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A Study of Active Participation Instructional Strategies Increasing Student's Higher Order Thinking Skills

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A STUDY OF ACTIVE PARTICIPATION INSTRUCTIONAL STRATEGIES INCREASING STUDENT'S HIGHER ORDER THINKING SKILLS

by

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CHAPTER I

INTRODUCTION

Purpose of the Study

In a report entitled, The Information Society: Are High School Graduates Ready? (Education Commission of the States, 1982), research indicates that basic skills are successfully mastered by most students. However, higher order thinking skills are satisfactorily achieved by only a minority of 17-year-olds. Also, the need for students to develop higher order thinking skills was explained in the publication, A Nation at Risk (National Commission on Excellence in Education, 1983), a report commissioned by the president of the United States in which the decline in the quality of education is documented.

The recent "back to basics" curriculum reform movements was prompted by the alarming concern that students were not mastering fundamental skills. While much attention has been devoted to the teaching of basic skills, the results of standardized achievement and competency tests indicate that students are experiencing difficulties with tasks requiring the application of acquired factual knowledge and basic skills.

As a reaction to the back-to-basics movement, a more productive change has been taking place in American education. While many people in other professions are advocating more emphasis in the mechanics of reading, writing, and arithmetic in public schools, educators are increasingly objecting to this simplistic demand (Gallup, 1985).

Many educators are wisely insisting that schools focus on skills necessitated as a result of the information explosion, such as, how to reason, produce, apply, and evaluate information and how to think (Narrol & Giblon, 1984).

Research indicates that test scores in academic subjects increase when thinking skills are a part of the curriculum (Whimbey, 1985b). Thus, these and other findings (Forbes, 1984) suggest the need for instructional curriculum focusing on both basic and thinking skill development.

The results of these studies prompted many states to initiate legislation designed to increase the higher order thinking skills of students. Beginning in the 1980s, higher educational institutions such as the California State University mandated the study of critical thinking as a requirement for graduation. Master degree programs in critical thinking were established at the University of Massachusetts in Boston and at Sonoma State University in Rohnert Park, California. Following recommendations of the National College Board, the concept of "reasoning" became one of the six basic skills for colleges; and the states of California and Connecticut incorporated critical thinking in their testing programs.

Interest in the thinking skills instruction is driven by the hope that such an approach will promote enthusiasm in the classroom, motivate students, and thus increase overall student achievement. Therefore, it is perceived by educators that learning is more meaningful and permanent when students have opportunities to make the learning process their own through both active mental involvement and reflection. The teaching of higher order thinking can provide students with such active involvement.

Therefore, the purpose of this study is to investigate the hypothesis that students taught through use of active participation strategies develop higher order thinking skills than students who are taught through the conventional instructional approach. Active participation is defined as the continuous involvement of all students in the lesson. It is a result of a deliberate and conscious attempt on the part of the teacher to cause students to participate overtly in the classroom (Hunter, 1982). For the purposes of this study, the conventional method is defined as the use of lectures, textbooks, worksheets, and other paper-pencil tasks used in the classroom setting without the employment of hands-on manipulatives.

Statement of the Problem

Because of today's rapidly changing society, it has been predicted that future workers of the 21st century will change jobs at least five to six times during their careers. Skills that were previously appropriate will no longer be adequate for the world outside of school (Forbes, 1984).

The fact that this is a scientific and technological era with a vast sophisticated changing knowledge base demands that students be able to function effectively in a complex society. Educational preparation for the task, however, requires less focus on retention of factual data and more emphasis on higher order thinking, reasoning, problem solving in diverse situations, and innovativeness in producing an efficient quality product.

Though a great deal of research exists about the teaching of thinking skills in the elementary school (Bloom, 1956), much of it is abstract and not easily applicable to the classroom. However, there is a neglected area that presents an ideal avenue for teaching children to think.

In examining the mathematics textbook used in fifth and sixth grade classes, the end of each session contains a number of word problems requiring a specific arithmetic operation, like dividing two numbers. When students know the section is on division they simply divide without reading and conceptualizing the problems.

The last two or three word problems are often starred or designated to denote a higher level of difficulty that may involve more than two numbers and more than one arithmetic operation. Since most students have not been taught how to analyze and conceptualize multistep problems, they usually serve only as "enrichment" activities for a few bright children.

Yet, while the ability to solve multistep problems is essential for success in physics, chemistry, computer programming, and most other scientific and technical careers, only 6.4% of 17-year-olds can compute them (National Assessment of Educational Progress, 1988). Moreover, the ability to solve word problems of any type is a primary expression of what researchers regard as the essence of critical thinking, a process requiring reflective thought to clarify meaning and construct relationships.

Beginning in the elementary grades, teachers can develop higher order thinking and stimulate the desire to analyze and reflect by fostering critical, divergent, inductive, and deductive thinking. Thus, activities which encourage students to apply newly acquired skills, such as analyzing, comparing, and contrasting, foster the concepts and categories for such abstract thinking.

Context of the Problem

Calls for educational reform have come from the mass of society, especially from the business world (Marzano, 1985). According to Forbes (1984), advanced technology has both positive and negative consequences in terms of jobs. While many clerical and middle level management positions are eliminated with high technology replacements, a high percentage of jobs are created and technology opens new doors.

Though accelerated changes make it difficult to determine what content to teach students, industrial leaders, having altered from an emphasis on goods to one of information, are communicating their needs to educators. Cooperative partnership alliances are being formed between industry and educators (Naisbitt, 1982; Peters & Waterman, 1982) in an attempt to assist students in developing necessary skills for intelligent behavior. Such skills include collaborative problem solving, forecasting problems, managing information, formulating group goals, empowering others, and engaging in the lifelong process of acquiring skills and knowledge. Reformers (National Commission on Excellence in Education, 1983) believe that actively engaging students in the learning process provides them with many of these skills that are crucial for survival in the world of work.

After years of assuming that higher order thinking skills should only be taught to the intellectually gifted, theorists have surfaced concepts suggesting that all human beings have cognitive weaknesses as well as strengths, and can continue to develop intelligences throughout life. One such concept was generated by Gardner (1982), who postulated in his theory of multiple intelligences that intelligence can be taught. In 1985, Whimbey and Sternberg stated in a thesis that IQ scores are not a valid predictor of one's successfulness in resolving problems encountered in life.

After returning to the basics, lecturing and questioning were the primary instructional strategies used to impart knowledge to students. Progress was measured by their ability to regurgitate and recite information they had heard or seen.

Research (L. M. Martin, 1988; Petry, 1980), however, in the past 20 years suggests that instruction provided through the inquiry-oriented approach encourages students to think about and experiment with new concepts, transform knowledge, and apply what was learned to other situations. This paradigm shift of instructional strategies sparked a new direction for student learning, but students were not taught how to use information for in-depth understanding of solving problems.

Significance of the Study

As previously stated, the purpose of this study was to investigate the hypothesis that students taught through use of active participation develop higher order thinking skills than students who are taught through the conventional instructional approach. The limited significance of such a study will assist teachers and other educators in determining whether active participation is a viable instructional strategy in increasing students' higher order thinking skills.

Summary

In summary, the purpose of the study was to investigate whether students taught through use of active participation strategies develop higher order thinking skills than students taught through the conventional instructional approach. Discussion was adhered to how thinking skills enhance the quality of education when implemented through active involvement of students in the learning process.

In Chapter II, the theoretical foundations for thinking skills are discussed in addition to programs designed to increase higher order thinking and the use of hands-on manipulatives as a viable instructional strategy to engage students as active participants in learning.

CHAPTER II

LITERATURE REVIEW CONCERNING THE USE OF ACTIVE PARTICIPATION STRATEGIES IN INCREASING STUDENTS' HIGHER ORDER THINKING SKILLS

Overview of the Chapter

In describing the concept of active participation, a definition is given for the term, hands-on manipulatives. Furthermore, a relationship is established showing the use of hands-on manipulatives as a viable, effective strategy for actively engaging students in the learning process.

The organization of this chapter is as follows: (a) theories of learning, (b) learning styles theories, (c) review of historical literature on higher-order thinking skills, (d) a conceptual definition of critical thinking skills, (e) programs describing critical thinking, (f) a discussion of research measuring critical thinking skills, and (g) hands-on manipulatives.

Theories of Learning

It seems logical to determine the learning process of children before deciding how to teach them. Learning theories show the integration of philosophies and theories into professional practices, as well as provide information of how people learn as a basis for effective teaching methods in the classroom.

As follows are specific philosophies of education used in public schools and the limitations each imposes on learning. Theories of learning are described, including conditions that promote learning.

Thorndike

During the 20th century, Edward L. Thorndike provided educators with a scientific theory to learning based on experimental research.

Through his theory of connectionist, Thorndike continues to have an influence on educational practices. He perceived motivation as caused by external rather than internal factors and postulated that the basis for motivation is reward. Rewards must be an integral part of the teaching-learning process. They should be sufficient in quality and occur immediately after demonstration of desired behavior. Thorndike indicated that reward strengthens the connection between a stimulus and a response (Pittenger & Gooding, 1971).

Thorndike theorized that intelligence is primarily quantitative in that one's mental capacity becomes relatively fixed upon reaching physical maturity (Pittenger & Gooding, 1971). However, he purported that the most intelligent people have built up the highest combination of connections or stimulus-response bonds.

The concept of connectiveness is closely congruent with the theory of transfer. Thorndike (cited in Pittenger & Gooding, 1971) suggested that transferability occurs in simplest forms when the elements of two situations are identical. A more complex form of transfer takes place when two elements are similar.

Adhering to this theory in conventional educational practices would suggest that high transferability subjects such as reading and mathematics have the greatest potential for transfer. Other subjects with less transferable ability such as language would be of little importance.

Thorndike postulated that one's stimulus-response connections weakens when they are not used, causing a decrease in memory.

Skinner

B. F. Skinner is well-known for his theory of behavioral control toward specified goals using animals in a laboratory. Skinner examined the development of organism behavior from an external, operational viewpoint; observe the behavior, condition it, and modify the conditioning process to produce desired results (Pittenger & Gooding, 1971).

In terms of motivation, Skinner believed that any response that is reinforced is likely to occur again given the same conditions. Punishment, however, was not viewed as an effective means of shaping behavior.

Skinner placed little emphasis on physiological limits. However, he contended that building a vast repertoire of responses in an organism enhanced the transferability of learning to new situations.

Gestalt

The Gestalt school of psychology evolved from German psychologists who theorized that people respond to whole patterns or situations. The focus of this theory is on visual perception or why people respond as they do in given situations. Learning was defined as a process of organizing perception to reduce ambiguity, totally unrelated to the teacher's behavior (Pittenger & Gooding, 1971). The Gestalt theory contends that learning begins with a whole, not parts.

Gestalt psychologists believed that man becomes motivated when unable to satisfactorily relate to a situation. Thus, motivation is the desire to organize the world according to one's perception of it.

The Gestalt school of thought requires the teacher to be able to help students assess their perceptiveness of the universe. This can be accomplished partly by increasing the number and types of problems the learner perceives.

Combs

Combs's theory emphasizes personalistic factors in that it views man as always seeking greater personal adequacy which is a driving force that motivates all behavior (Pittenger & Gooding, 1971).

Based on this theoretical standpoint, one is never unmotivated in that personal adequacy is constantly sought to be a process of differentiation, moving from the gross to the specific. Therefore, teaching is the facilitation of perceptual differentiation or a change in meaning.

Several factors that facilitate the exploration of personal meaning in a learning situation such as the freedom from threat, atmosphere of acceptance, security of limits, acceptance of mistakes as a part of the learning process, and an appreciation of uniqueness.

Psychosociological factors cause no limits on man's ability to make differentiations except for genetic defective or brain damage.

Combs (1962) pointed out that subject matter considered to be external or apart from the person will have little transferability to new learning situations. Once differentiations are made they become permanent as one cannon "unperceive" (Combs, 1962).

Piaget

Piaget suggested that thinking occurs in a hierarchy of developmental stages paralleling to a child's mental level: (a) sensory motor, using verbal symbols; (b) preoperational, thinking based on perception; (c) concrete operations, analyzing classifying; and (d) formal operations, imaginative, conceptual thinking (Bereiter, 1990).

Piaget's theory of the construction of knowledge, referred to as the theory of genetic epistemenology, is explained by two major factors: maturation and equilibration. Maturation is defined as the growth of the brain or nervous system which opens up for structure, while equilibration is delineated as a process producing levels of equilibrium (Stewart & Hewson, 1993). Bereiter (1990) stated that complaints against cognitive theories are that they ignore critical life forces such as culture, environment, and parenting, assuming that knowledge is actively created from within. Moreover, Bereiter also indicated that Piaget's theory fails to explain how learning occurs as Piaget ignored cultural influences.

Learning Styles Theories

The premise behind learning styles theories is that each individual student is provided an opportunity to be successful when teachers employ instructional strategies and activities according to his style of learning (Hunter, 1982).

In his book on multiple intelligences, Gardner (1982) related learning styles to brain-based learning principles. He theorized that people possess a variety of intelligences, one or more of which is dominant. Therefore, teachers can facilitate a student's learning by teaching to his dominant intelligence(s).

Sperry (1968) also supported learning styles theory in research pertaining to the right and left hemispheres of the brain. While each hemisphere has a specific function in acquiring and processing data, a predominantly left hemispheric person is extremely verbal and analytical and learns best when instructions are presented sequentially (Caine & Caine, 1991). In contrast, a predominantly right hemisphere person is not as verbal and possesses excellent spatial memory and sensory recall. He would best learn in a classroom focused on experiential activities appealing to the senses (McCarthy, 1990). This type of learning allows students to "do" and "apply" the information presented, becoming actively engaged in the learning process.

Research on Teaching Higher Order Thinking Skills to Students in Chapter 1 Programs

The National Council of Teachers of Mathematics (1989) advocated the use of manipulatives and concrete models for teaching higher order thinking skills to all students in the elementary mathematics curriculum, including those with below average skills. Moreover, research conducted by Pogrow (1988) suggested that it is essential that higher order thinking skills be taught to at-risk students. Pogrow contended that disadvantaged children lack cultural sense of how to develop higher order thinking abilities symbolically. He further indicated that these students typically come from environments that haven't enabled them to develop higher order thinking. Thinking abstractly and generalizing are not skills needed for survival on the street.

Higher Order Thinking Skills (HOTS), a program for teaching thinking to students in Chapter 1 programs, Grades 4-6, was developed by Pogrow and is currently used in nearly 2,000 schools across the nation (Pogrow, 1988). In this program supplemental materials containing drill and content instruction are replaced by general thinking activities employed through hands-on approaches and active engagement with computers, team competition, and drama.

The results of research on the successfulness of the HOTS program indicate that students' gain in thinking skills exceed national averages after a year's participation in the program (Pogrow, 1988). The HOTS program has been expanded to include students with learning disabilities in Grades 4-6, gifted students in Grades K-2, and Chapter 1 students in Grade 7 (Pogrow, 1988).

Historical Literature on Critical Thinking

Helping students develop higher order thinking skills is an ancient educational goal that is receiving focus in today's society. In 1883, Horace Mann reported to the Massachusetts State Board of Education that students lacked the abilities to problem solve (Mann, 1965). Mann's report was followed by John Dewey in the 1930s who attempted to define critical thinking for education based on the concept of schools as exploration or inquiry, giving teachers and students instructional objectives and strategies for achieving higher order thinking skills (Dewey, 1956). Dewey's view of school as a place where children explore questions of interest placed emphasis on the process of learning rather than the product. Dewey conceived the idea of "reflective thinking" as a major goal for students. In previous years many educators have also emphasized students' thinking as a fundamental academic discipline (Ennis, 1985).

During the last several decades, the teaching of thinking skills in the educational sector has received national attention. An urgent call to improve education emanated from the launching of Sputnik in 1957, resulting in the curriculum reform movement in the 1960s (McTighe, 1985). Emphasis was given to instructional materials pertaining to concept formulation, abstract reasoning, and problem-solving through strategies of discovering and inquiring (McTighe, 1985).

Definitions of Critical Thinking Skills

Schools continue to be concerned about the quality of students' thinking: whether it measures up to standards considered to be good thinking or critical thinking. Ennis (1985) defined critical thinking as reasonable, reflective thinking that is focused on deciding what to believe or what to do. Reasonable thinkers attempt to analyze arguments, seek valid evidence, and reach sound conclusions. Thus, the major goal of teaching people to think critically, according to Ennis, is to develop fairmindness, objectivity, and commitment to clarity and accuracy.

Some theorists perceive critical thinking to be linked to specific knowledge, which is in opposition to the process-first phenomena. However, during the 1980s, the discussion of critical thinking became more focused and attracted a great deal of attention from scholars in education. Emphasis was placed on clarifying and defining the concept of critical thinking in an attempt to shape decisions and formulate educational policy.

Sternberg (1985), one of the leading educational scholars, identified critical thinking from three perspectives: the philosophical, the psychological, and the educational.

The philosophical tradition is concerned with human thinking based on theory and logic often demonstrated through activities such as comparing and evaluating. According to Sternberg (1985), the problem with this theory is that it is based on pure logic in an ideal situation.

A psychological theory categories critical thinking according to limiting conditions posed on individuals and the environment as a laboratory under experimentation.

The pedagogical approach focuses on the relationship between critical thinking and the students' performance in school. This theory, however, lacks attributes of the philosophical and psychological approaches to critical thinking.

Because of the weaknesses inherent in all three perspectives, Sternberg (1985) concluded that the study of critical thinking not be restricted to one or two disciplines.

A review of the educational literature on critical thinking reveals that experts are far from agreement upon a precise definition of thinking and a common core of essential skills and methods for teaching such skills to students. Two definitions of thinking skills developed by educators are as follows: The active process involves a number of demonstrable mental operations, such as induction, deduction, reasoning, sequencing, and classification, as well as the ability to define relationship (Bijaya, 1989). Thinking involves applying cognitive skills, such as analysis to knowledge or experience, to meet some sort of objective (Thacker, 1990).

In spite of varying definitions, Strother (1989) wrote that one needs not wait for research to arrive at a precise definition of thinking skills before designing a program or selecting one from available educational packages. There are many recommendations from which to choose, such as the Creative and Academic Thinking Skills program (CATS) and Higher Order Thinking Skills program (HOTS).

Critical Thinking Skills Programs

Higher Order Thinking Skills (HOTS)

Higher Order Thinking Skills (HOTS) is a thinking skills program originally developed to help Chapter 1 students (Pogrow, 1985). The purpose of the program is to increase students' conceptual skills by focusing on learning experiences pertaining to analyzing, predicting, inferring, and evaluating (Pogrow, 1988). Chapter 1 is a program for at-risk students performing at least 2 or more years below achievement.

HOTS is a pull-out program involving the use of computer activities and effective instructional activities. The computer is used as a motivational tool as it provides immediate feedback relative to students' performance. Thinking activities are organized in a manner allowing students to process the development of strategies, rather than rely on teacher-directed strategies. An essential element of the HOTS curriculum is that teachers use a daily script of extensive verbal conversation with students to facilitate the transfer of concepts from computer usage to the classroom setting.

The HOTS program received positive evaluation as an effective instructional strategy for Chapter 1 students using standardized achievement tests, Ross Test of Higher Order Thinking, and social confidence as measured by sociograms. Research implications are that students experience enhanced thinking skills in terms of verbal understanding (Pogrow, 1990). HOTS has been endorsed by the United States Department of Education as an effective thinking skills program for students in Grades 4-7.

LOGO

LOGO is a computer language for programming in the exploration of mathematics and logical concepts (Nickerson, Perkins, & Smith, 1985). Instructional exercises are centered around concepts pertaining to logic, number representations, functions and equations, and strategies for problem solving. The program is intended to provide students with skills that can be transferred to the classroom as well as real life situations.

Research regarding the effectiveness of LOGO primarily involves individual case studies with physically and mentally handicapped students and students in the regular education setting. Results show that the LOGO turtle provides a concrete model for understanding abstract concepts; however, results are inconclusive as to whether the program develops students' problem-solving abilities (Robinson, 1984).

ODYSSEY

ODYSSEY: A Curriculum for Thinking is a thinking skills program designed by David Perkins of Harvard University and the consulting firm of Bolt, Beranek, and Newman, Inc., with the Venezuelan Ministry of Education. The program is used in mainstreamed classes with students in upper elementary and middle school (Chance, 1986). The purpose of the program is to teach students a variety of intellectual tasks, including reasoning, language development, memory, hypothesis generation and testing, problem solving, inventiveness and creativity, and decision making.

ODYSSEY is a 2-year program involving a combination of dialectic and didactic instructional methods based on Socratic-like and Piagetian-style of cognitive development. Student activities are centered around verbal discussion and written exercises to increase existing knowledge and acquire new information.

No detailed research studies have been conducted in the United States regarding the effectiveness of the program in increasing higher order thinking skills. However, research done in Venezuela suggests an increase in students' thinking on tests measuring thinking and on standardized tests (Chance, 1986).

Productive Thinking

Productive thinking is a program developed by psychologists Martin Covington, Richard Crutchfield, Lillian Davies, and Robert Olton, with assistance and support from the Carnegie Corporation. The program was developed over a 12-year period involving over 10,000 students in schools throughout the United States and Canada (Chance, 1986). Though targeted for mainstreamed students in Grades 5 or 6, materials are appropriate for either gifted or remedial students in other grades. Student activities involving the use of 16 thinking strategies aimed at problem solving are taught through separate-skills approach of both convergent and divergent thinking wherein knowledge is transferred into content areas. Principles of problem solving include idea generation, persistency, systematization, evaluation of ideas, and positive attitude as presented to individuals or groups of students through class discussions.

Research conducted in Canada with fifth grade students indicated that use of the program enhanced students' creative problem solving (Harris & Blank, 1983). Though other studies also yield positive results (Segal & Chipman, 1985), the program appeared to be less effective unless teachers reminded students to apply the thinking guides to content areas.

Strategic Reasoning

Strategic reasoning is a program developed by John Glade which models numerous other programs of critical thinking such as Upton's (1961) Design for Thinking, Guilford's model of intelligence, and Bloom's

Taxonomy of Educational Objectives (Blade & Citron, 1985). The program is designed for students in fourth grade through adult for purposes of integrating thinking skills instruction with classroom learning activities. More specifically, the broad goals of the program are to develop students' metacognitive and verbal expression abilities, improve critical thinking abilities, develop students' abilities to transfer their thinking skills to nonacademic material, and integrate subject matters and real-life problem solving. The following skills were identified as fundamental in strategic reasoning:

1. Thing-making--perceiving and mentally identifying names and mental images.

2. Qualification--analyzing the characteristics of things.

3. Classification--organizing things into groups according to shared characteristics.

4. Structured analysis--analyzing and creating part-whole relationships.

5. Operation analysis--sequencing things, events, or thoughts into logical order.

6. Seeing analogies--recognizing similar relationships.

Research conducted by Glade and Citron (1985) in Washington, California, Texas, New York, and Oklahoma with students of varying abilities and backgrounds suggest that the program has been effective in increasing students' performance on the Scholastic Aptitude Test (SAT) and other achievement tests, as well as some IQ tests. Another study conducted by Zenke (1985) in Tulsa schools indicated that the program cannot be implemented accurately without teacher training. Also, skill performance of middle school students increases in verbal analogies, number seriation, and figure analysis as measured by the Cognitive Abilities Test of Thorndike and Hagen (cited in Matthews, 1989).

Tactics for Thinking Program

Tactics for thinking program is a program developed by Robert Marzano (1986) as a set of strategies to utilize in designing lessons for students in kindergarten through 12th grade. The program is a summation of theory and research on cognition, intelligence, development psychology, and information processing wherein thinking skills have been grouped into three categories: (1) learning to learn skills, (2) content thinking skills, and (3) reasoning skills. Subskills are also included for each category.

Data collected by Marzano (1985) in a pilot project involving 77 teachers and approximately 1,900 students do not support the effectiveness of the program in terms of increasing students' performance, as measured by teachers' observations and teacher-made tests. Though results are considered to be unstable because of study limitations, the program purportedly increases students' motivation, metacognition of task performance, and better application of content (Marzano, 1986).

Research Measuring Critical Thinking Skills

In Bloom's (1965) Taxonomy of Critical Thinking Skills, six skills organize knowledge on a linear scale from concrete to the most abstract: knowledge, comprehension, application, analysis, synthesis, and evaluation. However, a traditional view of critical thinking consists of the upper levels of Bloom's (1956) Taxonomy of Educational Objectives--analysis, synthesis, and evaluation. Analysis involves students in the identification of some entity, seeing relationships between concepts, dissecting and breaking the entity into component parts, and relating the component parts in some logical order to see relationships among the parts (Shermis, 1992). Synthesis is the obverse of analysis in that it refers to those intellectual activities in which the components can be integrated and put together again into unified wholes (Shermis, 1992). Evaluation requires students to use existing evaluative criteria, and to create their own criteria. It involves making judgments, estimating, appraisal, or assessment of an entity (Shermis, 1992).

Though Bloom's (1956) objectives have become standard content in most teacher preparation programs since the 1950s, the hierarchy of thinking skills moving from simple to complex has been misinterpreted and recently criticized (J. Paul, 1985).

One noted caveat is that this taxonomy and its usefulness in the educational process is not universally accepted and valued, nor consistently applied. The misunderstanding among educators is that academic content at each level must be mastered before a student moves to the next level, thus, impeding the teaching of higher order skills and learning. This misunderstanding appears to manifest itself even more so in the teaching of mathematics because of the abstractness of many concepts inherent in the discipline. As a result, at-risk mathematics students are often required to remain at the "knowledge" level until they memorize their "facts" and demonstrate computational mastery. Yet, for these students, memory may be their weakest asset.

Though research indicates the necessity of teaching higher order thinking skills to students (Brandt, 1984), only 20% of the questions currently asked by teachers facilitate the development of higher level cognitive skills. Sixty percent require students to recall facts, and 20% are procedural (Gallup, 1985).

Other sources including the National Assessment of Educational Progress (NAEP, 1988) have also documented the fact that many students lack higher order thinking abilities. Though recent NAEP results in various subjects show improved student performance on lower-order thinking skills such as mathematical computation and word recognition, poor student achievement is evidenced on higher-order skills such as analyzing and interpreting information.

Most classroom teachers prefer and use the lecture method to deliver subject matter. This process is described by the teacher standing in front of the class talking and presenting information with little, if any, opportunity for clarification of positions or challenging of ideas (Boyer, 1987).

According to Boyer (1987), the lecture method is widely acceptable and is used when time is limited, the class size is large, and an enormous amount of material needs to be presented. This method appears to be easily adopted by new teachers as they often follow the sequential presentation of topics in the assigned text. However, the lecture format does not allow for the teaching of cognitive skills necessary for critical thinking. Because topics are discussed sequentially and not critically, students do not acquire a thorough understanding of the subject matter. Students also become passive using this method in that the teacher does most of the talking; questioning; answering; and therefore, most of the thinking. Students that are underprepared do not achieve with this method because they usually have inadequate rote-learning skills. Also, well-prepared students do not progress intellectually for lack of being challenged (Boyer, 1987).

Socratic questioning, also referred to as critical questioning, dialogical questioning, and productive questioning, is often approached through adaptation of learning taxonomies such as Bloom's hierarchy of thinking skills and Piaget's development hierarchy. Teachers compose questions in different levels of the taxonomies to develop students' critical thinking skills.

However, Socratic questioning appears to be most effective when class sizes are low, time is not a factor, and the subject is narrowly defined. As these are factors seldom found in classroom situations, this form of methodology presents limitations. It requires students to have prior knowledge of subject matter, limiting the amount that can be discussed. Because the teacher asks the questions, students rarely engage in question-posing which is essential for critical thinking. Also, this method is seldom used in subject areas of science and engineering where many students concentrate their efforts.

Procedures used in the Socratic questioning process evolve from the reflective-thought constructs of John Dewey.

The problem-solving process is used extensively in mathematics (Greenfield, 1987; Meyers, 1986; Woods, 1987) wherein a problem situation is defined and understood, a plan is devised and implemented, reviewed, and a solution is determined.

According to Greenfield (1987), this methodology appears to be most effective when addressing problem areas of which students have knowledge and understanding. Other limitations of this approach include ready-made rather than student problem-posing which does not allow for critical thinking. Also, the strategies of problem solving are not viable to disciplines other than science and mathematics.

According to Maiorana (1992), the ideal teaching methodology for promoting critical skills include attributes such as focus, involvement, and transferability.

Focus refers to placing emphasis on subject matter rather than the teacher, thereby allowing students to become more actively engaged in the learning process. Involvement also requires students to actively participate and interact directly with the subject matter. Transferability, however, is the ability to apply thinking skills outside of the classroom to other areas of life.

McBride, Gabbard, and Miller (1990) examined four instructional models that enhanced critical thinking. Two of these models--concept and attainment and inductive thinking--are designed to give students practice in categorizing, differentiating, and organizing information in order to develop concepts and make generalizations. The Group Investigation Model adds a social dimension to problem-solving activities. Finally, a model based on a continuum of teaching styles helps teachers to choose more student-centered instructional strategies. Questioning skills are a major strategy to use to actively involve students in the learning process as this strategy increases higher levels of thinking skills. Gall (1984) indicated that prediction, inference, and analysis are skills associated with higher order questions in that they require students to exercise independent thinking. An analysis of 20 studies on the relationship between questioning strategies and learning suggest an increase in student achievement with the consistent use of higher level probing questions (Redfield & Rosseau, 1981). And in 1988, Routman concluded that the use of higher level questioning is crucial in a hands-on approach where the goal is to have students actively participate. Some of the higher order thinking skills of particular importance in the area of mathematics include problem solving, decision methods, decomposition, and refinement.

While there has been a national effort to increase the critical thinking skills of students, few educators have been trained in the delivery of instructional strategies to accomplish this goal. Instruction to enhance thinking are predicated on the assumption that students will be more effective thinkers if they are successful at identifying and applying specific identifiable skills.

First, in order to develop an effective higher order thinking skill program, teachers must accept and be involved in program planning and implementation. Time must be provided for teacher professional development, to review existing data and literature, and to experiment with existing materials geared towards increasing higher order thinking. Teachers must be empowered and supported in their efforts to identify essential skills and incorporate them into daily activities and lesson presentations.

According to research (Halpern, 1984), helping students to possess an attitude conducive to higher order thinking is one of the major areas to be addressed. Beyer (1986) purported that the strategies used in classrooms to teach higher order thinking skills only serve the purpose of stimulating and providing students with opportunities to exercise or practice thinking. Teachers must actually teach thinking in order to help students improve their thinking skills.

Research indicates that practice is only effective in increasing higher-order thinking skills when it is combined with other instructional methods, with teacher guidance for skill execution and the teaching of these skills to transfer knowledge (Beyer, 1986).

Thacker (1990) described a model for teaching critical thinking skills that was developed and implemented cooperatively by four Indiana school corporations: Twin Lakes, Hammond, Blackford County, and Eagle-Union. The developers of the model concluded that teachers must be trained to become aware of thinking skills and of the strategies for creating a classroom environment conducive to the development of critical and creative thinking. Essential components of the classroom include a positive climate, active listening, wait time, active learning, and student recognition.

A comprehensive sequential plan for thinking skills was developed by faculty committee of the Walled Lake Consolidated Schools in Michigan. This plan establishes two or three new thinking skills to be introduced at each grade level and reviewed in succeeding grades. Each thinking skill relates to the content required by district curriculum (Beyer & Backes, 1990).

Bereiter (1989) proposed two strategies to assure that thinking skills are embedded in the total fabric of the instructional program. One way is to incorporate thinking skills with the existing instructional objectives, and the other is to integrate thinking skills into each subject area.

Perhaps most importantly in today's information age, thinking skills are perceived to be crucial for coping with a rapidly changing world. Many educators believe that specific knowledge will not be as important to the work force and citizenry as the ability to apply concepts, analyze, synthesize, and evaluate new information. From his view of existing programs, Bijaya (1989) concluded that such skills are best taught in conjunction with substantive content.

While there is evidence in the literature that higher order thinking skills may either be successfully included in the curriculum as an academic subject or integrated across all existing subject areas, the latter approach appears to be the most favored. Teaching higher order thinking skills in every subject does not decrease the amount of time spent on specific content material nor increase the numbers of subjects taught. Rather, the integrative approach provides additional opportunities for students to apply acquired thinking skills in diverse situations.

L. M. Martin (1988) stated that difficulties arise in attempting to motivate students or use inquiry learning in a classroom setting where a high degree of predictability is not expected and demanded. However, Petry (1980) suggested using the hands-on approach through a combination of both individual and group work with the focus on processes. In proceeding with hands-on activities, she further recommended that teachers access students' prior knowledge of a topic, categorize the information, then move to open inquiry to help students make inferences. After conducting hands-on activities, students would compare results against the information they categorized.

The process applied in discovery learning through the hands-on approach are those promoted in the use of higher order thinking skills in that students are expected to extend knowledge, increase understanding, and acquire skills in the structuring of a response (Egan, 1975). Higher level questioning challenges and motivates students to develop cognitive skills in inferring, analyzing, and synthesizing concepts and ideas.

Research on Hands-on Manipulatives

Though a review of the literature reveals various methods for increasing higher order thinking skills, research purports that one of the most effective strategies is to engage students in active learning through use of hands-on manipulatives. In a 3-year longitudinal study, students taught through developmental appropriate practices scored significantly higher in mathematics and science than students taught in classrooms using traditional approaches (Phillip, 1989). Penick and Yager (1983) concluded that working individually and in small groups with hands-on activities challenged students' thinking. In response to a survey, successful space scientists indicated that their most rewarding experiences were teachers who challenged their thinking and hands-on activities (Scholl, 1983).

Analogies and thinking-aloud processes are excellent strategies for problem solving. Thomas Good, an authority on mathematics education, indicated that thinking aloud about material provides students with structure for understanding relationships. Because of disappointing reports about poor mathematics achievement in American children (McKnight et al., 1987), many mathematics educators have diverted from basic drill and practice exercises to an emphasis on developing children's problem-solving and critical thinking skills (National Council of Teachers of Mathematics, 1980, 1989). The new approach emphasizes identification of key problem situations and the use of specific instructional strategies to arrive at solutions (Whimbey & Lockhead, 1986).

Research indicates that the teaching of mathematics is effective when instructional strategies are commensurate with children's thinking processes and natural solution strategies. The teacher motivates and directs the child's inquisitiveness and experimentation through particular forms of instruction such as with hands-on manipulatives. Manipulatives provide a connection between the concrete and abstract (Heddens, 1986); children can count, actively engage in the learning process, and actually observe concepts represented.

Worksheets and workbooks do not foster thinking skills and are often less intellectually stimulating and challenging than games. In her research on multisensory learning, Williams (1983) indicated that the alternative to paper-pencil tasks is to organize the classroom to provide experiences that stimulate high-level thinking and reasoning skills. The mathematical program should be based on manipulation of real objects, allowing students direct experiences to enhance logical thinking and problem solving. Moreover, the program could be centered around science wherein students engage in direct experiences with the phenomena under investigation. This type of learning is intrinsically motivating to children and provides a solid foundation for future learning (Williams, 1983). Furthermore, this type of classroom organization allows time for developmentally immature students to grow without the stigma of failure. All children can work at their developmental level as they progress. Instructional activities should require children to use all of their senses: kinesthetic, tactile, auditory, visual, and graphic.

The kinesthetic-tactile approach to learning which involves touching and movement is necessary to use with children who have difficulty processing auditory and visual stimuli and with abstraction. These children acquire information more readily through touching and handling items. In academic subjects such as mathematics, hands-on manipulation of objects offer both concrete experiences as the basis for understanding concepts and providing kinesthetic stimulation (Davidson, 1982).

Davidson (1982) also pointed out that it is important to differentiate between materials that use a discrete or set approach and those that use a continuous or length approach, and that both should be used in a program. A discrete approach uses counters and grouping of objects, while a continuous approach entails use of measurement and spatial concepts.

Math Their Way is a program of activities using concrete manipulatives in a discrete approach. Activities are sequenced and material is geared toward the teaching of basic cognitive skills such as logical thinking and pattern recognition in introducing mathematical concepts and operations. Cuisinaire rods and base 10 blocks use a continuous approach wherein relationships are represented spatially. Though both types of material present the same concepts, each type contributes to the development of different mental functions (Baratta-Lorton, 1976).

Using hands-on manipulatives bridges the instructional gap from an abstract to a concrete approach, making difficult concepts and material easier to understand and remember.

Summary

The discussion of the literature revealed various philosophies of how people learn and how learning strategies are incorporated into classroom activities.

The historical perspective of critical thinking revealed theories by educators promoting activities of an experimental, explorative, and inquiry nature.

Research pertaining to the definitions of critical thinking suggest a variety of theoretical perspectives resulting in the lack of a specific definition. However, a multitude of thinking skills programs exist, as well as research studies regarding the effectiveness of each.

The discussion of the literature indicates the necessity of teaching higher order thinking skills, and actively involving students in the learning. Lastly, the literature suggests the employment of hands-on manipulatives as a viable, effective instructional strategy for actively engaging students in the learning process.

In Chapter III, the methodology for determining whether active participation strategies using hands-on manipulatives increase students' higher order thinking will be discussed.

CHAPTER III

METHODOLOGY

Overview of Chapter

Chapter III consists of a description of (a) an overview of the research design, (b) the research environment, (c) the population and sample, (d) the instrument and procedure for collecting data, and (e) procedures used to analyze data. The research question in the study asked the following question: Does the use of active participation strategies increase students' higher order thinking skills?

Discussions reported in the review of literature of this document support the idea that active participation strategies presented through hands-on manipulatives challenged students' thinking and bridges the instructional gap from an abstract to a concrete approach.

An Overview of the Research Design

The conceptual hypothesis that students taught through use of active participation (independent variable) instructional strategies develop higher order thinking skills (dependent variable) than students taught using the conventional approach was investigated through experimental research. The research compared the use of two instructional methodologies in the teaching of a mathematics lesson on perimeters, hands-on manipulatives and conventional strategies. Hands-on manipulatives used in the experiment included tile and geoboards, whereas conventional strategies required the use of mathematics textbook, lecture, worksheets, and a mathematical formula. Thus, the study consisted of four groups of independent samples comprised of students' test scores from a three-item quiz. Two sets of scores reflected the use of hands-on manipulatives, whereas the other two resulted from the use of conventional strategies.

The Research Environment

Two elementary schools in different areas of an urban school district were selected for the study. Both schools are classified as Chapter 1 in that they receive federal funds due to high percentages of students with low socioeconomic status and achievement levels ranging at least 2 years below the age expectancy. The schools had approximately the same number of students enrolled, and both had two sixth grade classes. Shown in Table 1 is information concerning the demographics of the schools obtained from the district's 1994-95 census report:

Table 1

Demographics for the Two Schools

Demographic	School	
	A	B
Student enrollment	667	650
Class size:		
K-6	19.6	11.7
K-6 and special	18.7	18.6

Table 1--Continued

Demographic	School A	School B
Student absence rate	12.3	13.1
Student retention rate	0.0	0.0
Students by race (1-6):		
American Indian	1	5
Asian/Pacific Islander	3	0
African American	489	595
American Hispanic	0	2
White	4	6
Students eligible for free/ reduced lunch	331	512
Student mobility rate	48.8	67.2
Staff racial distribution:		
African American	41.5	29.7
White	58.5	67.6
American Hispanic	0	2.7
Staff distribution/gender		
Male	25.9	10.8
Female	74.1	89.2

The Population and Sampling Design

The research population consisted of 4 teachers, 2 in each school, and 102 sixth grade students comprised of four different classes. Teachers involved in the study had received extensive training provided by the district's instructional mathematics specialists in the use of hands-on manipulatives and used a combination of this approach and conventional teaching methods on a daily basis when instructing students in the area of mathematics. Students involved in the study were between the ages of 11 and 12 years old.

Instrumentation

Two instructional mathematics specialists developed the three-item quiz that was used to collect responses from student participants in the study. The purpose of the instrument was to assess students' measure of achievement resulting from the application of learned skills acquired through use of the instructional strategies employed in their classes. The nature of questions on the quiz required students to measure and calculate perimeters, find the perimeter of a region, graph, and draw a picture to solve a word problem. Specific questions on the quiz were as follows:

1. Find the perimeter of this garden.

2. Find the perimeter. The dining area is a rectangular room which is 3 meters long and 2 meters wide. Draw a picture to show the dimensions and solve.

3. Find the perimeter. Rectangle: length is 10 cm and width is 15 cm.

The Method for Developing the Instrument

The instructional mathematics specialists reviewed the research literature to find a mathematical curricular concept requiring sixth grade students to use analytical skills. Thus, the skill of calculating a perimeter was recommended by the National Council of Teachers of Mathematics (1989) as a skill required in the measurement standards for teaching connections between mathematical concepts to students in Grades 5-8. Analyzing skills are used to explain concepts by examining parts and relationships. When analyzing, one identifies and distinguishes components, patterns, reasons, or attributes. Analysis is the core of critical thinking (Bloom, 1965).

Showing relationships and patterns are common in the teaching of mathematics. The importance of analyzing patterns and relationships, using geometric figures and numerical relationships, and diagrams is reflected in many of the thinking skills programs (National Council of Teachers of Mathematics, 1989).

After the four teachers confirmed that the skill had not been previously taught to their students and agreed to use it in the experiment, the instructional specialist developed the instrument. Questions constructed for the instrument were similar to those used as examples by the National Council in determining a perimeter. The instrument was then reviewed by two other instructional mathematics specialists before being approved for use in the experiment.

Establishing Reliability for the Instrument

According to Best (1970), an instrument is reliable to the degree that it accurately and consistently measures what it purports to measure. The following approaches used to obtain reliability in this study are in keeping with recommendations in the literature pertaining to construction of an instrument, difficulty level of a test, consistency in administration procedures, and obtaining accurate scores (Ary, Jacobs, & Razavieh, 1979).

Prior to the experiment, the four participating teachers and the instructional mathematics specialist identified specific elements to be considered in developing criteria for the objectives, format, and design of the lesson to avoid bias in the lesson presentation. The data collected was used to make final decisions about procedures and the type of content materials. A list of these elements is included in Appendix J of this document.

The lesson objectives were formulated and evaluated against the preestablished criteria which included appropriate difficulty, time frame of the lesson, symmetry between abstract concepts and concrete application, and the potential for posttest measurement. The treatment conditions were designed to correlate or parallel with the lesson objectives.

In designing the instrument, the instructional mathematics specialist obtained input from the four teachers regarding the appropriateness of questions on the quiz and whether students should be able to correctly solve them. According to Babbie (1990), in his book entitled Survey

Research Methods, researchers can create a reliable instrument by asking people only questions to which they are likely to know the answers, ask about things relevant to them, and be clear in what is being asked.

The three-item quiz was designed to include the lesson objectives at the cognitive level of analysis which requires examining, integrating, and connecting elements of the test items in order to solve problems correctly (Bloom, 1965).

Another method to assure reliability was having the instrument reviewed for clarity by the third instructional mathematics specialist (Babbie, 1990).

The reliability of a test is in part a function of the ability of the individual who takes the test (Ary et al., 1979). In constructing the instrument for this study, the instructional mathematics specialist researched the literature to find an appropriate mathematics concept to test the cognitive skill of analyzing for sixth grade students. Also, the teachers in the study verified that the questions on the test were considered to be within the ability level of their students. Moreover, the nature of the questions on the test required accurate computation and calculation, eliminating the possibility of guessing the correct response.

Consistency in test scores were determined by testing all students in both groups on the same day, monitoring the lesson presentation, and using the same content material in each of the four lessons. To avoid error in test administration, the instructional mathematics specialist monitored each lesson to assure that teachers followed the preestablished procedures agreed to by everyone.

Reliability was also established for purpose of this study because the design of the instrument allowed for a direct measure of the dependent variable student achievement using hands-on activities (Campbell & Stanley, 1963).

Establishing Validity for the Instrument

An instrument possesses validity to the extent that it measures what it purports to measure (Best, 1970). Though validity may be defined in a number of ways, the measures employed in this study to assure qualities of a good test include characteristics of the types referred to as construct and content validity. Construct validity suggests that a test actually measures or specifically relates to the attribute(s) for which it was designed (Best, 1970). The term construct refers to something that cannot be measured but which has an observable effect, such as the concept of higher order thinking. Construct validity consists of both logical and empirical approaches (Ary et al., 1979). Content validity, however, is defined as the extent to which the test reflects the content of interest (Ary et al., 1979).

Empirical validity is concerned with the use of the instrument in predicting successful performance (Best, 1970). Making an accurate prediction may be accomplished by having experts in the content area develop criteria from which the test is constructed, as was the case in this study. Criteria for devising the instrument was established by the two instructional mathematics specialists and the four participating teachers after identifying the cognitive skill of focus from the curriculum written by experts on the National Council of Teachers of Mathematics

(1989). The criteria is outlined in Appendix K of this document.

In this study the experts who developed the criteria and designed the instrument have considerable experience in the content subject area. One of the specialists has a master's degree in mathematics with 7 years of classroom experience as a mathematics teacher for students in Grades K-8 and 15 years as a Chapter 1 compensatory education instructional mathematics specialist for the school district. The other specialist has a bachelor's and a master's degree in mathematics, with 10 years as a classroom teacher, 12 years as a compensatory mathematics instructional specialist, and 10 years as a mathematics staff associate for the school district.

One element of the logical approach is to ask if the elements the test measures are the elements that the construct is comprised of (Ary et al., 1979). The instructional mathematics specialist who designed the instrument patterned questions from those used as examples by the National Council of Teachers of Mathematics in calculating a perimeter at the sixth grade level. Input was received from the four teachers in the study as to the appropriateness of the test items for sixth graders. The instrument was also reviewed by two other instructional mathematics specialists before it was approved for the experiment by the district's research statistician who has considerable knowledge in the use of hands-on manipulatives.

The instrument in this study also possessed logical validity in that the higher order thinking skill of analysis was directly measured by all three test items. Students demonstrated the ability to analyze and interpret by connecting elements of the rectangular design and the multi-step word problems.

Methods for Collecting Data

Prior to the experiment, the instructional mathematics specialist gave specific instructions to teachers concerning procedures to follow in conducting the lessons with students. She instructed two teachers in the use of hands-on manipulatives and two in the employment of conventional strategies. All four teachers had been trained extensively by the district in using hands-on manipulatives. In both schools students and teachers were randomly assigned to a group and each of the classes were randomly divided into two groups for purposes of conducting the study.

The treatment consisted of a 30-minute lesson on calculating a perimeter taught in the classroom setting by the four teachers. Under the supervision of an instructional mathematics specialist, teachers taught each of the four groups with the same content material, except active participation strategies were used with the two experimental groups and conventional instructional techniques, without active participation strategies, were used to teach the other two groups.

Analysis of Data

Responses from each of the two classes taught using the same instructional strategy were totaled to form a group score. The t test of independent means and the Mann-Whitney test were used to compare the mean difference between group responses and to test the null hypothesis using the Statistical Package for Social Sciences (SPSS) procedures. Alpha was preset at the .05 significance level.

Summary

In summary, the purpose of the research was to investigate the conceptual hypothesis that students taught through use of active participation instructional strategies develop higher order thinking skills than students taught using the conventional instructional approach. Four teachers, under the supervision of an instructional mathematics specialist, conducted a 30-minute lesson to 102 sixth grade students on calculating a perimeter. Though all teachers were trained extensively in the use of hands-on manipulatives, only two of them employed this approach. The other two used the conventional instructional methodology consisting of lectures, textbook review, board demonstration and worksheets. Upon conclusion of the lesson, students were administered a three-item quiz to assess their measure of achievement resulting from the analysis and application of learned skills acquired through use of the instructional strategies employed in their classes.

In Chapter IV, the descriptive data for the three-item quiz are presented and the inferential data for the null hypothesis are analyzed.

CHAPTER IV

DATA ANALYSIS

In Chapter IV, the results of the data analysis is reported and explained for the null hypothesis tested to compare differences in instructional methodologies for increasing students' higher order thinking skills. The chapter is organized in the following manner: (a) a summary of the research, (b) employment profile of teacher participants, (c) an explanation of descriptive data, and (d) an explanation of the hypothesis testing.

Summary of the Research Design

The purpose of the research was to determine whether the use of active participation instructional strategies increase students' higher order thinking skills rather than conventional instructional strategies. Active participation instructional strategies was the independent variable of the study and higher order thinking skills was the dependent variable. The mean was used to operationalize the hypothesis.

The research was conducted in two urban elementary schools with 102 students and 4 teachers who had received extensive professional development using hands-on manipulatives to teach mathematics. Two teachers in each school taught a 30-minute lesson to students in their classes on calculating a perimeter. The two experimental groups were taught using active participation strategies and conventional strategies were used to teach the control groups.

Immediately following the lesson, each teacher administered a three-item quiz to students without the use of hands-on manipulatives. An instructional mathematics specialist observed the lessons and recorded the presentations to assure consistency and similarities in each teacher's delivery procedure.

Responses from each of the two classes taught using the same instructional strategy were totaled to form a group score. The t test of independent means was used to compare the mean differences between group responses and to test the null hypothesis using Statistical Package for Social Sciences (SPSS) procedures. Alpha was preset at the .05 significance level. A Mann-Whitney U-Wilcoxom Rank Sum W Test was also performed to compare mean rank scores of the two groups.

Tables 2, 3, and 4 summarize the profiles of teacher participants in the study.

Table 2

Profile of Teacher Participants

Teacher	No. of years teaching	No. of years teaching mathematics
1	3	3
2	22	7
3	18	10
4	2	2

Table 3

Profile of Teachers Using Hands-on Manipulatives

Teacher	No. of years teaching	No. of years teaching mathematics
1	22	7
2	2	2

Table 4

Profile of Teachers Using Conventional Instructional Strategies

Teacher	No. of years teaching	No. of years teaching mathematics
1	3	3
2	18	10

Analysis of Inferential Data and Results of the Hypothesis

The t test of independent samples was used to test for statistical differences between the two independent groups using SPSS procedure. The t test determines whether the differences observed in the mean scores between the two sample groups are statistically significant. Alpha level was set at .05. The mean differences were compared between active participation and conventional instructional strategies in increasing students' higher order thinking skills.

Because the null hypothesis predicts the types of relationship to be observed between the two groups, a two-tailed test was used to interpret the results. When results can yield either positive or negative value, a two-tailed test must be used (Popham & Sirotnik, 1992). When a one-tailed test is used, the null hypothesis is likely to be rejected more often because the rejection area is confined to one tail. Therefore, a yielded value that may not be too far from the means can still be considered statistically significant.

The results of the t test computed a p value of .019 which is less than the .05 alpha level ($t = -2.40$, $df = 87.84$, $p = .019$). Therefore, the null hypothesis of no difference in mean scores between the two instructional strategies was rejected. However, since the mean score of the control group was greater than the mean score of the experimental group, a treatment effect is not supported. Therefore, in this study, there is no evidence that using active participation instructional strategies increase students' higher order thinking skills. These scores are summarized in Table 5.

Similar results were found on the Mann-Whitney U-Wilcoxom Rank Sum W Test which was used as an additional measure to determine the differences in mean rank scores between the two sample groups. This instrument is based on the assumption that there will be considerable intertwining of ranking of scores from two similar groups. However, if the groups are different, the ranking will be higher for the superior group than those of the inferior group.

Inferential data from the Mann-Whitney U test shows that the calculated two-tailed value of p, .0211 is less than the alpha level of .05 (U = 967.0, Z = -2.3069, p = .0211). Therefore, the null hypothesis of no difference in mean ranks between the two instructional strategies is rejected. The data extracted from this instrument are summarized in Table 6.

Table 5

Active Participation Instructional Strategies/Conventional Instructional Strategies Increase Students' Higher Order Thinking Skills Using the t Test

Variable	No. of cases	Mean	SD	P/F two-tailed prob.	t value
Group 1	46	1.7826	1.134	.019	2.40
Group 2	56	2.2857	0.948		

Note. Group 1 = with manipulatives. Group 2 = without manipulatives.

Table 6

Active Participation Instructional Strategies/Conventional Instructional Strategies Increase Students' Higher Order Thinking Skills Using Mann-Whitney Test

Variable	Mean rank	Cases
Group 1	44.52	46
Group 2	57.23	56
Total		102

Note. U = 9.67.0, W = 2,048.0, Z = -2.3069, and two-tailed p = .0211.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

Overview of the Chapter

Chapter V is a summary of the research study. In this chapter, the problem and purpose of the study are reviewed, as well as the literature, results of the hypothesis testing, and a summary of the data. Educational implications and limitations of the study are discussed, and recommendations for future studies are suggested.

Summary of the Problem and the Purpose of the Study

The research study was conducted to determine whether the use of active participation instructional strategies increase students' higher order thinking skills rather than the use of conventional instructional strategies.

Educational preparation to assure that students function effectively in the scientific and technological era requires more emphasis on higher order thinking, reasoning, and problem solving in diverse situations (Forbes, 1984). One strategy for accomplishing this goal is to change from conventional instructional strategies to actively engaging students in the learning process through employment of hands-on manipulatives (Penick & Yager, 1983; Phillip, 1989; Scholl, 1983). However, data resulting from this study does not support the use of active participation as a viable, effective strategy for increasing higher order thinking skills.

In this study inferential data were used to compare differences in mean and mean rank scores of the two instructional approaches--conventional and active participation.

The Results of the Data Analysis and a Summary of the Data

In summary, the descriptive data showed the differences in the two instructional methodologies--active participation and conventional instructional strategies. The average mean scores from Groups 1 and 2 revealed that using active participation instructional strategies does not increase students' higher order thinking skills.

Hypothesis testing for the research included two independent samples for the mean at alpha level .05. The null hypothesis of no difference in mean scores between the two groups was rejected. Moreover, a treatment effect is not supported as the data indicated that the mean scores were higher for students taught using conventional instructional strategies. Therefore, the conceptual hypothesis that using active participation instructional strategies increases students' higher order thinking skills rather than conventional strategies was rejected at the .05 alpha level.

Limitations of the Study

Educational researchers postulate that reliability is often affected by random error resulting in discrepancies between scores in the administration of a measuring instrument (Ary et al., 1979). As random errors arise from a number of sources, it is conceivable that in this study the null hypothesis of no difference in mean scores between the two instructional strategies was rejected due to manifestations of random error in the limited sample size and the short test.

A limited sample of behavior is subjected to chance influences and often result in an unstable score (Ary et al., 1979). Therefore, larger sample sizes tend to be representative of higher reliability factors.

Researchers also theorize that longer tests have greater reliability in that they are more representative of the true score of the person taking the test (Ary et al., 1979). The fact that the test in this study consisted of three items may have caused students who knew the answers to obtain higher scores, whereas those who didn't know the answers achieved lower scores than they deserved. In a short test, luck is more of a factor than it is in a long test (Ary et al., 1979).

Another speculation for not obtaining adequate data in support of the hypothesis is the short time duration of the treatment component in the study. Perhaps the accumulative effects of incremental learning over a longer period of time could make a substantial difference in the total learning outcome of students. A study conducted by Sowell (1989) substantiates that manipulative materials do indeed have a positive effect on achievement when they are used over a long period of time.

The high mobility rate of students in both schools could have decreased the number of students having received instructions in the use of hands-on manipulatives.

A definite limitation of the study is that the research was confined to sixth grade students in Chapter 1 schools. Therefore, the results can only be generalized to a population with the same characteristics of age, socioeconomic status, and achievement levels. However, it is recommended that future research include students of varying ages and abilities.

Implications for the Educational Process

Data obtained in this study supports the use of conventional instructional strategies rather than the employment of active participation instructional strategies in teaching higher order thinking skills to students. The conventional approach focuses on the teacher as the dispenser of knowledge emphasizing use of the lecture, textbooks, and paper-pencil tasks. In contrast, the employment of active participation requires teachers to function as guides to aid in the discovery of student knowledge by engaging them in experiential and stimulating activities.

Though theorists emphasize the teaching of higher order thinking skills such as reasoning, problem solving, and applying and evaluating information (Narrol & Giblon, 1984) to prepare students for the technological society (Forbes, 1984), continuous research studies are needed to pursue additional effective strategies for such purposes.

As it is the responsibility of educators to help produce a citizenry with the ability to think critically in order to protect and maintain the democratic way of life, they must engage in the lifelong quest of identifying varying means of motivating students and increasing their academic achievement.

Recommendations for Further Study

As this study consisted of one lesson taught in a short time period, a longitudinal study is recommended to observe the effects of active participation instructional strategies on higher order thinking skills. Future studies in this area should also include a field study with teachers to develop and measure criteria for identifying critical thinking skills.

It is also suggested that further studies of this nature include larger sample sizes of students of varying ages and abilities. Student mobility rate could be controlled by selecting subjects who have maintained enrollment stability for a year in a designated school where hands-on manipulatives are employed on a daily basis.

In continuing to assess the effectiveness of active participation strategies on higher order thinking, the following studies can be conducted: (a) instructing students through primary learning modalities, (b) instructing students through primary intelligence modality, and (c) determining whether a relationship exists between the instructional focus of conceptual understanding and problem solving and the achievement of advanced mathematical skills on standardized tests. Research conducted by Gardner (1982) and Bruner et al. (1967) suggests that these variables are worthy of exploring to enhance knowledge of critical thinking and improve the quality of education.

Summary

As significant differences were found between the mean scores of the two groups (t = 2.40, df = 87.84, p = .019, the unequal variance used), the null hypothesis was rejected. However, since the mean score of the control group was greater than the mean score of the experimental group, a treatment effect is not supported. Therefore, in this study there was no evidence that using active participation instructional strategies increase students' higher order thinking skills.

In summary, the conceptual hypothesis that students taught using active participation instructional strategies develop higher order thinking skills than students taught using conventional strategies was rejected at alpha level .05. However, the literature verified that the use of hands-on manipulatives is a viable, effective instructional strategy for engaging students in learning.

APPENDICES

Appendix A

Questions Generated From the Literature

Questions Generated From the Literature in Development of the Instrument Measuring Students' Active Participation

Higher Order Thinking Skills

In 1989, the National Council of Teachers of Mathematics (NCTM) generated a major reform movement in school mathematics, eliminating curriculum focused on computational skills to fundamental goals of instruction relative to conceptual understanding, reasoning, and problem solving. This change was needed in Grades 5-8 as students viewed the existing curriculum as irrelevant, dull, and routine (NCTM, 1989). Moreover, a broader curriculum for students in Grades 5-8 was necessary to expand students' knowledge and prepare them for secondary school mathematics. Research in learning revealed deficiencies in the instructional approaches to teaching mathematics, and that technological advances in the last decade have eliminated the need for paper-pencil computational skills (NCTM, 1989).

Therefore, changes in the curriculum for students in Grades 5-8 include greater emphasis on topics such as geometry, probability, statistics, and algebra, which are crucial in that these concepts are required for success in advanced technology. Other features of the reformed curriculum demand the teaching of situations relating to real-life problems, mathematical reasoning, use of technology, and topic integration of mathematics with other subjects.

As specified in the NCTM's Curriculum and Evaluation Standards for School Mathematics, instructional activities in mathematics should require children to explore, justify, represent, solve, construct, discuss, use, investigate, describe, develop and predict. These actions require the teaching of higher order thinking skills in the academic curriculum.

Hands-on Manipulatives

Traditionally, mathematics education has been taught using the lecture-discussion approach with over-reliance on textbooks, memorization of facts, and drill and practice worksheets. Hands-on experiences were typically limited to a few students receiving additional support services in compensatory and special education classes.

Although the conventional approach allowed mathematics teachers to cover a great many topics, the quality of student learning it yielded has proven disappointing (National Assessment of Educational Progress, 1992). Many students can regurgitate what they learn, but their understanding of mathematical concepts is limited. This is evidenced on standardized tests measuring reasoning and problem-solving skills.

To alleviate these concerns, the mathematics education community promotes hands-on, inquiry-based activities as a reform initiative. Major themes in the reform literature (NCTM, 1989) includes the following:

Learning concepts should be emphasized over memorization of terms and facts.

Students should be given ample opportunities to engage in hands-on learning to explore, analyze, and apply mathematics.

Mathematics instruction should include an inquiry-based approach in which students pose their own questions, design and pursue investigations, analyze data, and present findings.

Academic activities should allow for the use of concrete material and technology.

The teacher should function as a facilitator of learning.

Students should be provided opportunities to apply mathematical knowledge and make connections between what they learn and their everyday lives.

Instructional activities should integrate culture background and build upon students' prior knowledge and understanding.

Mathematical assessment should be an ongoing process.

Questions Concerning Hands-on Manipulatives

The following questions were posed to teachers about their beliefs and practices regarding hands-on manipulatives and mathematics skills appropriate for sixth grade students:

1. Should students be involved in hands-on activities? If so, to what extent?

2. Should students interact with each other in cooperative teams?

3. Do students understand mathematics operations better when a concrete approach is used?

4. Is the skill of calculating a perimeter identified in the mathematics curriculum for sixth graders?

5. Can students use hands-on manipulatives to calculate a perimeter? If so, what items are appropriate for use?

6. Should students be involved in class presentations and demonstrations?

7. Should students evaluate their own work?

8. Should students evaluate their peers' work?

Appendix B

Recommendations From the National Council of Teachers of Mathematics

Recommendations for Classrooms

1. Each classroom should be equipped with a set of manipulative materials and supplies such as cubes, tiles, geoboards, and pattern blocks.

2. Teachers and students should have access to appropriate resource materials from which to develop problems and ideas for exploration.

3. Each student should have a calculator.

4. There should be at least one computer per classroom for demonstration and student use.

Appendix C

Teachers' Responses to Questions
Concerning Curriculum Reform

Teachers' Attitudes Towards Curriculum Reform in Mathematics Education

The four teachers involved in the study expressed enthusiasm about reform ideas and agreed that hands-on activities should be included in mathematics instruction. However, they identified several obstacles to implementing manipulatives in the classroom.

Using hands-on manipulatives require teachers to organize activities and find materials because of the limited school budget. Also, the majority of teachers have no training and lack directions about what to do with manipulatives. There is insufficient time to conduct activities in districts where demands are placed on teaching specific curriculum objectives. Overall, the teachers felt that mathematics should be taught using a combination of instructional approaches.

Appendix D

Human Subjects Institutional Review Board Approval

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899
616 387-8293

WESTERN MICHIGAN UNIVERSITY

Date: March 13, 1995

To: Griffin, Scottie, J.

From: Richard Wright, Interim Chair Richard A. Wright

Re: HSIRB Project Number 95-03-17

This letter will serve as confirmation that your research project entitled "The use of active participation strategies increase students' higher order thinking skills " has been approved under the exempt category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. This approval is conditional upon two revisions:

1. The assent statement needs only to be read to the class. There is no need for student to sign the form.
2. You must have a procedure in place to insure that no student participates in the experimental group who does not have parental consent.

You may now begin to implement the research as described in the application plus the two changes described above. Please send copies of the revisions to the HSIRB.

Please note that you must seek specific approval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date. In addition if there are any unanticipated adverse or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: Mar 13, 1996

xc: Warfield, Charles, EDLE

Appendix E

School District's Authorization to Conduct Research

Inter-office Memorandum

Research and Testing
Flint Community Schools

DATE: May 12, 1995

FROM: Stevan Nikoloff SVN

TO: John McCoy
Curtis Speights

RE: Research

Scottie Griffin and Carrie McCree have my permission to conduct a mathematics research project in your schools this spring.

SVN/jid

pc: C. McCree
S. Griffin

Appendix F

Authorization From Building Principals
to Conduct Research

February 28, 1995

From:
Mr. John A. McCoy
Pierson Community School
300 E. Mott Avenue
Flint, MI 48505

To:
The Human Subjects Institution Review Board
Western Michigan University
Kalamazoo, MI 49008-3899

Dear Sirs:

This correspondence serves as confirmation that Mrs. Scottie Griffin is authorized to conduct research at Pierson Elementary School between April and May of 1995. It is my understanding that the research will consist of a thirty-minute lesson to 6th grade students on finding the perimeter of a rectangle, and a three-item quiz to measure students' achievement from the instructional strategy used. The lesson and quiz will be administered by an instructional mathematic specialist in the district.

The purpose of the research is to determine whether the use of hands-on manipulatives are a viable effective instructional strategy for classroom teachers to use in increasing students' higher order thinking skills.

If there are questions, I may be reached at (810) 760-1666, between the hours of 8:00am and 4:30pm.

Sincerely,

John A. McCoy

John A. McCoy,
Principal

February 28, 1995

From:
Mr. Curtis Speights
Brownell Community School
6302 Oxley Drive
Flint, MI 48505

To:
The Human Subjects Institution Review Board
Western Michigan University
Kalamazoo, MI 49008-3899

Dear Sirs:

This correspondence serves as confirmation that Mrs. Scottie Griffin is authorized to conduct research at Brownell Elementary School between April and May of 1995. It is my understanding that the research will consist of a thirty-minute lesson to 6th grade students on finding the perimeter of a rectangle, and a three-item quiz to measure students' achievement from the instructional strategy used. The lesson and quiz will be administered by an instructional mathematic specialist in the district.

The purpose of the research is to determine whether the use of hands-on manipulatives are a viable effective instructional strategy for classroom teachers to use in increasing students' higher order thinking skills.

If there are questions, I may be reached at (810) 760-1643, between the hours of 8:00am and 4:30pm.

Sincerely,

Curtis L. Speights

Curtis Speights,
Principal

Appendix G

Parent Letter of Authorization

Western Michigan University
Department of Educational Leadership
Principal Investigator: Dr. Charles Warfield
Research Associate: Scottie J. Griffin

Dear Sirs:

I understand that my child has been invited to participate in a research project entitled, "The Use of Active Participation Increasing Students' Higher Order Thinking Skills." The purpose of this study is to determine the usefulness of the hands-on manipulatives as a viable effective instructional strategy for classroom teachers. I further understand that the purpose of this project is to fulfull Mrs Griffin's dissertation requirement.

My consent for my child to participate in this project means that my child will be taught a 30 minute lesson on finding the area of a perimeter and administered a three-question quiz to assess his/her measure of achievement resulting from the application of learned skills acquired through use of the instructional strategies employed in class. The lesson and quiz will be given during April or May and would involve about one class period. An instructional Math specialist with expertise in active participation strategies will teach the lesson and administer the quiz. Students are free at any time--even during the test administration-- to choose not to participate. If a student refuses or quits, there will be no negative effect on her/his school programming. Although there may be no immediate benefits to my child for participating, there may eventually be benefits to the school district and subsequently to all students.

I also understand that all test data and information will remain confidential. That means that my child's name will be omitted from all test forms. I also understand that the only risks anticipated are minor discomforts typically experienced by students when they are being tested, (eg, boredom, mild stress). I understand that all usual methods employed during testing to minimize discomforts will be employed in this study. As in all research, there may be unforeseen risks to my child. If an accidental injury occurs, appropriate emergency measures will be taken, however, no compensation or treatment will be made available to me except as otherwise specified in this consent form.

I understand that I may also withdraw my child from this study at any time without any negative effect on services to my youngster. If I have any questions or concerns about this study, I may contact either, Scottie Griffin at (810) 760-1450 or Carrie McCree at (810) 760-1006. I may also contact the Chair of Human Subjects Institutional Review Board at (616) 387-8293 or the Vice President for Research with any concerns that I have.

Subjects Institutional Review Board at (616) 387-8293 or the Vice President for Research with any concerns that I have.

My signature below indicates that I give permission for ____________________, (child's name) to participate in the experimental lesson and be tested. And if the strategy is useful, the results will be reported to his/her teacher.

________________________________ ____________________________

Signature Date

Appendix H

Letter to Students

Western Michigan University
Department of Educational Leadership
Principal Investigator: Dr. Charles Warfield
Research Associate: Scottie J. Griffin

I understand that I have been asked to be in a research project that will find out what works best to help students learn about math problems: worksheets, or hands-on items such as rulers, base 10 cubes, and geoboards. The purpose of the study is to find out if the hands-on approach works better.

I understand that if I agree, I will be in a lesson on perimeters and take a short quiz to test what I learned. If I choose to be in the study, I understand that I will not get any credit, and if I don't wish to be in the study there will be no effect on my school grades. Even if I agree to be in the study I can change my mind any time after we begin the lesson or during testing.

If I choose to be tested, and if these test scores prove to be helpful, you will report these scores to the teacher. If they are not helpful, they will not be shared with the teacher.

I understand that my name will not be on any of the forms.

If I have questions or concerns about this study, I may contact either Mrs. Griffin at (810) 760-1450, or Mrs. McCree at (810) 760-1006.

Today's Date ______________

Appendix I

Instrument

Instrument

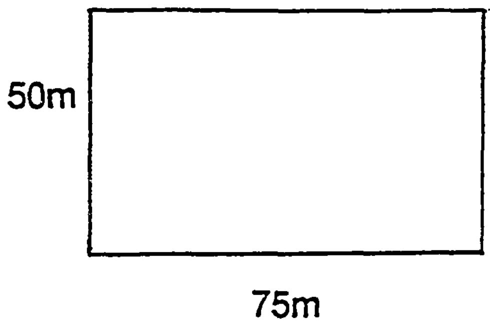
The following three-item quiz will be administered to students.

Quiz:

Directions: Use a centimeter ruler in performing measurements to answer the following questions. Do not write your name on the form.

PERIMETER

1. Find the perimeter of this garden.



2. Find the perimeter. The dining area is a rectangular room which is 3 meters long and 2 meters wide. Draw a picture to show the dimensions and solve.

3. Find the perimeter.
   Rectangle
   length: 10cm
   width: 15cm

Appendix J

Specific Elements as Basis of Criteria for the Lesson's Objectives, Design, and Format

Specific Elements as Basis of Criteria for the Lesson's Objectives, Design, and Format

The following elements specifically relate to teaching the higher order thinking skill of analysis. Consideration was given to the purpose the test serves, the appropriateness of difficulty of the task for sixth grade students, students accomplishments of prerequisite skills, and the time factor in teaching the lesson and taking the test:

1. The use of hands-on manipulatives and conventional instructional methods.

2. Determination of specific manipulatives and conventional strategies needed to teach the skill.

3. An inclusion of graphic designs to show relationships and distinguish patterns.

4. Use of geometric figures.

5. Construct a design requiring use of centimeter rulers.

6. Students' ability to measure accurately and to calculate the area of a rectangle.

Appendix K

Items Generated as Measures for Assuring Consistency Across Treatment in Lesson Presentations

Items Generated as Measures for Assuring Consistency
Across Treatment in Lesson Presentations

1. Lessons to be taught in the a.m.

2. Teachers adhere to their individual teaching style.

3. Teachers adhere to their individual management style.

4. No excessive teacher praise or unusual enthusiasm.

5. All teachers use the same content material.

6. Not varying from the lesson.

7. Teachers identified appropriate use of manipulatives and conventional strategies.

8. Each teacher stay within the established time line for teaching the lesson.

Appendix L

Lesson Presentations on Finding Perimeter and Area and Lesson Objectives

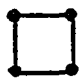
USING HANDS-ON MANIPULATIVES
(Experimental Group)

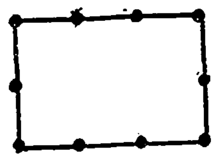
1. Students walked the length and width of the classroom and counted the number of floor tiles. Afterwards, they multiplied the length times the width to calculate the area.

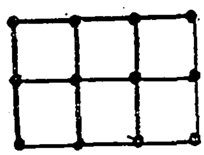
2. Tiles were used to construct replication of the floor plan. (students calculated the total units of tiles).

3. Geo-boards and rubber bands were used to determine:

   (a) unit 

   (b) square units 

   (c) perimeter (distance around rectangle) 

   (d) square units were counted to determine the area of a rectangle 

4. Centimeter rulers were used to measure the perimeter of a rectangle and divide the rectangle into equal square units.

5. Administered the test without manipulatives.

(a) students drew square units to demonstrate that they understood the concept of dividing a rectangular region into square units to find the area.

(b) answers were calculated

Strategies/Materials Used

1. Tiles
2. Geo-boards
3. Rubber bands
4. Centimeter rulers
5. Overhead projector

LESSON PRESENTATION on FINDING PERIMETER and AREA

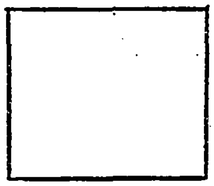
Without Hands-On Manipulatives
(Control Group)

1. Definition of perimeter

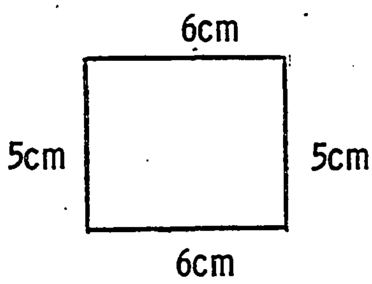
(distance around a region – a rectangle was used as an example to show students how to find the perimeter)

Used the chalkboard to:

(a) draw a rectangle

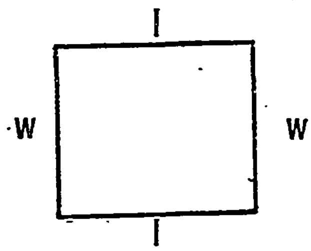


(b) label the dimensions of the rectangle with width and length.

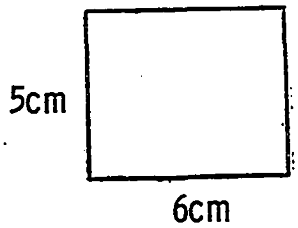


(c) graphically explain formula

$P = l + w + l + w$



(d) Calculate (sum) the length and width of all sides of the rectangle.

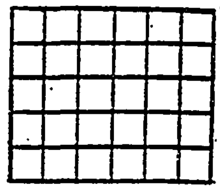


$6 + 5 + 6 + 5 = 22$

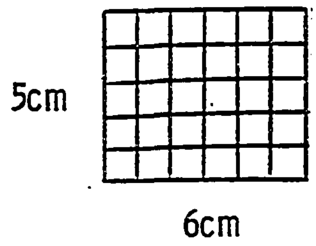
$P = 22$

2. Definition of area
   (a measure inside a region)

   Used the chalkboard to:
   (a) draw rectangle on the board and sectioned into square units



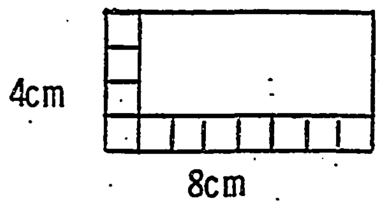
   (b) count square units of the rectangle and calculate the width and length to determine the area (multiply).



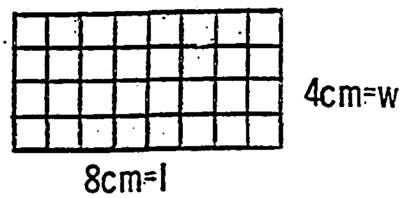
3. Used examples in textbook to

   Present: formula for calculating area of a rectangle (A = l x w)

   (a) drew picture of a region including dimensions of width and length



   (b) students drew square units inside of the region



   (c) square units were counted to determine the area of the region.

$$A = 8\text{cm} \times 4\text{ cm} = 32\text{ cm}^2$$

(32 square centimeters)

4. DISTRIBUTED WORKSHEET CONTAINING PROBLEM

MATERIALS/STRATEGIES

1. WORKSHEETS
2. FORMULA
3. CHALKBOARD
4. TEXTBOOK

5. ADMINISTERED THE TEST WITHOUT MANIPULATIVES

Lesson Objectives

1. Students will measure and calculate perimeters.

2. Students will find the perimeter of a region.

3. Students will find the perimeter through use of manipulatives--tiles and geoboards.

4. Students will find the perimeter using a formula ($\underline{p} = l + w + l + w$).

Appendix M

Summaries of Learning Theories and
Learning Styles Theories

Summary of Learning Theories

Theorist	Learning paradigm
Thorndike	Reward strengthens the connection between a stimulus and a response.
Skinner	Reinforcement increases the probability of a response reoccurring.
Gestalt	Reorganizing of perceptions.

Summary of Learning Styles Theories

Theorist	Learning paradigm
Hunter	Student success directly related to varied instructional strategies and activities to accommodate different learning styles.
Gardner	Students should be instructed through dominant intelligence(s).
Sperry	Teach students through predominant hemisphere of brain.

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