. L., Huling-Austin, L., & Hall, G. E. (1987). Taking charge of change. Alexandria, VA: Association for Supervision and Curriculum Development.

Joyce, R. B., & Showers, B. (1982). The coaching of teaching Educational Leadership, 40(1), 4-10.

Kagan, J. (1965). Impulsive and reflective children: Significance of conceptual tempo. In J. Krumboltz (Ed.), Learning and the educational process. IL: Rand McNally.

Kamii, C. (1990). Constructivisim and beginning arithmetic. In T. J. Cooney and C. R. Hirsch (Eds.), Teaching and learning mathematics in the 1990s: 1990 Yearbook (NCTM) (pp. 22-30). Reston, VA: The Council.

Kirby, P. (1979). Cognitive style, learning style, and transfer skill acquisition. Columbus: The National Center for Research in Vocational Education.

Kolb, D. A. (1977). A learning style inventory: A self-description of preferred learning modes. Boston: McBer.

Kolb, D. A. (1983). Experiental learning: Experience as the source of learning and development. Englewood Cliffs, NY: Prentice-Hall.

Kuchinskas, G. (1979). Whose cognitive style makes the difference? Educational Leadership, 47(5) 269-271.

Laffey, M. A. (1983). The relationship among principal learning styles, teacher learning styles, and principal communication styles. Dissertation Abstracts International, 44, 3560A. (University Microfilms No.84-06, 214).

Lave,J., Smith, S., & Butler, M. (1988). Problem solving as an everyday practice. In R. I. Charles & E. A. Silver (Eds.), The teaching and assessing of mathematical problem solving (pp. 61-80). Reston, VA: National Council of Teachers of Mathematics.

Lester, F. K. Jr. (1988). Reflections about mathematical problem-solving research. In R. I. Charles & E. A. Silver (Eds.), The teaching and assessing of mathematical problem solving (pp. 115-124). Reston, VA: National Council of Teachers of Mathematics.

Lewis, M. E. (1988). Continuation of a curriculum innovation: Salient and alterable variables. Journal of Curriculum and Supervision, 4(1), 52-64.

Lincoln, Y. S., & Guba, E. G. (1985). Naturalistiac inquiry. Beverly Hills, CA: Sage.

Loucks, S. F, Newlove, B. W., & Hall, G. E. (1975). Measuring levels of use of the innovation: A manual for trainers, interviewers, and raters. (Report No. 3013). Austin: The University of Texas at Austin, Research and Development Center for Teacher Education.

MacNeil, R. D. (1980). The relationship of cognitive style and instructional style to the learning performance of undergraduate students. Journal of Educational Research, 73(6), 354-359.

Marshall, C. & Rossman, G. (1988). Designing qualitative research. Newbury Park, CA: Sage.

Marzano, R. (1992). Dimensions of learning. ASCD Mid-continent Regional Laboratory. No. 61192114.

McCarthy, B. (1986). The 4Mat System. Oak Brook, IL: Excel.

McDaniel, T. R. (1982). What's your P.W.: A quiz on improving instruction. Phi Delta Kappan, 63(7), 464-468.

Merriam, S. (1988). Case study research in education: A qualitative approach. San Francisco: Jossey-Bass.

Messick, S. (Ed.). (1976). Individuality in learning. San Francisco: Jossey-Bass.

Miles, M., & Huberman, A. (1984). Qualitative data analysis. Beverly Hills, CA: Sage.

Moretti, G., Stephens, M., Goodnow, J., & Hoogeboom, S. (1987). The Problem Solver 5. Palo Alto, CA: Creative Publications.

Myers, I. (1962). The Myers-Briggs type indicator. Princeton, NJ: Educatonal Testing Service.

National Assessment of Educational Progress. (1991). The state of mathematics achievement: NAEP's 1990 assessment of the nation and the trial assessment of the states (Report No. 21-ST-04). Washington, DC: U.S. Government Printing Office.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Washington, DC: U.S. Government Printing Office.

National Council of Teachers of Mathematics. (1980). An agenda for action. Reston, VA: The Council.

National Council of Teachers of Mathematics, Commission on Teaching Standards for School Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: The Council.

National Council of Teachers of Mathematics. (1991). Professional standards for teaching mathematics. Reston, VA: The Council.

O'Neil, J. (1990). Making sense of style. Educational Leadership, 48(2) 4-9.

Patton, M. Q. (1987). How to use qualitative methods in evaluation. Beverly Hills, CA: Sage.

Patton, M. Q. (1980). Qualitative evaluation methods. Beverly Hills, CA: Sage.

Pendarvis, E. D., Howley, A. (1988). Developmental teaching: A cognitive approach to improving student achievement (OERI Occasional Paper No. 27). WVA: AEL.

Polya, G. (1966). On teaching problem solving. In E. G. Begle (Ed.), The role of axiomatics and problem solving in mathematics (pp. 123-129). Boston: Ginn.

Polya, G. (1981). Mathematical discovery: On understanding, learning, and teaching problem solving. (Combined ed.). New York: Wiley.

Pressley, M. & Associates. (1990). Cognitive strategy instruction that really improves children's academic performance. Cambridge, MA: Brookline Books.

Ramirez, III, M., & Castaneda. (1974). Cultural democracy, bicognitive development, and education. NY: Academic Press.

Renzulli, J. S., & Smith, L. H. (1978). Learning styles inventory. Mansfield Center, CT: Creative Learning.

Renzulli, J. S., & Smith, L. H. (1981). A guidebook for developing individualized educational programs (IEP) for gifted and talented students. In M. Jende, & S. Chavez (Eds.), Teaching students through their preferred learning styles. (pp. 18-24). Dayton, OH: Montgomery County Office of Education.

Resnick, L. B. (1988). Treating mathematics as an ill-structured discipline. In R. I. Charles & E. A. Silver (Eds.), The teaching and assessing of mathematical problem solving (pp.32-60). Reston, VA: National Council of Teachers of Mathematics.

Rowan, T. E., & Cetorelli, N. C. (1990). An eclectic model for teaching elementary school mathematics. In T. J. Cooney & C. R. Hirsch (Eds.), Teaching and learning mathematics in the 1990s: 1990 Yearbook (NCTM) (pp. 62-68).

Ryckman, R. M. (1985). Theories of personality (3rd ed.). Monterey, CA: Brooks/Cole.

Sedlak, M. (1986). Selling students short. New York: Teachers College Press.

Silver, E. A. (1985). Research on teaching mathematical problem solving: Some underrepresented themes and needed directions. In E. A. Silver (Ed.), Teaching and learning mathematical problem solving: Multiple research perspectives (pp. 222-266). NJ: Lawrence Erlbaum.

Sizer, T. (1984). Horace's compromise. Boston: Houghton Mifflin.

Stanic, G. M. A. (1984). Why teach mathematics? A historical study of the justification question (Doctoral dissertation, University of Wisconsin-Madison, 1983). Dissertation Abstracts International, 44, 2347A.

Stanic, G. M. A. (1986). The growing crisis in mathematics education in the early twentieth century. Journal for Research in Mathematics Education, 17, 190-205.

Stanic, G. M. A., & Kilpatrick, J. (1988). Historical perspectives on problem solving in the mathematics curriculum. R. I. Charles & E. A. Silver (Eds.) The teaching and assessing of mathematical problem solving (NCTM) (pp. 1-22). Reston, VA: National Council of Teachers of Mathematics.

Steffe, L. P. (1990). Adaptive mathematics teaching. In T. J. Cooney & C. R. Hirsch (Eds.), Teaching and learning mathematics in the 1990s: 1990 Yearbook (NCTM) (pp. 41-51). Reston, VA: National Council of Teachers of Mathematics.

Sternberg, R. J. (1990). Thinking styles: Keys to understanding student performance. Phi Delta Kappan,71(5), 366-371.

Strauss, A., & Corbin, J. (1990). Basics of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage.

Wakefield, A. P. (1990). Do graduate students in the Mat program learn in a distinctly different way from teachers enrolled in the Med program? Journal of Early Childhood Teacher Education, 11(34), 100-112.

Wakefield, A. P. (1992). An investigation of teaching style and orientation to reading instruction. Reading Improvement, 29(3), 183-187.

Wax, M. L. (1967). On misunderstanding Verstehen: A reply to Abel. Sociology and Social Research, 51, 323-333.

Wilson, L. O. (1991). Oklahoma elementary teachers' of perceptions of personal style and the acceptance of holistic education (Doctoral dissertation, Oklahoma State University, 1990). Dissertation Abstracts International, 51, 3324-A.

Winocur, S. L. (1983). Classroom observation checklist by Project IMPACT. Costa Mesa, CA: Orange County Department of Education.

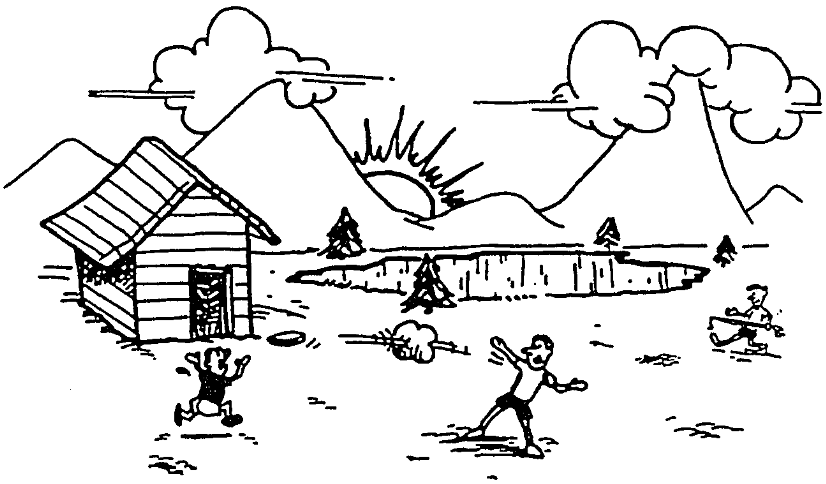
Witkin, H. A., Moore, C. A., Goodenough, D. R., and Cox, P. W. (1977). Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 47(1), 1-64.

Wolfe, G. L. (1983). Learning styles and the teaching of reading. Dissertation Abstracts International, 43, 3810A. (University Microfilms No. 83-00, 381).

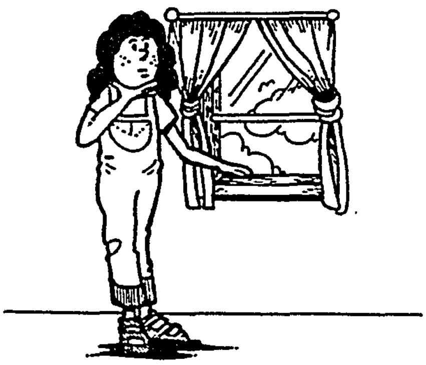
Appendix A

The Problem Solver Examples

97 Camp Whitewater, the local Boy Scout camp, is open for the summer. Once again the woods are alive with shouts, games, and the running feet of happy campers. On the first day, four campers arrive, filling up one cabin. The next day eight new campers arrive, filling up 2 more cabins. Each day, the number of new campers is double the number of the new campers the day before. If the campers keep arriving at this rate, how many cabins will be filled at the end of the sixth day of opening week?



98 It is Saturday, and Ramona is waiting for her friend Rhonda. Ramona started thinking about the different ways that Rhonda could get to her apartment from the street. There are two stairways in front of the building and one stairway on the side of the building. Each stairway goes up to a door that leads into the lobby of the apartment building. Then there is a stairway and two elevators up to the third floor where Ramona's apartment is. How many different ways can Rhonda take from outside the building to Ramona's apartment?



Appendix B

Gregorc Style Delineator™

DIRECTIONS

Before starting with the word matrix on the next page, carefully read all seven of the following directions and suggestions:

1. Reference Point. You must assess the relative value of the words in each group using your SELF as a reference point; that is, who you are deep down. NOT who you are at home, at work, at school or who you would like to be or feel you ought to be. THE REAL YOU MUST BE THE REFERENCE POINT.

2. Words. The words used in the *Gregorc Style Delineator* matrix are not parallel in construction nor are they all adjectives or all nouns. This was done on purpose. Just react to the words as they are presented.

Example

X

a. 4 sun

b. 2 moon

c. 3 stars

d. 1 clouds

3. Rank. Rank in order the ten sets of four words. Put a "4" in the box above the word in each set which is the best and most powerful descriptor of your SELF. Give a "3" to the word which is the next most like you, a "2" to the next and a "1" to the word which is the least descriptive of your SELF. Each word in a set must have a ranking of 4, 3, 2 or 1. No two words in a set can have the same rank.

4 = MOST descriptive of you
1 = LEAST descriptive of you

4. React. To rank the words in a set, react to your *first impression*. There are no "right" or "wrong" answers. The real, deep-down you is best revealed through a first impression. Go with it. Analyzing each group will obscure the qualities of SELF sought by the Delineator.

5. Proceed. Continue to rank all ten vertical columns of words, one set at a time.

6. Time. Recommended time for word ranking: 4 minutes.

7. Start. Turn the page and start now.

Appendix C

Stages of Concern Questionnaire (CBAM)

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 Problem Solver Program.	0 1 2 3 4 5 6 7
2.	I now know of some other approaches that might work better.	0 1 2 3 4 5 6 7
3.	I don't even know what The Problem Solver Program is.	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 other faculty in their use of The Problem Solver Program.	0 1 2 3 4 5 6 7
6.	I have a very limited knowledge about The Problem Solver 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 Problem Solver 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 Problem Solver Program.	0 1 2 3 4 5 6 7
11.	I am concerned about how The Problem Solver 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 Problem Solver Program.	0 1 2 3 4 5 6 7
13.	I would like to know who will make the decisions in the new system.	0 1 2 3 4 5 6 7
14.	I would like to discuss the possibility of using The Problem Solver Program.	0 1 2 3 4 5 6 7
15.	I would like to know what resources are available if we decide to adopt The Problem Solver Program.	0 1 2 3 4 5 6 7
16.	I am concerned about my inability to manage all The Problem Solver 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 this new approach.	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 Problem Solver Program's instructional approach.	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 The Problem Solver Program based on the experiences of our students.	0 1 2 3 4 5 6 7
23.	Although I don't know about The Problem Solver Program, I am concerned about things in the area.	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**	

24.	I would like to excite my students about their part in this approach.	0 1 2 3 4 5 6 7
25.	I am concerned about time spent working with nonacademic problems related to The Problem Solver Program.	0 1 2 3 4 5 6 7
26.	I would like to know what the use of The Problem Solver 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 Problem Solver 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 Problem Solver 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 about The Problem Solver Program.	0 1 2 3 4 5 6 7
31.	I would like to determine how to supplement, enhance, or replace The Problem Solver Program.	0 1 2 3 4 5 6 7
32.	I would like to use feedback from students to change The Problem Solver Program.	0 1 2 3 4 5 6 7
33.	I would like to know how my role will change when I am using The Problem Solver 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 Problem Solver Program is better than what we have now.	0 1 2 3 4 5 6 7

Appendix D

Innovation Configurations Checklist (CBAM)

	1 2 3 4 5	
Desks are arranged in rows. Children are expected to stay in their seats during the lesson.		Desks are grouped in various ways. Children move in and out of cooperative groups during the lesson.
	1 2 3 4 5	
Evidence that mathematics is integrated into subject areas outside of the math "period." Minimum: history graph, reading chart, etc.		The children relate the problem to other learning--strategies or content. It is evident that children are familiar with PSP strategies.
	1 2 3 4 5	
Evidence that the PSP is being used as intended. Minimum: Strategies Chart visible, manipulatives, and/or other mathematical thinking prompts such as an "estimate" the number jar.		Children's work demonstrating use and understanding of PSP is highly visible: drawings of various strategies, projects, etc.
	1 2 3 4 5	
The teacher as the source of knowledge; emphasis is on which strategy to use and steps to follow to get the "right" answer.		The teacher as facilitator sets the "stage" for learning, guides children as they explore various approaches in problem solving.
	1 2 3 4 5	
The teacher asks questions requiring little thought; no effort is made to make problems relevant to the children.		The teacher asks questions to promote thinking and guide the children to discover relationships themselves.
	1 2 3 4 5	
The children are "passive" receivers of knowledge. Lack of engagement with the PSP. No sharing of ideas, debate, or consensus in the problem solving process.		The children "actively" participate in efforts to try different strategies. Enthusiasm in finding solution is evident.

<u>Critical incidents</u>:

Notation of critical incidents observed during the lesson.

The incident:

Appendix E

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 Bloom'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.	____	____	____

	Yes	No	Unsure
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.	____	____	____

Appendix F

Levels of Use (CBAM)

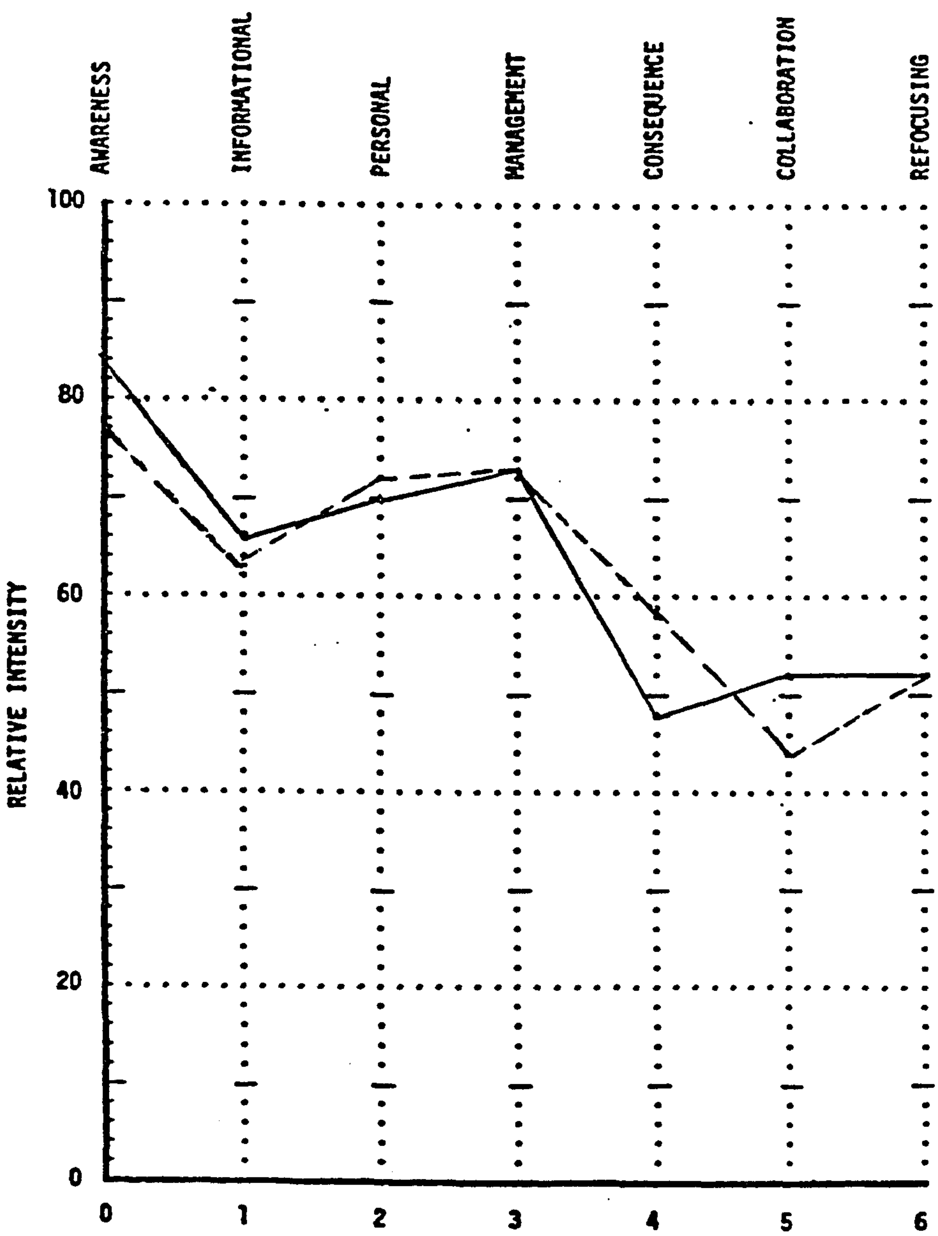
1. Are you using the Problem Solver Program (PSP)?
2. How much of your math "time" is spent with the PSP?
3. Do you use it at a regular time each week?
4. About how long is each lesson?
5. What do you see as the strengths and weaknesses of the PSP?
6. Do you feel your use of it is going along satisfactorily?
7. Are you currently looking for any more information on using process problems?
8. Do you ever talk with other teachers about the PSP?
9. If yes, what kinds of things do you tell them?
10. What do you focus on in using the PSP?
11. What do you see as being the effects of using this program?
12. Do you feel uncomfortable using any of the strategies or materials?
13. Have you made any changes recently in how you use the PSP?
14. Are there some strategies you use more than others?
15. Are you considering making any changes in any of the pages you use now?
16. Are you considering or planning to make major modifications in the way you teach the PSP?
17. Have you had to make major changes in the way you teach story problems since the adoption of the PSP?
18. Has it been worth the effort?
19. Do you feel the PSP has a similar philosophic base to that of thematic units, or whole language?

20. Do you feel that the quarterly math tests determines the extent to which most teachers use the PSP?

21. Do you see a difference in the way your students interact with each other or with you compared to the old math program?

Appendix G

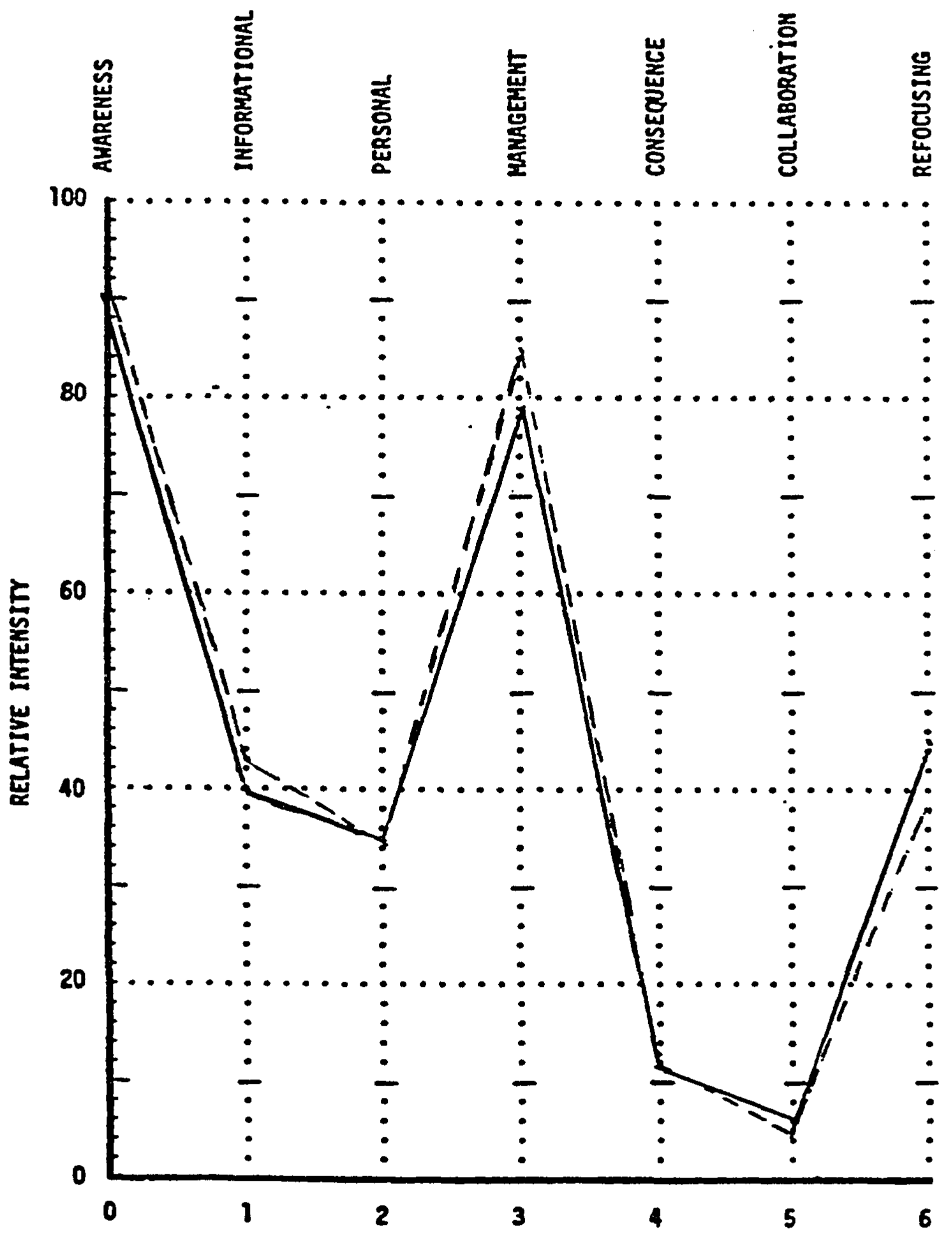
Large Sample Stages of Concern Graph



Subjects: N equals 67 **Fall - - - Spring _____**

Appendix H

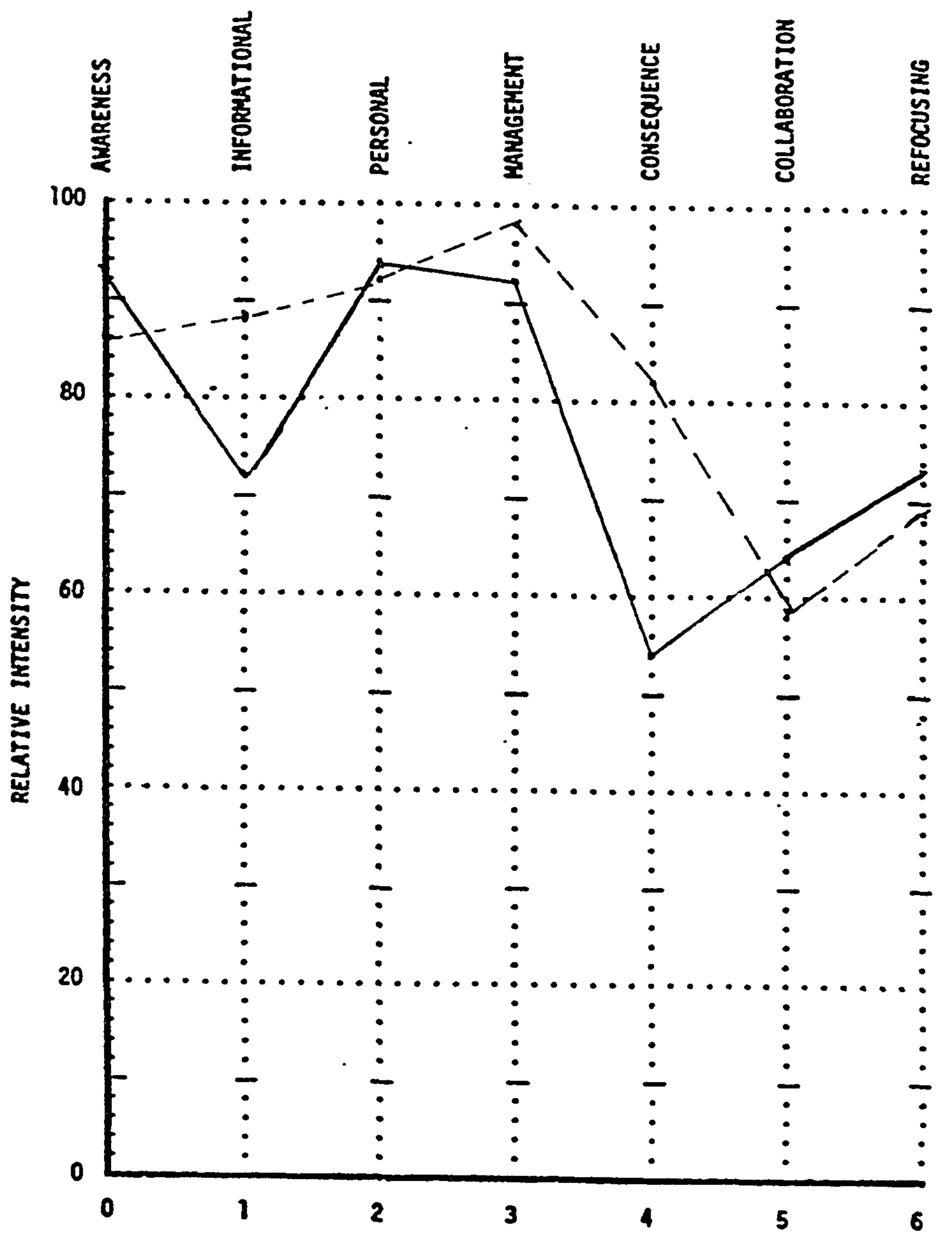
Stages of Concern Graph of Susan Edwards (S-up)



Fall - - - - Spring _______ Gregorc Style Delineator
Scores: CS 40 AS 20 AR 25 CR 15 Ordering type: Sequential

Appendix I

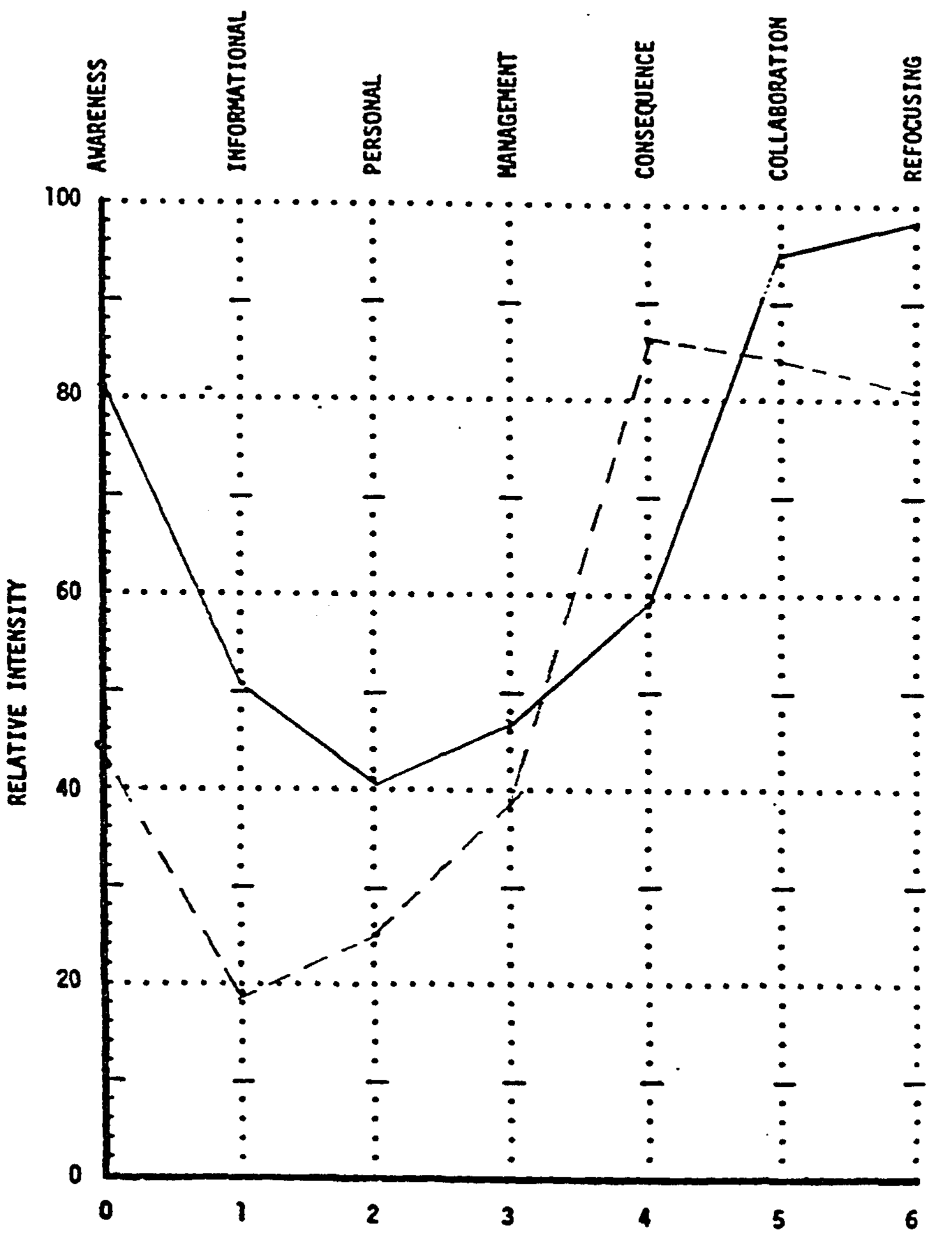
Stages of Concern Graph of Frances Morgan (S-pr)



Fall - - - - Spring _______ Gregorc Style Delineator
Scores: CS 25 AS 28 AR 23 CR 24 Ordering type: Sequential

Appendix J

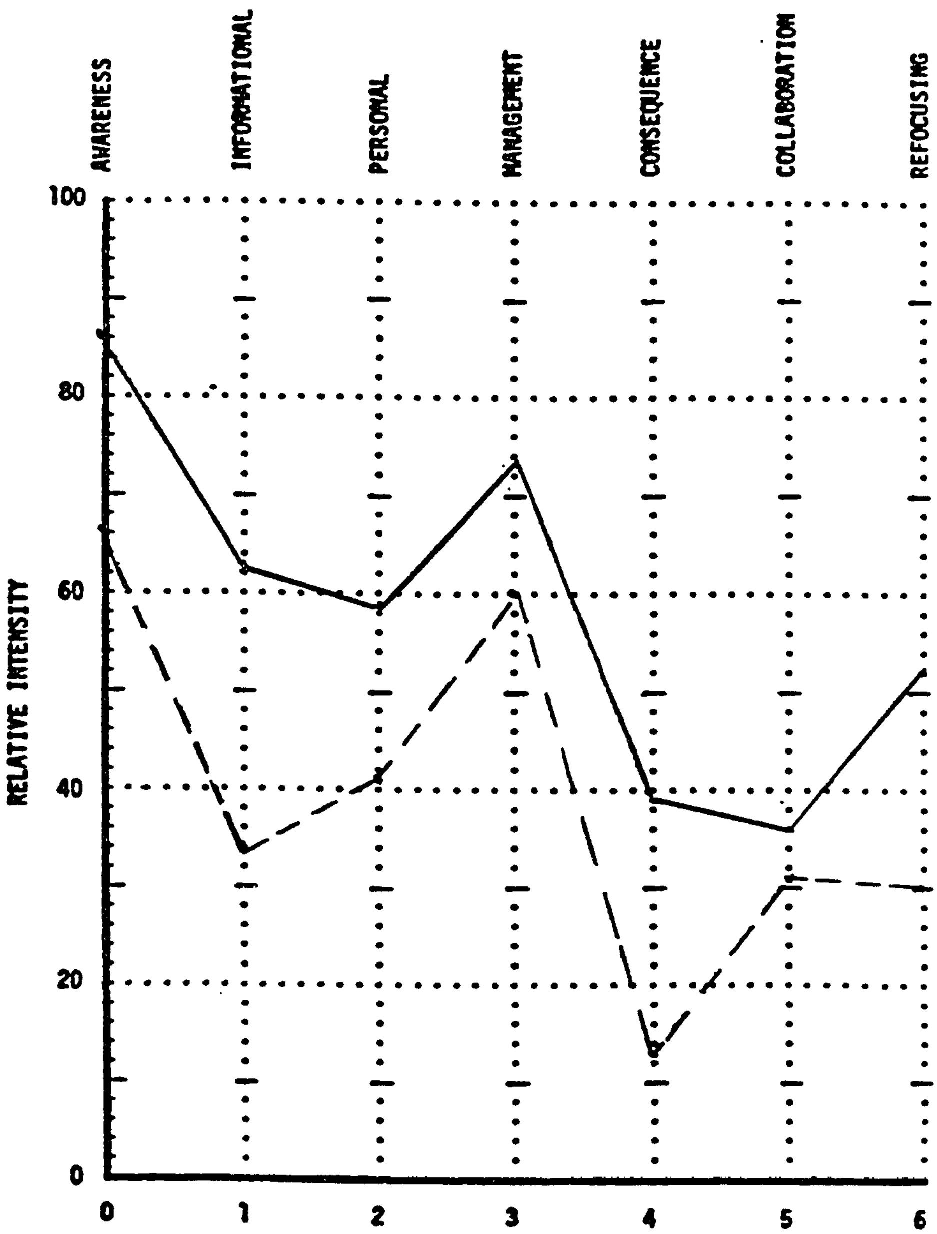
Stages of Concern Graph of Glenda Feldman (R-up)



Fall - - - - Spring _______ Gregorc Style Delineator
Scores: CS 21 AS 25 AR 25 CR 29 Ordering type: Random

Appendix K

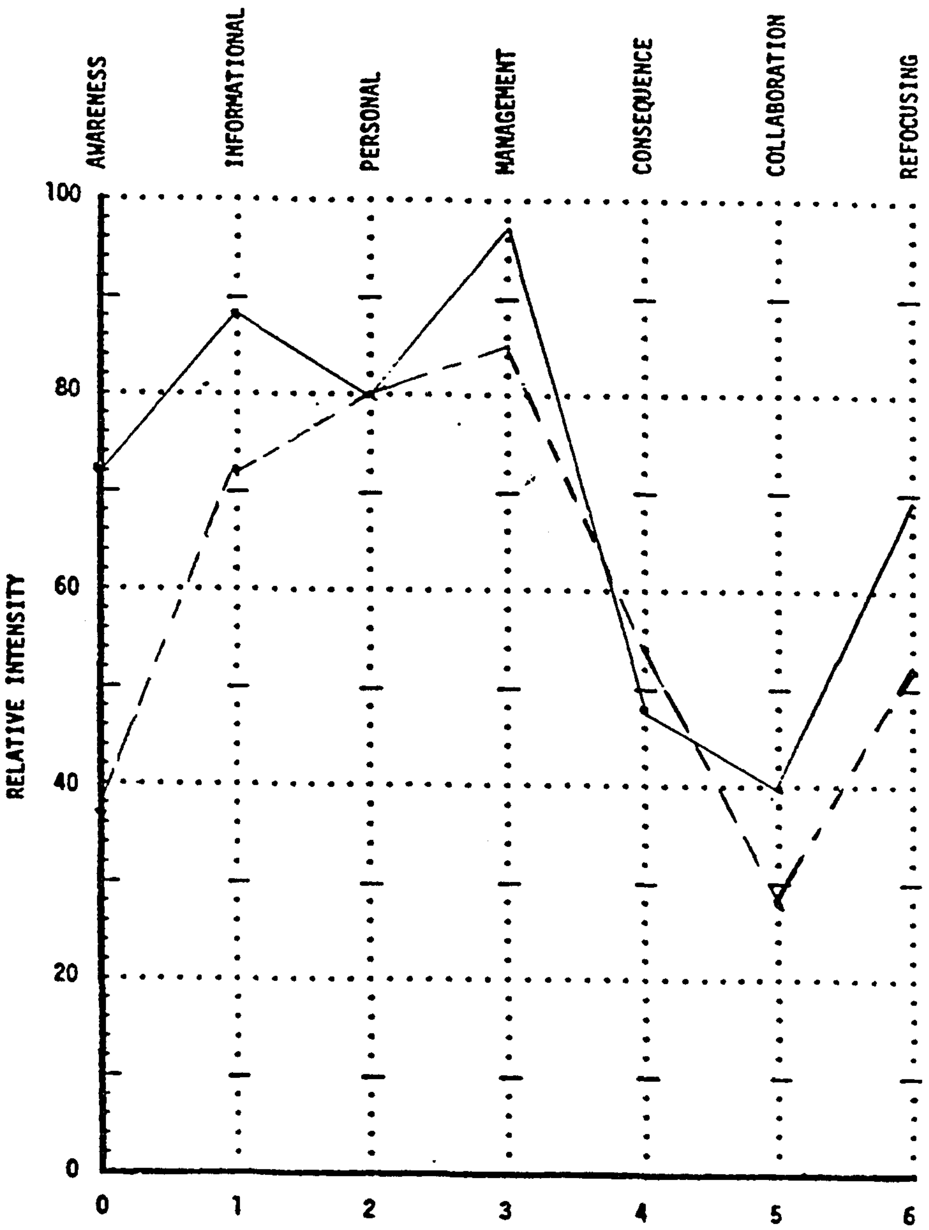
Stages of Concern Graph of Mary Ann Bostich (R-pr)



Fall - - - - Spring _______ Gregorc Style Delineator
Scores: CS 17 AS 21 AR 27 CR 35 Ordering type: Random

Appendix L

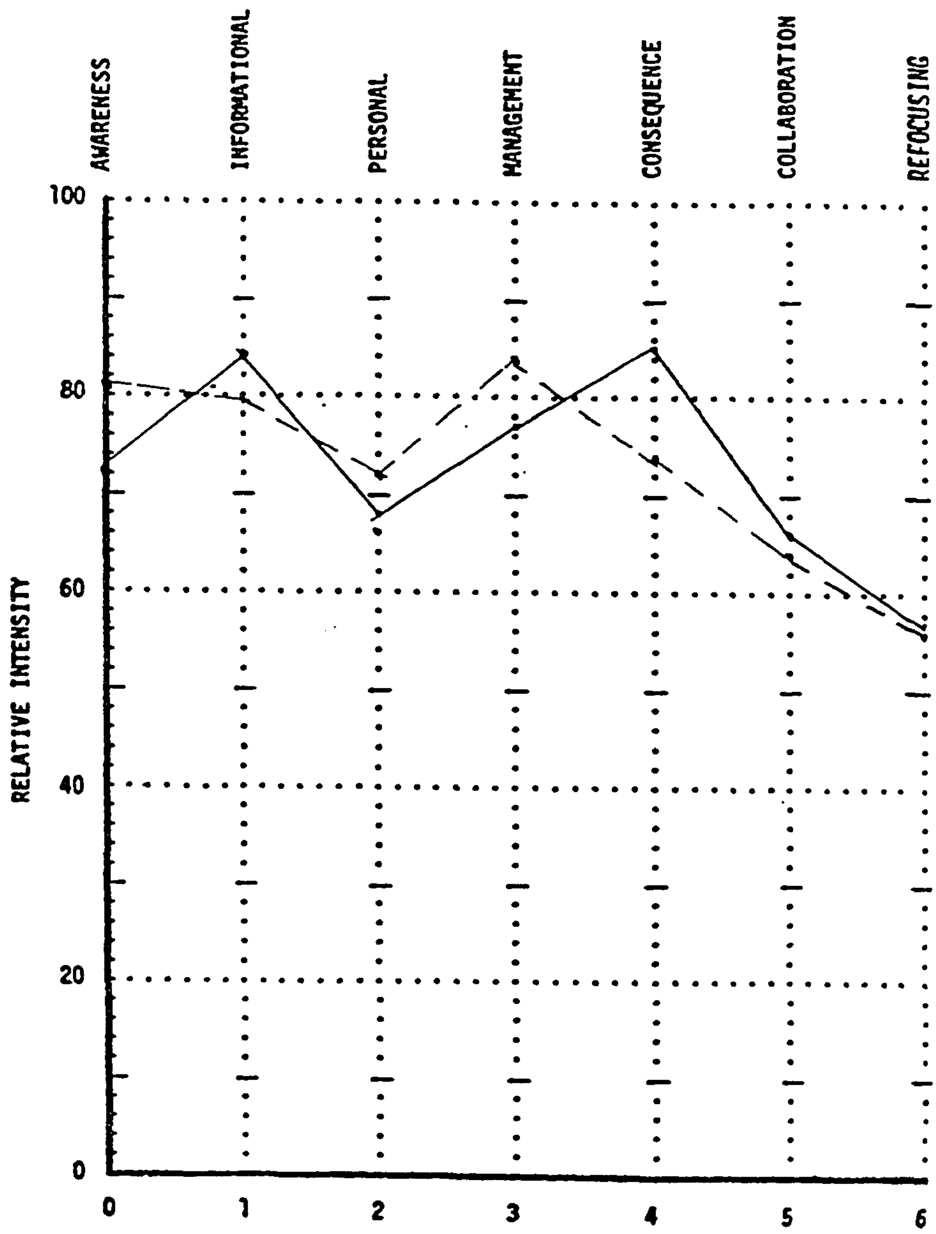
Stages of Concern Graph of Cathy Proctor (M-pr)



Fall - - - - Spring _______ Gregorc Style Delineator
Scores: CS 27 AS 22 AR 27 CR 24 Ordering type: Mixed

Appendix M

Stages of Concern Graph of Patricia Sullivan (M-up)



Fall - - - -   Spring _______ Gregorc Style Delineator
Scores: CS 33 AS 20 AR 27 CR 20 Ordering type: Mixed

Autobiographical Statement

Mary Lou Meinhold Fogarty

Ed.B. June 1964, Rhode Island College
M.S. May 1987, Old Dominion University

Mary Lou Meinhold Fogarty was born on May 11, 1942, in Whitman, Massachusetts. She is an educator with twenty-one years of teaching experience in second through sixth grade in the public school systems in Colorado Springs, Colorado; Blytheville, Arkansas; and York County, Virginia. In addition she taught for the Department of Defense in Goose Bay, Labrador and gained teaching experience in grades seven through nine in Cambridgeshire, England.

She is employed by the York County School System in Virginia where she has served as a mentor and worked with several student teachers. She is a specialist in the Cognitive Process of Instruction and in that capacity has provided staff development in classroom settings and in workshops.

She is presently teaching fifth grade and serving as grade level chair at Bethel Manor Elementary School where she also works with colleagues doing graduate research.

Additionally, she is a member of Kappa Delta Pi and Phi Kappa Phi honorary societies.