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An assessment of hands-on activity-based science for summer school remediation

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AN ASSESSMENT OF HANDS-ON ACTIVITY-BASED SCIENCE
FOR SUMMER SCHOOL REMEDIATION

by

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APPROVAL PAGE

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STURDIVANT, LEON HARLIE, Ed.D. An Assessment of Hands-on Activity-based Science for Summer School Remediation. Directed by Dr. David B Strahan. 160 pp. (1993)

The purpose of this investigation was to examine, assess, and evaluate the appropriateness of hands-on activity-based science for summer school remediation at the middle school level as related to students' attitude toward science; achievement in science; goal orientation as well as teachers and students perceptions of cognitive engagement within the instructional environment. The research sample was comprised of 130 middle school students, all whom were identified as at-risk. The students were in 10 science classes taught by four science teachers. A survey, a questionnaire, and a series of student and teacher interviews were used to examine and evaluate results. A pretest/posttest design was used for the survey and the questionnaire to compare and contrast data. Interviews were facilitated to evaluate teachers and students perceptions of the hands-on science approach. The study lasted for the four-week summer school period. Staff development in-services were provided to teachers who participated in this study. The purposes of the teacher in-services were to provide materials, strategies, and training in the use of hands-on activity-based approach to teaching.

The data collected suggested that student attitude toward science improved with a hands-on approach. Students were generally involved in science when the hands-on approach was used and they described hands-on science as

"fun". Student achievement improved greatly, 96% of all students in the study passed science. Results showed a goal orientation shift of 25.5% toward task-mastery. Students and teachers were significantly more cognitively engaged within the instructional environment. These results suggested that hands-on activity-based science was an appropriate and effective approach of summer school science remediation for middle school students.

CHAPTER I

INTRODUCTION

A growing number of educational researchers have begun to focus on cognitive processes related to hands-on science within the instructional environment of the classroom (Blumenfeld, 1988; Hoyle, 1987; Miller, 1990; and Meece, 1988). This emerging trend has been supported by the idea that current technological advances are constantly outdating scientific knowledge and generating new knowledge at a speed beyond the level of the grasp of human comprehension. The scientific process skills required to understand the evolving technological world have changed very little over the past century. These process skills of experimenting, scientific thinking, and reasoning have been essential to teaching hands-on science. A hands-on approach has encouraged students to become more scientifically literate. It involves teaching students how to do science and how to make decisions about societal issues that affect everyday life.

The hands-on approach to science education had its origin in the early 1960's with pioneers such as Jerome Bruner and Richard Suchman. They proposed to revolutionize science teaching by a process oriented, hands-on inquiry-approach to science education. The goals of this new science curriculum were as follows:

1. To increase scientific literacy;
2. To promote scientific discoveries and inventions;
3. To attract more scientifically literate people to science careers;
4. To create and maintain a scientifically literate society.

Yet, 30 years later in 1992, several recent studies approved by the National Science Foundation (NSF), the National Science Teachers' Association (NSTA), and the National Commission on Education (NCE) unanimously agreed that the goals of scientific literacy had not been accomplished. Evidence to support this view was as follows:

1. American students are technologically illiterate possessing few if any of the cognitive science skills needed to function successfully in the world today (Johnson, 1990);
2. It is increasingly difficult for high technology firms to find the scientists and engineers to make tomorrow's discoveries (Lynch, 1992);
3. American colleges and universities are facing a dwindling number of students majoring in science fields (Schaeffer, 1991);

4. Japan is more advanced technologically than the United States in the global economy (Schaeffer, 1991).

This evidence pointed to a need for teaching all students to become scientifically literate by improving the science education program in the schools.

Background

At the same time that educators have attempted to improve science education in general, efforts to promote scientific literacy among at-risk students have grown increasingly intense. This was in part due to the implication of the Peter W. Court case in which a student sued the State of California for graduating from high school and not being able to function beyond an 8th grade level. This case caused each state to emphasize promotion with accountability. As a result, the early 1980's experienced a national increase of students who were retained. Nationally, 13 percent of school grade students were retained in 1982 with the highest student percentage in the southeastern United States (Rose et. al., 1983).

Basic Education Act (1988)

As a part of North Carolina's accountability movement, the Basic Education Act was implemented in 1984. It required an annual testing program to determine who will be promoted in all core areas for grades 3, 6, 8, and 9.

Students who score less than the 25 percentile have been classified as non-promoted. These students have been required to attend a four to six week, state-funded summer school remediation program in order to pass on to the next grade. The North Carolina Science Test has been the instrument used to determine the state allocation appropriated to each school district for science summer school remediation. North Carolina Basic Education Summer School Remediation was modeled after the Dolan Study in 1982 (Rose, et. al., 1983). In this study, potential failures were identified early and were given special help. When the decision to retain was made, the parent was consulted for permission. An individualized and detailed education plan was prepared for remediation purposes. The children were not recycled through the same curriculum but were, instead, placed in special classes with low student/teacher ratios.

Characteristics of At-Risk Students

Students who attended summer school for remediation in science and other subjects have been characterized as at-risk students (Strahan and O'Sullivan, 1989). Students characterized as at-risk have often been potential dropouts, or marginal students who share common traits or characteristics. Common characteristics of these at-risk students have included low social economic background, residence in the urban or rural South, minority group status, or single-parent family (Wehlage and Rutter, 1986).

Strahan (1987) characterized the at-risk or marginal student as one who feels disconnected from school. These potential dropouts have often been low-achieving students who were frequently absent from school, were often in trouble and have been retained in grade level. "They have come to be called youth 'at-risk' because they are at risk of emerging from school unprepared for further education or the kind of work there is to do" (Smith and Lincoln, 1988, p. 2).

The Effects of Hands-on Science

"Students were motivated when they experienced repeated success through structured hands-on activities to the extent that they have learned to expect success" (Brophy, 1987). Hands-on science provided concrete, structured content activities that required students to learn by doing. These activities were structured to produce object manipulation and cognitive engagement to develop successful problem-solving skills. The effectiveness of the hands-on approach to science education as a positive correlation to student attitude, achievement and motivation was supported by other studies (Bredderman, 1985; Hawkins, 1983; Rowe, 1983; Shymansky, Kyle, and Alport, 1983). These studies provided evidence that this approach should be effective for middle schools students.

"Students who have difficulty reading, decoding and comprehending information lack essential skills for successful performance in many classes. These students withdraw, feel angry and come to see school as a social event" (Hare, 1987, p. 35). Hands-on approaches have been developed on the premise that at-risk students, who often lack the skills necessary to perform successfully on paper-and-pencil tests, can experience and achieve success in hands-on science activities where physical actions, senses and oral skills can be utilized. This hands-on activity approach was highly recommended for any summer school science remediation program. Hare stated, "Ruth Wellman (1978) and Ted Bredderman (1985), among others, have argued, a number of reasons children's success in hands-on science experiences often leads to academic and social improvements in general" (p.36). Additional evidence has suggested that students make greater gains in achievement and in cognitive development when they receive concrete rather than formal instruction (Bredderman, 1984; Saunders & Shepardson, 1987). Saunders and Shepardson state that "for learners who are reasoning at a concrete level, science laboratory activities, or more generally hands-on activities, may play an important role in at least two major educational outcomes: 1) science achievement and 2) cognitive development" (p. 39, 40).

Hands-on, activity-based science instruction can be structured and designed to provide students with successful remediation while enhancing student attitudes toward science and student learning. Recent evidence has suggested that particular concrete instructional strategies were effective when used with low achieving students (Cosden, 1988; Jones and Friedman, 1988). According to Jones and Friedman (1988) the connections between teacher behavior and student learning can be properly understood only in the instructional context. Research from Jones and Friedman (1988) and from other studies (Natriello, McDill, and Pallas, 1985; Tobin, 1984; Wang, Rubenstein, and Reynolds, 1985) has suggested that providing at-risk students with hands-on activity-based science would not be effective unless it was provided in the context of a supportive instructional environment. Elements of a supportive or effective instructional environment were identified in studies by Tobin (1984), Blumenfeld and Meece 1988, and Meece, Blumenfeld, and Puro (in Press).

Statement of the Problem

Evidence has suggested that a number of middle school students fail science (Johnson, 1990; Lynch, 1992; and Shaeffer, 1991). Thus, there is a need for the science educators in the United States to use new and innovative teaching approaches to address the problem of students completing high school "scientifically illiterate" and not able to function in our ever changing world. This problem is a particular concern for the remedial at-risk middle school students who repeatedly fail science. For this group of students, North Carolina Department of Public Instruction (NCDPI) under the Basic Education Act (1984) has provided a Summer School Program for science remediation.

A recent approach that has received attention of most educators is the hands-on activity-based science approach. Hands-on science is a process-oriented approach that provides concrete, structured content activities that requires students to learn by doing (Brody, 1987). Recent research supports hands-on activity based science approach as an effective teaching strategy for middle school students (Blumenfeld, 1988; Bredderman, 1985; Hawkins, 1983; Rowe, 1983; Shymansky, Kyle, and Alport, 1983).

The Purpose of the Study

The purpose of the study was to examine, assess, and evaluate the appropriateness of hands-on activity-based science instruction for middle school students attending summer school science remediation classes as related to students' attitudes toward science; achievement in science; goal orientation; and teachers/students perception of cognitive engagement in science within the instructional environment. A survey, a questionnaire, and a series of student and teacher interviews were used to examine and evaluate results. For the survey and questionnaire, a pretest/posttest design was facilitated to compare and contrast data. Interviews were used to evaluate teachers and students perceptions of the hands-on science approach. The research sample was comprised of 130 Greensboro Public Schools at-risk middle school students. The students were in 10 science classes taught by four science teachers. Each class consisted of students who had failed state or local promotion standards. The study lasted for the four-week summer school period. Staff development in-services were provided to the teachers who participated in this study. The purposes of the teacher in-service were to provide materials, strategies, and training in the use of hands-on, activity-based approach to teaching.

Significant Related Studies

This study was related to two other studies. The purpose of this section was to identify, describe, and give results of previous related studies. The following studies were identified to relate to this research:

1. Student's Goal Orientations and Cognitive Engagement in Classroom Activities (Blumenfeld, Hoyle, and Meece, 1988);
2. Effects of Hands-on Activity-Based Science and a Supportive Instructional Environment on At-Risk Goal Orientation, and Toward Science Achievement in Science, Goal Orientation and Cognitive Engagement in Science (Miller-Courtney, Anne, Dissertation University of North Carolina at Greensboro, 1990).

The Blumenfeld, Hoyle, and Meece Study focused on investigating the motivational processes that foster a high level of cognitive engagement in classroom activities. The results of this study indicated three important relationships.

1. Students who placed greater emphasis on task-mastery goals reported more active cognitive engagement. In contrast, students oriented toward gaining social recognition, pleasing the teacher, or avoiding work reported a lower level of cognitive engagement.
2. Student involvement did not differ significantly by difficulty of cognitive content, type of social organization or procedure complexity of tasks.
3. There was a direct correlation between teacher behavior to student's motivation and cognitive engagement. According to Blumenfeld, Hoyle and Meece, the predictors for learning were the degree of self-motivation, the extent of student involvement, and the level of teacher expectation communicated to students.

The results of the Miller's (1990) Study suggested several relationships of hands-on activity-based science instruction.

1. A probably correlation between student attitude and student achievement does exist.
2. A direct correlation was observed for at-risk students between task mastery orientation and cognitive engagement.
3. The quality of the instructional environment was positively related to the degree of students' cognitive engagement.

The Miller Study suggested the nature of the task taught by the hands-on approach enhanced the student's involvement and fostered more learning of science.

Two studies formed the major reference framework of this research. The Blumenfeld, Hoyle, and Meece study found that the teacher's behavior and communicated expectations were related to students' motivation and the degree of cognitive engagement. The extent of cognitive engagement was discovered to be related to students' goal orientation:

1. task-mastery goals reported high cognitive engagement;
2. ego-social goals reported moderate cognitive engagement;
3. task avoidant goals reported a low level of cognitive engagement.

This research suggested that if teachers can increase the level of students' cognitive engagement in science classes, then students would become more intrinsically motivated to adapt a positive attitude toward science, which could result in task-mastery goals. However, the Miller Study showed no positive relationship between cognitive engagement and motivation, attitude or achievement. It did show a strong correlation between increased task-mastery and cognitive engagement. Both studies support the notion that when students increased task-mastery, more active cognitive engagement occurred, which enhanced the quality of the instructional environment.

Hypotheses

The study will address the following hypotheses:

Hypothesis 1

Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a positive gain in attitude toward science by the Children's Attitude Toward Science Survey.

Hypothesis 2

Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher gain in achievement as measured by process-oriented science test scores expressed in numerical grade averages.

Hypothesis 3

Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher goal orientation toward task-mastery as measured by the Goal Orientation Scale of the Science Activity Questionnaire (SAQ).

Hypothesis 4

Middle school students in summer school remedial science classes who are taught CEPUP hands-on science would show more active engagement in science as measured by the Cognitive Engagement Scale of the SAQ.

Hypothesis 5

Students in the classes of teachers who incorporate hands-on science to teach summer school remedial students in their classrooms will demonstrate a high level of cognitive engagement as measured by the Instructional Environment Scale (IES).

Hypothesis 6

Teachers in this study who used CEPUP hands-on science activities to teach remedial summer school students will express the perception that hands-on science is an appropriate teaching approach for these students.

Assumptions and Limitations

The basic assumptions of the study were as follows:

1. Teachers could enhance the quality of students learning in science by using the hands-on CEPUP approach to teach science (Bruner, 1964; Halkitis, 1984; and Lynch, 1990).
2. Summer school students in homogeneous groups functioned differently than regular school students in heterogeneous groups (Blumenfeld, Hoyle, and Meece, 1988).
3. Students wanted to experience success in the science classroom in summer school (Doyle, 1984; Rose, et. al., 1988).
4. Teachers wanted to implement a science program that would involve students in active learning (Brophy, 1984; Blumenfeld and meece, 1988).

The following limitations were made:

1. This study was limited to a four week summer school science remediation period.
2. Some of the positive changes observed in a study of this duration may result from participating in a new hands-on approach.

Definition of Terms

Active cognitive engagement is a self-regulated student learning process. It is observed when students' initial learning strategies monitor time and effort and utilize resources for problem-solving that result in a better understanding of the relationship of new information to existing knowledge.

Attitudes toward science is an affective characteristic of students' thoughts and feelings about learning science, which involves interest, enjoyment and willingness to engage in scientific inquiry.

Goal Orientations are "a set of behavioral intentions that determines how students approach and engage in learning activities" (meece, Blumenfeld, and Hoyle, 1988, p. 514). There are three goal orientations; task-mastery, ego-social and work avoidant. Task-mastery-oriented students seek to master an understanding of their work. Ego-social-oriented students seek to impress the teacher or show high ability. Work-avoidant oriented students attempt to get work done with minimal effect. The differences in students' achievement can be explained by these behaviors relating to goal orientations (p.514).

Hands-on science is an instructional approach that involves students in manipulating concrete materials or objects for problem-solving activities. In this study, a science class is considered "hands-on," when the students are involved in direct manipulation or interactions with materials or objects for 25% of the time.

Instructional environment as defined by Miller, (1990) is composed of classroom factors that include the teacher, student, content, and context. This would include classroom climate factors such as teaching strategies, student grouping and teacher questioning.

Learning as defined by Meece et.al. (1988), "involves the active process of integrating and organizing new information, constructing meaning, and monitoring comprehension in order to develop a sound understanding of a subject matter" (p. 514).

Summer school remediation is a state-funded, four-week program offered at a regular school site for students who scored less than the 25% on annual testing in all core subjects.

Task as defined by Doyle and Carter (1984) "designates situational structures that organize and direct thought and action" (p. 130). These authors state that tasks with the same content, may differ in form, may involve different activities, procedures or properties and can vary in complexity.

Significance of the Study

Helping students to become scientifically literate should be a primary concern to educators as well as the general public. At the same time, teachers must expose students to specific science content areas which meet the curriculum requirements provided by the state departments, and/or school districts. However, the teachers have the flexibility in selecting and facilitating techniques, strategies and methods to accomplish curriculum goals. Many middle school teachers have the desire to use "hands-on" science with their students, but lack the training.

The study focused on examining and evaluating the appropriateness of the hands-on activity-based science for summer school remediation. Little published data exist on the use of hands-on science instruction for summer school remediation. The results of this study will provide valuable information concerning student's attitude toward science, achievement and goal orientation as well as teacher/student perceptions of their cognitive engagement with hands-on science within the instructional environment. The study findings can provide directions for science teachers to select an appropriate instructional approach for remedial classes.

Uniqueness of the Study

This study had several unique features which distinguished it from previous significant, related studies (Blumenfeld, Hoyle, Meece, 1988; and Miller, 1990). These unique circumstances may explain the discrepancies between the other studies and may show whether or not hands-on science is suitable for the highly at-risk students.

1. It was conducted with an at-risk remedial science population attending summer school.
2. It was focused system-wide for middle school students who were required to attend summer school to be promoted.
3. The Chemical Education Program for Understanding Project (CEPUP) would be the hands-on program used by trained science teachers to facilitate the study.
4. Student achievement would be measured by the process oriented tests in the CEPUP teacher's handbook.
5. The class size would be 15 students or less for each science class.
6. Student and teacher interviews would be administered to add a qualitative component to this research.

These six significant factors were not considered in the other two research projects. By applying further research of these special circumstances, more substantial information was gained about hands-on science as a suitable teaching approach for the at-risk students. Evidence about the effectiveness of hands-on activity-based science used with at-risk middle school students for summer school remediation was unexplored and implications of similar research in heterogeneous classrooms were inconclusive. The purpose of this study was to examine and evaluate the effectiveness of this approach when used for summer school remediation in a supportive instructional environment.

Summary

Hands-on activity-based science has been shown to be an effective approach for teaching middle school students. Most of the previous studies investigated the effectiveness of hands-on science instruction during the regular school year which consisted of heterogeneous classes of at-risk and non at-risk students. Several studies suggested that hands-on science instruction increased task-mastery and cognitive engagement and had a positive affect on students' attitude toward science for at-risk and non at-risk students. However, the appropriateness of hands-on activity-based science instruction for summer school remediation have not adequately been researched.

There was a need to explore new and innovative ways of increasing the scientific literacy of remedial students who fail science during the regular school year and were required to attend summer school. In this study, a hand-on activity-based science approach was facilitated in summer school to examine, assess, and evaluate the appropriateness of this approach for remedial students. A pretest/posttest design was used with four weeks between the sessions. Interviews were used to evaluate teachers and students perceptions of hands-on approach. Ten hours of staff development in-service were provided to all teachers who participated in this study. Teacher in-service provided materials, strategies, and training in the use of the hands-on activity-based approach within a supportive instructional environment.

CHAPTER II

REVIEW OF RELATED LITERATURE

The complex nature of the present study required a survey of the literature in several areas of educational research and development. The literature related to school science, in-service training for teachers, cognitive development, and hands-on science was especially useful in selecting the problem and designing procedures for the present study. The extensive scope of research and development which is relevant to the present study prohibited an in-depth analysis of the literature in each area. Consequently, a limited number of readings with special relevance for the present study have been selected from the four areas previously identified. In Chapter II, the selected readings have been reviewed and summarized with implications for the present study.

A Historical Perspective of Science Education

The antecedents of contemporary hands-on activity-based science education can be traced to the Nature-Study movement which developed during the latter part of the nineteenth century and dominated early science education until the 1920's. Nature-Study resulted from the combined influences of Romanticism and the "new" education growing out of the influence of Comenius, Pestalozzi, Rousseau, and Froebel.

The movement grew as a reaction to problems of urbanization. Nature-Study was intended to aid the farmer by making individuals so sympathetic with nature that they would enjoy rural life. Inculcation of aesthetic values and a moral commitment to nature was the fundamental purpose of Nature-Study programs.

Nature-Study received significant criticism almost from its inception. Critics cited the lack of organization, the use of anthropomorphic interpretation of nature, and extravagant claims for aesthetic and emotional values as weaknesses of the programs.

Although the Nature-Study movement was eventually replaced by an emphasis on problem solving skills, and science content with distinct social utility, several aspects of the movement have been modified and retained as prominent features in current programs. For example, the importance of the child as a developing biological organism with its own inherent needs, particularly as expressed by Froebel, was an influential factor in shaping details of Nature-Study programs. A similar, but more sophisticated, understanding of human growth and development is evident in many of the current science programs (Karplus, 1968).

Underhill (1941) noted that advocates of Nature-Study assumed that the "...immediate and casual interests of children should be the leading factor in selection of what is to be studied (p. 214.)" A similar position is taken by some of the recently developed early science programs. Underhill (1941) also noted the continued emphasis on first-hand observation which led to seasonal organization of materials, emphasis on field trips, and out-of-door nature experience. The Nature-Study movement was instrumental in establishing some of the theoretical framework and activities which have become characteristic of current hands-on activity-based science.

By 1925 a shift in emphasis in the aims for science education was emerging, and by 1932 a strong stance against Nature-Study was taken by the National Society for the Study of Education (NSSE Yearbook, 1932). The yearbook sanctioned the approach of Craig (1927) and advocated stressing generalizations in science rather than facts. The report of the Progressive Education Association's Committee on the Function of Science in General Education delivered in 1938 made a strong pleas for stressing the "problem solving" and "scientific method" aspects of science (Atkin & Burnett, 1969). Advocates of science curriculum emphasizing social utility and problem solving skills leaned heavily on the writings of Dewey (1933) for their theoretical base.

Commitment to objectives related to scientific method and problem solving remained a major feature of early science programs until the late 1950's. The evolution of well-defined objectives and effective teaching strategies related to problem solving is evident in many of the current hands-on activity-based science programs.

By the late 1950's the National Science Foundation (1962) was supporting an effort to develop elementary science programs based upon principles identified by research scientists. The characteristic which distinguished the wave of curriculum reform generated in the late 1950's was the participation of academic scientists as a central factor in curriculum development activities. The inclusion of academic scientists in curriculum development helped establish the academic credibility enjoyed by many hands-on activity-based science programs today.

A major issue in science education during the 1960's was the relative stress to be given "content" goals and "process" goals. The American Association for the Advancement of Science (Hall, 1961) sponsored a major study designed to review the status of school science and to formulate a plan for improvements. The study conferences involved scientists, psychologists, teachers, school supervisors and science educators. The report stressed the merit of a major focus on problems of school science education and advocated that "cognitive processes" be given special emphasis at the middle school level.

Suchman (1961), Atkin and Karplus (1962), Butts (1963), Heathers (1961) and others have reported studies that seem to indicate that the "content" approach, the "process" approach, or combinations of the two, can be effectively used as a basis for school science curriculum. Most schools during the 1960's developed, or accepted, programs that stress both facets of science. "It is probably impossible as well as undesirable to separate the two completely (Atkin & Burnett, 1969)."

Science Curriculum Improvement Study

The cultural and educational ferment of the 1960's resulted in several model programs sponsored by NSF. One of these model programs, Science Curriculum Improvement Study (SCIS), has special significance to the present study. Analysis of the SCIS project was instrumental in determining the criteria for hands-on activity-based science education programs proposed by the present study.

A concise historical summary of the project is located in the Clearinghouse Report (Lockard, 1968). It states:

The Science Curriculum Improvement Study was established in the winter of 1962 by Robert Karplus, a Professor of Theoretical Physics at the University of California, Berkeley, as a result of his work with the Elementary School Science Project (ESSP) at that University. This experience had led Professor Karplus to the conclusion that science had not only to be simplified for the elementary school, but organized on a drastically different basis from the usual logical subject matter presentations to which the university scientist is accustomed (p. 19).

Two broad objectives permeate the SCIS program; (a) intellectual development, and (b) scientific literacy. Thier's definition (Karplus & Thier, 1967) of "functional scientific literacy" states:

The individual must have a conceptual structure and a means of communication that enables him to interpret the information as though he had obtained it himself (p. 43).

The objective of scientific literacy is developed through concrete experiences and interaction among students and teachers. Decision-making ability is another major objective developed through an atmosphere of intellectual freedom and respect for the ideas of individuals (Thompson & Voelker, 1970).

The psychological basis of SCIS has been carefully developed. The works of Hunt (1961), Bruner (1968), Piaget (1964) and Almy (1966) lead the developers to conclude that the middle school years should provide:

1. A diversified program based heavily on concrete manipulative experiences. (Used guidelines of Piaget).
2. These experiences in a context that helps to build a conceptual framework.
3. A conceptual framework that permits them to perceive phenomena in a more meaningful way; (i.e., integrate

their inferences into generalizations of greater value than the ones they would form if left to their own devices (Karplus & Their, 1967, p. 43).

While the primary focus of the SCIS program is on the cognitive domain, the affective and psychomotor domains (Bloom, 1967) are also reflected in the philosophy of the program. The role of the affective domain in learning is seen as a circular process whereby interest leads to involvement and success. Success, in turn, leads to heightened interest. The emphasis on concrete experiences provides opportunity for students to improve their psychomotor skills (Thompson & Voelker, 1970).

The SCIS implementation program was designed to train science educators who wish to start SCIS projects in their communities. Participants attend one or two week training sessions which include classroom visits, informal discussions, and meetings with the SCIS staff. For educators unable to attend an implementation program prior to initiating the use of SCIS materials, a list of persons in the implementation area who can assist them is provided (SCIS Newsletter, 1969).

SCIS has attempted to provide evaluation as an integral component of curriculum development by establishing a strong task force to pursue test development and evaluation (Thompson & Voelker, 1970). An emphasis on the evaluation aspect of development is reflected in the quality and quantity of studies focused on the SCIS program. For example, the review of SCIS evaluation by Thompson and Voelker (1970) included more than 25 studies completed between 1963 and 1969. Information derived from the review of the studies was classified into two categories--"descriptive feedback," and "experimental."

The major function of descriptive feedback evaluation has been the modification and improvement of existing SCIS materials. Descriptive data have been collected through observative techniques and discussion with teachers, illustrating what occurs in the classroom. Karplus (1968) concluded that teachers are an invaluable source of critical analysis of materials and may have been a "major resource" in the SCIS project.

In observational study of 28 classrooms reported by Karplus (1968) it was discovered that a large percentage of time was being spent at the discussion level which is in contradiction to the SCIS philosophy. Results of the study suggest that teachers need in-service training when working with SCIS and similar programs.

Since the initial evaluation of SCIS materials, primarily for the purpose of revision, a second wave of investigations have been completed. Studies by Allen (1971, 1972), Stafford and Renner (1971), Bruce (1971), and Lawlor (1970) support the effectiveness of SCIS programs to achieve the three outcomes identified by Hurd and Gallagher (1968):

(A) an understanding of science principles, (b) skills for acquiring knowledge, and (c) favorable attitudes toward science. These desired outcomes of the SCIS programs were achieved by students manipulating concrete materials, making observations, and drawing logical conclusions.

Cognitive Development

Cognitive development involves long-term intellectual growth and learning (Costa, 1985). Cognitive skills are skills used in thinking, learning, understanding, and reasoning. Developing these "skills of the mind" rests on the analysis, integration, and evaluation of a vast quantity of environmental experiences, and on an understanding of these experiences (Clark, 1985). Piaget (1952) emphasized the principles of assimilation and accommodative interaction, believing that intellectual development resulted form one's active participation in the learning process, invariably sequenced into stages (Clark, 1985). A question concerning cognitive development theorists and early childhood educators has been "Can learning, or rather the benchmarks for development, be accelerated, or is it dependent solely on maturation?" (p. 57).

Modern research in cognitive psychology has offered some new thinking on the learning process. Individual abilities are not viewed as ceilings on learning but as indices of what the learner brings to the learning situation

(Kirby & Biggs, 1980). The notion that intelligence is a fixed and immutable character of the individual has been challenged by recent research that intelligence can be taught in the classroom under certain conditions (Levy, 1983). Research by Sternberg (1984) and Gardner (1983) clearly suggested that any student's intelligence can be nurtured. Marzano and Arredonodo (1986) have proposed that all student scan learn well if given the benefit of thinking-oriented curriculum and instruction.

Clark (1985) stated that a child's innate ability was in constant and continuous interaction with his environment, and the strength of that interaction will determine just how much ability he will be able to develop. "By the environment we provide, we change not just the behavior of children, we change them at the cellular level" (p. 21). She explained that the brain's unique synaptic activity could be accelerated by the richness of the environment provided. She stressed that educators needed to provide for an array of experiences and should encourage the cognitive processes of understanding, analyzing, organizing, integrating, and evaluating. This inferred that the structure of the instructional environment could determine the degree of cognitive development for students.

Hart (1986) in response to the current emphasis on teaching thinking skills, stated: "How can anyone claim that thinking is not a brain function? How can we ignore the incredible organ where thinking occurs, or-I would hold-not begin with exploring what we now know about it and can use immediately?" (p. 46). He expressed alarm that so few of the writers of thinking skills programs were familiar with the "flourishing" field of cognitive science. New directions in cognitive psychology are just beginning to have an influence on the teaching of thinking and on educators' perception of cognitive development (Brandt, 1986; Segal et al., 1985; Clark, 1985; Gardner, 1985; Hart, 1975, 1981, 1983a, 1983b, 1986; Kirby & Biggs, 1980).

Brain theory proposes that the brain is continually attempting to categorize and pattern new information with what is already learned. At a high rate of speed, and apparently in random order on both unconscious and conscious levels, the brain actively integrates and develops what Hart (1983, 1986) called "program structures" or "prosters." Brandt (1984), citing the research on brain-compatible learning (Hart, 1983b; Restak, 1980) explained the process of thinking and learning in this way:

> Our thinking starts with our current idea of something and changes as we accumulate impressions and information. What affects us most is direct experience. We do not absorb ideas ready made; we actually construct meaning for ourselves and reconstruct it over time (p. 3).

The most effective learning takes place when a student is challenged to "call up' the greatest number of appropriate programs,...expand on already existing programs, and... develop new programs" (Nummela & Rosengren, 1986, p. 50). Many factors may affect a student's thinking, including different temperament styles at birth (Thomas et al., 1970), critical periods of development and growth spurts (Clark, 1983), and cross development factors which may influence cognitive development (Piaget, 1952). However, if a lesson poses too little challenge, too little complexity, or too much threat, it will fail to stimulate the inner processing needed for more complex thinking and learning.

Levy (1983) inferred from current brain research that the human brain was built to be challenged and to understand itself. "I believe that children will learn best if their limits are stretched, their emotions are engaged, and if they are helped to understand themselves and their own special ways of thinking and seeing the world" (p. 71). Several theorists, however, have raised concerns about classroom conditions and teaching for learning. Haglund (1981) cited findings in human development and cognitive psychology, including Hart, 1975; Bruner, 1973; Epstein, 1977, and suggested that "students do not resist learning; rather the formal classroom setting is antithetical to inquiring minds..."(p. 225). The conditions for higher-level thinking are not apparent; an insignificant number of students leave secondary school stimulated or motivated to continue the learning process.

To foster the development of attitudes associated with thinking, Beyer noted that teachers could 1) model the desired disposition by seeking a variety of views or a number of alternative answers or solutions; 2) require that students display similar dispositions by giving reasons for thier decisions or by exploring a variety of viewpoints; 3) engage students, consistently and continuously, in learning opportunities to practice the behaviors; and 4) reinforce the appropriate dispositions by valuing and rewarding the behavior, not the student. He contended that effective, student thinking was not likely to develop without this attention to the affective dimension:

Considered attention to this aspect of the teaching of thinking is as important as is attention to metacognition and to systematic teaching of...specific thinking skills and strategies, if students are to become as proficient as possible in thinking (p. 214).

Marzano et al. (1990) identified three categories of attitudes and perceptions especially relevant to learning: 1) self and climate, which concludes perceptions about safety, comfort, and order within the environment; 2) self and others, which includes perceptions about teacher and peer acceptance; and 3) self and task, which includes attitudes about personal competence. In establishing an appropriate environment for learning and thinking, a teacher should provide equal opportunities for involvement, structure tasks for high success, and communicate to students a sense of confidence in their ability to accomplish classroom tasks.

Within a single classroom, students' interpretations of what is meaningful and important vary considerably, especially when social backgrounds vary (Good & Weinstein, 1986b). Frequently these perceptions have been learned in response to expectations communicated by the teacher through teacher-student interactions. Good and Brophy (1984) showed that some teachers varied markedly in their interaction with high and low-achieving students. These teacher behaviors toward low achieving students included calling on them less frequently; waiting less time for them to answer; either giving them the answer, calling on another without giving sustaining feedback, or giving little informative feedback; criticizing them more often for failure (as opposed to praising highs more for success); and asking them fewer higher level questions. Students are frequently aware of this differential teacher behavior, and such behavior can affect students directly, in that they have reduced opportunity to interact, think and learn; and indirectly, in that they form lowered perceptions of their own ability, and hence do not try any harder.

Weinstein (1983), in an article focusing on students' perceptions of schooling and classroom interaction patterns, cautioned teachers to be sensitive to and aware of students as active interpreters of socio-cognitive classroom interaction. Good and Weinstein (1986b) noted that ultimately, the nature of classroom interactions and communications of expectations depended on the teacher's beliefs about their own efficacy and about the limits of student abilities.

Hart (1983) explained that by creating a supportive classroom environment, a teacher could avoid the tendency of the brain to "downshift" when students feel threatened and their capacity to learn is reduced. New learning takes place primarily in the cerebrum, which works most fully in the absence of threat (Hart, 1986). His learning theory emphasized that classroom climate and instruction must be compatible with the nature of the brain, and not "brain-antagonistic" (p. 49), as many conventional classrooms are. The teacher's ability to generate trust and to engage students in meaningful and challenging learning is a powerful invitation. Barell (1985b) noted:

Of all factors...it seems to me that creating this warm, supportive environment is perhaps the sine qua non for higher-level thinking. Without trust, open communication, and a willingness to tolerate and encourage differences, little thinking can occur. Thinking requires what Bronowski called 'this constant adventure of taking the closed system and pushing its frontiers imaginatively into the open spaces where we shall make mistakes' (1978, p. 13). Going beyond the known into those new, unexplored territories and continents where we seek to make connections is risky business (p. 22).

Beyer noted that classrooms conducive to the teaching of thinking continuously invite-almost bet-students to think" (1984, p. 66). Seating arrangements that facilitate grouping and face-to-face interaction are more conducive to an exchange of ideas than lecterns and theater-style seating. These classrooms are typified by more student-student than student-teacher interaction. Students are expected to consider the ideas, contributions and arguments of peers and to value the quality of their reasoning. "Such classrooms virtually call out, 'It's okay to think! It's useful to think! Come on, let's think to learn!" (p. 68).

One of the biggest challenges teachers face is to help students to develop "habits of the mind" associated with thinking (Marzano et al., 1990). These include 1) being clear and seeking clarity; 2) being accurate and seeking accuracy; 3) taking a position and defending it; 4) being sensitive to the level of knowledge and feelings of others; and avoiding impulsivity (p. 21), Ennis (1985) has declared that these and similar behaviors were at the core of critical thinking. Research and theory in metacognition and self-efficacy (Brown, 1976; Flavell, 1976) have indicated that people could learn to be aware of their own thinking and evaluate its own effectiveness. Students develop these behaviors by interacting with adults who model such behaviors and by consciously practicing them (Marzano et al., 1990).

Why Students Fail Science

Doyle (1979, 1983) argues that curricular content is enacted via tasks students accomplish. As such, academic tasks can be thought of as the basic treatment unit in the classroom. According to Doyle, academic tasks are defined by the products students are required to generate and the cognitive processes they use to do so. Tasks thus influence learners by directing their attention to particular aspects of content and by specifying ways of processing information and presenting it for evaluation.

Social organization. Variations in the social organization of tasks place different participation demands on students (Berliner, 1983; Stodolsky, 1983, 1984a). Small-group and individual structures require a grater degree of student self-regulation and self-management for learning. Social organizational forms like small groups can promote understanding through the sharing of information (Sharan, 1980; Slavin, 1983; Stodolsky, 1984b); such arrangements can also encourage reliance on others as resources, thus decreasing personal responsibility and independent thinking (Corno & Mandinach, 1983: Webb, 1982). In contrast, whole-group lessons that involve lecture, demonstration, or recitation place the burden of instruction on the teacher. Not only is it often difficult for teachers to carry out cognitively difficult tasks in a recitation format, students do not always actively process material being presented (Peterson, Swing, Stark, & Waas, 1984; Tobin & Gallagher, 1987; Winne & Marx, 1982). In addition, recitations tend to be teacher controlled, formal and evaluative, which can negatively affect students' motivation to participate (Bossert, 1979; Eccles, Midgley, & Adler, 1984).

Procedural complexity. The complexity of procedures necessary for task completion also can affect student work orientation. Generally, completing a worksheet requires fewer materials and fewer steps than conducting an experiment. When procedures are complex, students are likely to focus their attention and spend time on aspects of the task that interfere with their successfully achieving the cognitive goal (Atwood, 1983; Blumenfeld et al., 1987; Hofstein & Lunetta, 1982)

Products. Products, or what students present for evaluation, are seen as critical in all discussion of tasks. The means students can use to complete products determine what is learned (Doyle, 1983). The form of the product determines how difficult it is for students to demonstrate knowledge or understanding of learning objectives. For instance, a worksheet requires students to fill in blanks or circle correct answers. In contrast, writing a report requires students to gather information, write grammatically, and communicate in a clear and organized manner. If the form of a product is complicated or ambiguous, students my encounter difficulty, request help, and focus more on the product than on its content (Blumenfeld et al., 1987; Doyle & Carter, 1984).

Teacher behavior. Tasks, of course do not exist by themselves in a classroom. They are assigned and orchestrated by teachers. Teachers establish and maintain instructional environments that promote or impede high cognitive engagement. How this occurs, however, is not entirely clear. Findings from classroom-based and experimental analyses (see reviews by Brophy & Good, 1986; Doyle, 1986; Weingstin & Mayer, 1986; Wittrock, 1986) indicate that students are more likely to assume an active role in the learning process when teachers use a more active learning approach. This involves: (a) providing clear directions, (b) relating information to what students already know, (c) suggesting ways to organize and learn the material, (d) modeling use of cognitive strategies, and (e) providing feedback that is immediate, informative, and identifies and corrects errors. These practices communicate expectations that students will learn; they also increase students' understanding of how and what to learn and therefore increase achievement.

In summary, elements of tasks and teacher behavior have been found to influence student achievement and attitudes. Characteristics of academic tasks (content, organization, procedures, and products) affect how students work and think. Aspects of teacher instructional and managerial behavior influence students' orientations to learning, their knowledge of how to learn, and their perceptions of the importance of learning, as the studies cited above suggest, the effects of tasks and teachers on students have generally been examined separately.

Encouragement of Engagement Through Hands-on Science

Blumenfeld, Hoyle, and Meece (1988) and Miller (1990) investigated the effects of hands-on activity-based science as related to student achievement and student attitude toward science. Blumenfeld, Hoyle, and Meece (1988) found that the teacher's behavior and communicated expectations were related to students' motivation and the degree of cognitive engagement. The extent of cognitive engagement was discovered to be related to students' goal orientation.

After each of four science lessons, students responded to questionnaires designed to measure task involvement as use of cognitive strategies. Cognitive engagement was defined by the number of self-regulating, rather than work avoidant or help-seeking strategies, children reported using. The type of cognitive engagement was similar for tasks judged as low and high in cognitive difficulty. Cognitive engagement was lower during small-group work than when tasks were procedurally complex. Qualitative analyses of patterns of teacher behavior suggested that when teachers pressed for mastery as well as for participation, students' cognitive strategy use was higher, and that the importance of particular behaviors for maintaining this engagement varied according to the lesson.

The results of the Blumenfield, Hoyle and Meece study (1988) indicated a positive correlation existed between teacher communicated expectations and student cognitive engagement. Teacher expectations were communicated as statements about task value, interest or relation of content to students' experiences or current events. This strategy gave the learning tasks relevance and served as a technique to motivate students to task mastery. The teacher expectations were further reinforced through behavioral and time management practices. Teachers actively monitored work performance, elicited participation and evaluated students' progress. Blumenfeld, Hoyle, and Meece (1988) concluded that there was a definitive direct correlation between teacher behavior and students' motivation and cognitive engagement.

Miller's dissertation study (1990); indicated that hands-on activity-based science was an effective strategy for teaching at-risk students. This population of (n-204) was subdivided into 2 groups: at-risk (n-64) and not at-risk (n-140). Both groups were taught for 9 weeks using the hands-on science approach during the second grading period of 1989.

Before the study began, all teachers that participated received a ten hour teacher in-service designed to show them how to teach hands-on science effectively. Pretests and posttests were then used to evaluate the effectiveness of hands-on science for at-risk students in five areas:

1. student attitude;
2. student achievement;
3. goal orientation;
4. cognitive engagement; and
5. instructional environment.

The results of this study supported the findings of Blumenfeld, Hoyle, and Meece (1988) that hands on science activities increased task-mastery, and cognitive engagement. Students who placed greater emphasis on task-mastery goals reported more active cognitive engagement. In contrast, students oriented toward gaining social recognition or avoiding work reported a lower level of cognitive engagement. Miller (1980) reported a strong correlation between the instructional environment and cognitive engagement. The correlation between cognitive engagement of students and the instructional environment suggested the teacher must take an active role in monitoring and encourage good performance to facilitate an effective hands-on science program.

Miller found no positive correlation between cognitive engagement, and motivation, attitude or achievement. Miller inferred that affective domain was not related to the observable effective domain.

The results of Miller's (1990) study suggested that while hands-on, activity-based science instruction did not have a positive affect on students' attitudes toward science or student achievement, a probable correlation between student attitude and student achievement does exist. Miller suggested that inconsistencies in her study might be explained by the fact that traditional teacher-made tests were used to measure student achievement. A process oriented test might have been more suitable to measure the success for hands-on science and might have yielded a significant increase in students' achievement and students' attitudes toward science.

Miller concluded that hands-on, activity-based science instruction did have a significant effect on the task mastery orientation of at-risk students and on at-risk students' cognitive engagement in science. Both task mastery and cognitive engagement increased significantly during the period of the study. The increase in task mastery and cognitive engagement were positively correlated with the quality of the instructional environment by encouraging higher cognitive engagement to promote task mastery.

The Hands-on Approach for Teaching Remedial Science

Based in part on the work of Blumenfeld, hoyle, and Meece (1988) and Miller (1990) the study examined, assessed, and evaluated a hands-on approach for teaching remedial science. It was conducted with remedial student population attending summer school. It focused on a broad spectrum of at-risk middle school students from a large urban district. This study used the Chemical Education Program for Understanding Project (CEPUP) as the basis for hands-on instruction. Student achievement was measured by the process oriented tests in the CEPUP teachers's handbook. CEPUP materials provided a basis for in-service activities that preceded the study.

Earlier studies have indicated that effective in-service programs are needed to provide teachers with the confidence and expertise needed to implement effective hands-on activity-based science programs. After a careful review of the related literature, Hone and Wilber (1969) cited four conditions which contribute to the need for in-service programs in science teachers.

1. Children typically are more sophisticated in some aspects of science than their teachers.
2. The great majority of teachers feel deeply inadequate about science.
3. Much of the pre-service course work of teacher in science is obsolete.
4. The individualized, open-ended activities and multiple materials of new (science) programs pose problems for teachers (p. 146).

In review of the SCIS project, Karplus (1968) recommended a laboratory-based in-service program which provides opportunities to become familiar with new materials and the responses of pupils through actual use of the materials in situations which simulated a classroom environment. Additional SCIS-related evaluation has indicated that in-service programs are most effective when:

1. Teachers participate in the program planning and implementation (Karplus, 1968).
2. An initial orientation to the new program is followed by continuous in-service assistance from consultant (Vivian, 1968).
3. Multiple media are used for instruction (Thompson & Voelker, 1970).

Dufee (1967) summarized a review of the related research by concluding that in-service education is most effective when: (a) teachers are trained to use methods and materials they must in turn use in the classroom, (b) teachers approve of the proposed program, and (c) cooperative planning is used to establish objectives and procedures for the training.

Summer School Design

A summer school science program was needed for at-risk students that would promote scientific literacy, enhance achievement and foster a positive attitude toward science. The present review of the literature supported the hands-on approach as a means to achieve these desired results. This hands-on activity-based science approach required students to be involved in the following was to solve problems:

1. object manipulation,
2. observation, and
3. logical thinking.

These processes allowed students to learn science by doing. To do science suggested a hands-on object manipulation process. To learn science indicated a mental cognitive process of awareness and understanding. Subsequently in this study, hands-on science will be used interchangeably with hands-on/minds-on science.

The researcher selected CEPUP as an appropriate hands-on/minds-on science program to implement in summer school for remedial middle school students. This CEPUP hands-on activity-based science curriculum was facilitated in this study for three reasons.

1. It was a well organized hands-on program with materials readily accessible for class use.
2. It dealt with a broad spectrum of societal issues related to fundamental scientific concepts.
3. It promoted scientific literacy and decision making.

All of these reasons supported CEPUP as a means to increase at-risk students' understanding of science and how it is related to the world in which they live. The emphasis on discovery of fundamental concepts by involving the learner made CEPUP ideal for the present study.

Several needed components were identified to successfully inplement a summer school students.

1. To have an adequate supply of CEPUP kits.
2. To have 10 hours of teacher in-service for each participant on how to teach CEPUP activities.
3. To have a schedule to administer pretests and posttests.
4. To have a schedule to conduct teacher and student interviews.

5. To frequently visit classroom and activity monitor and assess the instructional environment.

The strategies used to carry out this plan are explained in detail in Chapter 3.

Summary

The review of the literature revealed that hands-on activity-based science instruction has been shown effective when used with elementary and middle school students. Different programs have been tried with differing population of at-risk students during the regular school year. Several studies suggested that a supportive, instructional environment enhances student learning. In this study CEPUP materials provided a core set of hands-on mond-on activities. However, research showed no evidence of the effectiveness of hands-on, activity-based science instruction in middle school summer remediation program in a supportative instructional environment. In this study, the effects of hands-on, activity-based science in a supportive environment are examined. A pretest/posttest design was used with four weeks in between sessions. Teachers involved in the study were provided staff development in the form of materials, supplies, activities, and training in the use of instructional strategies and techniques.

CHAPTER III

METHOD OF RESEARCH

Overview

The purpose of this investigation was to examine, assess, and evaluate the appropriateness of hands-on activity-based science instruction for middle school students attending a summer school remediation program with regard to:

1. their attitudes toward science;
2. achievement in science;
3. goal orientation; and
4. cognitive engagement

with an emphasis on how elements of the instructional environment were related to high cognitive engagement.

The resources of computer services in the Educational Research Center at the University of North Carolina at Greensboro were used to compile, calculate, analyze and summarize quantitative statistical data. The Statistical Consulting Center of UNC-Greensboro and Dr. Rita Sullivan of The Department of Educational Administration and Research provided assistance with data interpretation. The Statistical package used to analyze this data was Statistic Analysis System (SAS).

Context of the Study

In 1984, North Carolina implemented a state funded-summer school remediation program under the Basic Education Act. An annual testing program was mandated in grades 3, 8, and 9 in all core subjects areas to determine who would or would not be promoted. Students who scored less than the 25 percentile were classified as non-promoted. These students were required to attend a four to six week state funded summer school remediation program in order to be passed to the next grade. The North Carolina Science Test was the instrument used to determine promotion and non-promotion in science.

As a part of the state and local accountability movement, all of Greensboro Public School students were tested in all core areas in March 1992. These tests were given, monitored and administrated in classrooms by a teacher and a proctor according with North Carolina Annual Testing Standards. The North Carolina Science Test was collected by each school guidance counselor and given to the local school testing coordinator to be sealed and sent to the Department of Public Instruction in Raleigh, North Carolina to be graded. The test results were returned to each school by May 10, 1992. The school counselor identified the students who scored less than the 25th percentile. Teachers were given a list of these students to complete an Education Instruction Plan (EIP) for summer school remediation. An eligibility letter was mailed on May 18, 1992 to each student who scored less than the 25th percentile in science requesting parental consent for their child to attend a summer school remediation in science. The consent letters were returned to the guidance counselor by May 25, 1992. Additionally, an eligibility letter was also mailed to the parent of each student who was failing science and one other academic subject, requesting parental consent for summer school remediation classes in science and at least one other core subject in order to be promoted. These consent letters were also returned to the school counselor by May 25, 1992. The number of consent letters each school received granting permission for summer school attendance in science would identify the summer school remediation population for science.

Greensboro Public Schools had six middle schools (Aycock, Allen, Jackson, Kiser, Lincoln, and Mendenhall). Each school defined its potential number of students attending summer school for science remediation. A science summer school teacher was selected to teach summer school based on each 15 students eligible per individual school. This way, the summer school site teaching staff was reflective of the regular school student population in attendance.

The summer school remediation program for middle grade students was integrated science, which represented a combination of life science, earth science, and physical science. The broad scope science curriculum was implemented in 1984 under the Basic Education Program. Its purpose was to integrate the teaching of scientific concepts so that students would better understand the world in which we live. This summer school science curriculum provided the flexibility and academic freedom to complete this research. Summer school science remediation had no specific textbook, curriculum guide or test for success like the Minimum Skill Diagnostic Test (MSDT) as in other summer school classes. The goal of science remediation in middle school summer programs was for the student to gain a better understanding of science concepts.

Due to the nature of this study, all summer school science teachers were encouraged to participate. and staff development was provided for all summer school science teachers. The focus group of this study was 130 middle school students (22 sixth graders, 22 seventh graders, 94 eighth graders) in summer school for science remediation. This sample included all students failing the North Carolina Science Test who enrolled in summer school science classes. Class enrollment ranged from 9 to 19 students with an average class enrollment of 14 students. Since no comparison group was available, the treatment used was internal. A pretest/posttest design was used with each student serving as his/her own control.

Selection of Participants

Based on the number of students failing the North Carolina Science Test, the population of this study was 130 middle school students attending summer school remediation science classes in grades: 6, 7, and 8 within the Greensboro Public Schools, Greensboro, North Carolina for 1992 summer school program. All of these students participating in this study failed science during the regular school year.

Teachers

Teachers of the six middle schools within Greensboro Public Schools are determined by the number of their students who failed state and local promotion standards in science. They submitted this number to a summer school interviewing committee who selected summer school teachers reflective of the proportionality of their students expecting to attend for science remediation. Teachers were hired by a 1 to 15 ratio. The teachers selected were certified in science with teaching experience in Greensboro Public Schools.

The summer school science teachers had an average of 14 years of teaching experience in science. All of the four teachers had used the traditional textbook approach during the regular school year. Therefore, they had little or no experience with teaching science by the hands-on approach.

All teachers were evaluated as above average science teachers by their school administrators.

Table 1 gives a breakdown of class enrollment by teacher and class period. The science class period was the first morning class for each teacher from 8:20 a.m. to 9:30 a.m. Second period was from 9:30 a.m. to 10:40 a.m. for each teacher. Only two 8th grade teachers had 3rd period science classes from 10:40 a.m. to 12:00 noon. Each class period was 1 hour and 20 minutes.

Each class was composed of middle school science remedial students attending summer school. Teacher A was a 6th grade teacher who taught two science classes with an enrollment of 22 students. Teacher B taught two 7th grade science classes with an enrollment of 22. Teacher C and D taught 8th grade science three periods each. Their class enrollment was 86 students. All teachers used the same hands-on activity-based CEPUP activities.

Table 1

Student Enrollment by Teacher and Science Period

Same Chart as given

Teacher	Grade	Science Period	Enrollment	Total
A	6th	1	13	
		2	9	
				22
B	7th	1	11	
		2	11	
				22
C	8th	1	17	
		2	10	
		3	12	
				39
D	8th	1	18	
		2	19	
		3	10	
				47
Total		10	130	130

All science teachers that participated in this study received a ten hour in-service on how to teach CEPUP hands-on science in a nurturing classroom environment. Each teacher was provided with a set of free classroom materials. The workshop and materials were sponsored by the CEPUP pilot science project (Greensboro Public Schools).

Hands-on, Activity-Based Science Project

The Chemical Education Program for Understanding Project (CEPUP), with its emphasis on hands-on science using organized modules to facilitate cognitive thinking skills to develop contextual understandings, and scientific literate processes used to make decisions about societal issues, made it ideal for this study. CEPUP was a diverse educational program highlighting chemicals and their uses in the context of societal issues, so that learners experienced the reality of science. Students collected and processed scientific evidence and used it to make decisions. As a result, they began to appreciate both the power and limitations of science. The goals of CEPUP were:

1. To provide educational experiences focusing on chemicals and their interaction with people and the environment;
2. To promote the use of scientific principles, processes, and evidence in public decision making;
3. To contribute to improving the quality of science education in America.

CEPUP did not teach people what decisions to make. Instead, it provided the necessary knowledge and understanding so that individuals could more effectively make their own decisions as participating members of a free and democratic society.

The Design Process

The CEPUP approach to materials design and development was based on the premise that effective instructional development takes place with the direct and continuous participation of classroom teachers.

Staff observations, scientific review panel comments, teacher feedback forms, students' success on cognitive and attitudinal assessment materials, verbal comments from teachers and administrators, completed student sheets, and analysis of used equipment packages, all provided feedback on the success of a module during pilot trials. Using this feedback, the staff decided whether to revise the module and produce a field test version. Modules revised for field tests were tried by up to fifty teachers distributed among eight to ten sites in different states. They were partially supported by a grant from the National Science Foundation, and materials were provided by Lab-Aids, Inc., the CEPUP equipment supplier. The field tests were under the direction of the CEPUP Field Test Center directors, who were educational leaders nationwide involved in the development of the project nationwide.

Field testing provided extensive evaluation data, which was used to produce a commercial version for distribution if the module was successful. The conceptual overview displayed the major concepts in the module. These were chosen after considering the current expectations for science education in major states and school systems nationwide. Chemistry-oriented concepts could be cross-referenced in the textbook or course curriculum. Process-oriented concepts were the skills of science. Societal issue-oriented concepts were those that relate specifically to societal concerns and were a major focus of all CEPUP materials.

The activity had a standard format in all modules. On the first page there was an overview, time recommendation, purpose statement, materials list, and preparation suggestions. This was followed by an introduction and step-by-step instructions. Where suggested, student questions were provided. We tried to anticipate the range of likely student responses to give some familiarity with how the activity would unfold in the classroom. At the end of the activity, there were blackline masters that could be duplicated for classroom use.

CEPUP and the Learner

CEPUP was designed for the middle school science student. During the middle school years, students become more independent in many ways, and the middle/junior high school expected greater independence and maturity on the part of its students. Academically, longer term, complex assignments became the norm. Essentially, there was a transition from the home-dependent years of childhood to the self-oriented, independent years of adulthood. Effective independent adulthood in our society requires that the individual be able to process, evaluate, and use evidence and ideas in order to make informed decisions in his or her own best interests as well as those of society. The emphasis on concrete experiences combined with inference and decision making helps foster the transition from concrete to abstract thinking which is so important to the intellectual development of learners at this age level.

The science curriculum coordinator for Greensboro Public Schools provided a certified CEPUP trainer for the in-service for summer school teachers. The in-service trainer must have completed 15 hours of CEPUP training in order to effectively instruct other teachers in this approach. A 10 hour teacher in-service was required before any teacher could use the CEPUP teaching kit to teach students.

Data Sources

There were seven different measures used in this study. These instruments included:

1. Children's Attitude Toward Science Survey (CATSS);
2. The Instructional Environment Scale (IES);
3. The Science Activity Questionnaire;
4. The Task Mastery Goal Orientation (TM) scale;
5. The Cognitive Engagement (CE) scale;
6. Summer school letter grade average; and
7. Interviews.

This research was facilitated by a pretest/posttest design in which students served as their own controls. Since no comparison group of at-risk students was practical, the pretest/posttest design was the best possible experimental design to use.

A similar pretest/posttest design was used in this study as in related studies (Blumenfeld, Hoyle, and Meece, 1988 and Miller, 1990). The teacher would give the pretests and posttests to students in each summer school remedial science class. Each teacher read directions and read each question and possible answer choices. Teachers were asked to write down any unusual circumstances or happenings. Students were told that all answers to questions were voluntary. Some students did not complete questionnaires. Each measure addressed how to treat incomplete data. The pretests were given on the first day of summer school. Posttests were given on the last day of summer school. Any problem or irregularity in administering either the pretest or posttest were reported.

Attitude Toward Science

The instrument used to measure student attitude toward science was the Children's Attitude Toward Science Survey (CATSS). Anderson, Enochs, and Harty (1984) developed this instrument by revising the "Attitude Survey for Junior High Science" (Fisher, 1973). Both of these instruments assured a high reliability level for middle school students.

A 20 Likert-type item design with five choices of responses was used on this instrument. The choices of answers were: (1) strongly disagree, (2) disagree, (3) agree, (4) strongly agree, and (5) undecided. Inconsistent answers on five of these items canceled out scores. The scores ranged from 20-100. A more positive attitude toward science was indicated by higher scores.

The validity of the original "Attitude Survey" was developed and refined by six science curriculum specialists. An evaluation of this instrument reported a split-half reliability of 0.83 and test/retest reliability of 0.79.

The Children's Attitude Toward Science Survey (CATSS), developed by Harty, Anderson, and Enochs (1984), was field tested by science curriculum specialists using 171 fifth grade students. The following reliability results were discovered:

1. Alpha internal consistency 0.78;
2. Split-half internal consistency 0.76; and
3. Test-retest 0.55 (P<0.05).

Checking or circling the correct response under each question was the format used in this study. An open-ended question was used to add a qualitative component to analyze responses. The open-ended question responses were coded as a positive, negative, or neutral attitude toward science. A negative code was assigned to responses such as "dull," "dumb," and "a waste of time." A neutral code was assigned to all non-responses, incomplete responses, and illegible responses, or such responses as "so so," "ok," or "interesting." A positive attitude toward science was assured by the following responses: "good," "I like it," "fun," and "I like doing the experiments."

Student Achievement in Science

Student achievement in science was measured by the sum of four test grades given at the end of each of the three science experiments. During the study teachers were not aware that these grades were used to measure student achievement. The teachers gave a process skills test from the CEPUP teaching kit after each experiment.

Student Goal Orientation

The Science Activity Questionnaire (SAQ) was the instrument used to measure student goal orientation. This instrument was developed by Meece et. al. (1988). It consisted of 39 Likert-type items that were adapted from several questionnaires (Ames, 1984, Nicholls, Patashnick, and Nolen 1985), and from pilot work (Nolen, Meece, and Blumenfeld, 1986).

Student goal orientation was classified into three scales:

1. Task mastery,
2. Ego-social,
3. Work avoidant.

Each student SAQ answer was rated on a four-point Likert scale (1) not at all true, (2) a little true, (3) somewhat true, and (4) very true. The mean score was calculated for each student under three categories on this Goal Orientation Scale. Table 2 listed the three categories for goal orientation, the number of items on each scale and the reliability coefficient alpha.

Table 2

Goal Orientation Scale (SAQ)

Scale	Number of Items	Coefficient Alpha
Task Mastery	9	0.94
Ego-social	3	0.85
Work avoidant	3	0.77

Student Cognitive Engagement in Science

The Cognitive Engagement (CE) scale of the Science Activity Questionnaire (SAQ) was used to measure students' cognitive engagement in science. This instrument consisted of 15 items on a 3-part Likert scale (1) a lot like me, (2) a little like me, and (3) not at all like me. Each student response was classified as two types of cognitive engagement; active or superficial. Table 3 shows the type of engagement, number of items per type, and the coefficient Alpha for each type.

Table 3

Cognitive Engagement Scale (SAQ)

Type of Engagement	Number of Items	Coefficient Alpha
Active Cognitive	8	0.87
Superficial Cognitive	5	0.79

Classroom Instructional Environment

An Instructional Environment Scale (IES) adapted from Tobin (1984) was used to measure the degree of supportive instructional environment in a science classroom. The instrument used in this study consisted of 14 items rated on a scale of 1 to 5. One, on the rating scale, represented the lowest rating indicating that the observer saw little or no communication of teacher expectation to students, five represented the highest indicating active teacher and student involvement in meeting high expectations communicated by the teacher. A highly supportive instructional environment was represented with a score greater than 3. Scores less than 2 indicated a negative non-supportive instructional environment. Scores between 2 and 3 indicated a moderately supportive instructional environment. One observer made all observations and evaluated ratings on the IES.

The quality of the instructional environment suggested by Tobin was related to teacher behaviors. There was high correlation between teacher behavior, cognitive engagement, and student achievement (Capie, Anderson, Johnson, and Ellet, 1979; Capie and Ellet, 1982; Blumenfeld, Hoyle and Meece, 1988; and Capie, Tobin, 1982). Examples of teacher behavior that enhanced learning on the Teacher Performance Appraisal Instruction (TPAI) are:

1. (Item #10) teacher helps students recognize the importance of activity;
2. (Item #12) teacher manages instructional time effectively; and
3. (Item #14) teacher manages disruptive behavior among learners.

The teacher performance variables and the rating correlations on the student engagement by Tobin are given in Table 4.

Table 4

Correlations Between Performance Variables on the IES and Student Cognitive Engagement

Variable Item	Correlation
1	.72
2	.63
3	.56
4	.62
5	.57
6	.58
7	.76 a
8	.54
9	.65
10 b	.24
11	.57
12 b	.17
13	.57
14 b	.44

a $\underline{P}$ < .01, all other items $\underline{P}$ < .05

b Items replaced with factors identified from Blumenfeld, Hoyle, and Meece Study, 1988.

Teacher Interviews

Another research approach used to evaluate the hands-on science activities within the instructional environment was the "teacher interview." The interview as an open-minded approach, valuable to in-field research because if provided data of rich and varied details which added depth when used in conjunction with other data. A structured interview was administered to three teachers to better understand the effects of the CEPUP hands-on science within the instructional environment.

The structured interview consisted of 14 questions that were revised from the Instructional Environment Scale previously mentioned in this study. Questions were revised from this instrument to better correlate the evaluation of the observer with the ideas and perceptions of the teacher. All four teachers were interviewed using the following questions:

1. Was the hands-on teaching approach appropriate for the objectives of the summer school science remediation student and the classroom environment? Explain!
2. What suggestions do you have about concrete materials, supplies, instructional aids used to teach these at-risk students in summer school science remediation classes?
3. Did the instrumental materials used provide the learner with appropriate practice on objectives? Explain!
4. What was done to interest students in the activities and make sure they understood the purpose of the activities and how to carry them out?
5. How was feedback provided throughout the lesson to affirm correct answers and to correct mistakes?
6. Explain the variety of teaching methods used in a particular class period?

7. How did you provide opportunities for individual, small and large group work?
8. How was each learner encouraged to participate, and provided the opportunity to participate, in various learning strategies?
9. Describe how you provided positive reinforcement for learners and encouraged the learner to maintain involvement?
10. What techniques did you use to involve all learners?
11. How did you attend to routine tasks such as organizing materials, distributing materials and collecting supplies?
12. How did you know if the learner had mastered the material or scientific concept?
13. How did you maintain appropriate classroom behavior?
14. What did you do to model cognitive strategies for students?

Each teacher who agreed to participate, completed a human subjects research form. All teachers interviewed were assured complete anonymity. The interviews took place the last teacher work day of the summer school program in the media center. Each teacher interviewed was scheduled for a 20 minute time period. All teachers were interviewed by the researcher. All interviews were recorded on audio cassette tape. After completing the interviews, a word per word written transcription was made for each respondent from the audio tape. The teachers interviewed were identified as Teacher A, Teacher B, and Teacher C. A direct quote of each teacher's response was recorded under each question. The most requent responses were used to attain the general positive and negative perceptions of their involvement and support of hands-on science for remedial students.

Student Interviews

A sample of 30 students was interviewed to add a qualitative component to this study. Three students were interviewed individually from each teacher's class after the third hands-on science activity. Each teacher selected three representative students to be interviewed. The purpose of the interviews was to gather more information about goal orientation and cognitive engagement to supplement responses to questionnaires. Students were asked to bring their work to refer to during the interviews. All interviews were recorded on audio cassette tape. Each interview took 5-10 minutes and was conducted by the researcher who observed the class and became familiar with the students. These students' interview questions focused on four areas:

1. Why the students were or were not involved in the lesson?
2. Did students understand the goal of the lesson?

3. What strategies did students use during the lesson?
4. Whether and why students thought it was important to understand the material or do well?

Each students' audio-taped responses were transcribed into a detailed narrative. All student responses were coded A, B, C, D to protect the identity of the participant. Responses were analyzed to discover patterns and relationships about goal orientation and cognitive engagement. The generalizations drawn from these interviews were helpful in interpreting the qualitative aspects of this study.

A proposed schedule of student interviews was helpful in organizing time and space variables for implementing study. There were 4 teachers, teaching 10 classes of science using 3 CEPUP activities in this study. Three students were interviewed per class after the following CEPUP activities:

1. Ground Water;
2. Toxic Waste;
3. Chemical Survey Solutions and Pollution.

Table 5 gives the proposed schedule.

Table 5

Student Interview Schedule by Teacher, Date, and Time

Class	Teacher	Student	Date	Time
1	A	A(1,2,3)	6/14/92	9:00-9:20
2	A	A(1,2,3)	6/21/92	9:00-9:20
3	B	A(1,2,3)	6/28/92	9:00-9:20
4	B	B(1,2,3)	6/14/92	9:45-10:05
5	C	B(1,2,3)	6/21/92	9:45-10:05
6	C	B(1,2,3)	6/28/92	9:45-10:05
7	C	C(1,2,3)	6/14/92	10:30-10:50
8	D	C(1,2,3)	6/21/92	10:30-10:50
9	D	C(1,2,3)	6/28/92	10:30-10:50
10	D	D(1,2,3)	6/29/92	9:00-9:20

All interviews were analyzed to identify common qualitative statements.

Summary

The research method used in this study was to examine, assess, and evaluate the appropriateness of hands-on activity- based science instruction for middle school students attending a summer school remediation program as related to attitudes toward science, achievement in science, goal orientation and cognative engagement within the instructional environment. A pretest/posttest design was used to compare, contrast, and evaluate quanitative data. Interviews were used to describe and evaluate teachers and students perceptions of the hands-on approach.

CHAPTER IV

DATA: RESULTS AND DATA ANALYSIS

Overview

The study investigated ways that students and teachers in remediation classes experienced a hands-on approach to teaching science. The results of this study addressed the question: How did summer school students and teachers assess and evaluate hands-on science as an approach for teaching remedial students?

The purpose of Chapter IV is to present the data collected in this study and to describe how the data were analyzed and interpreted. Results of the investigation are reported by the six areas defined by the research hypotheses:

1. Attitude Toward Science
2. Achievement in Science
3. Goal Orientation in Science
4. Cognitive Engagement in Science
5. Instructional Environment
6. Teacher's Perceptions

Student Attitude Toward Science

Hypothesis 1

> Middle school students in summer remedial science classes who were taught CEPUP hands-on science will show a positive gain in attitude toward science by the Children's Attitude Toward Science Survey.

The Children's Attitude Toward Science Survey (CATSS) was administered as a pretest and posttest to remedial science students to assess any change in attitude related to CEPUP hands-on science instruction. The CATSS consisted of 20 multiple choice statements and one open-ended question. Each statement had three response choices; agree, undecided, or disagree. The response agree meant that the subject thought the statement was true, undecided meant that the participant was not sure of a correct response, and disagree meant that the subject thought the statement was false. Pretest/posttest responses were totaled for each response choice by each statement. Each of the 20 statement pretest/posttest response choices was analyzed by cumulative frequencies of responses. The most frequent responses to the open-ended question were analyzed and reported as qualitative data.

For scoring purposes, student responses for the 20 statements on the CATSS were computed and analyzed in three categories (agree, undecided, and disagree) for the 130 subjects. If a student omitted one statement on the _CATSS_, the responses was scored an undecided. If a student omitted more than one response or did not complete the 19 responses, that survey was not included in the data.

The _CATSS_ addressed the following changes in student attitude toward science:

1. enjoyment of science
2. interest in science
3. curiosity for science

as related to _CEPUP_ hands-on science for middle school remedial students in summer school.

Results indicated that middle school students who were taught _CEPUP_ hands-on science demonstrated a more positive attitude toward science as predicted in hypothesis 1. Table 6 was designed to summarize students' changes in attitude on the 20 item _Children's Attitude Toward Science Survey_. It shows the cumulative frequency numbers of student pretest and posttest responses for each statement under the following categories: Agree; Undecided; and Disagree.

Table 6

Pretest/Posttest Frequency of Responses For Statements

Student Attitude on CATSS

Statement	Agree		Undecided		Disagree	
	Pre	Post	Pre	Post	Pre	Post
*1. Reading about science is hard for me.	38	25	15	14	77	91
2. I would like to spend more time doing science experiments.	86	95	33	17	11	18
3. I am learning a lot about science in school this year.	78	92	26	23	26	15
4. What we do in science is what a real scientist would do.	38	46	38	35	54	49
*5. In science class, we study "today's problem" related to science.	69	82	34	28	27	20
6. I do not like coming to science class.	64	51	14	25	52	54
7. I read more science materials than I did in regular school last year.	96	107	15	11	19	12
8. I enjoy doing the science activities.	101	115	17	15	12	0
9. I can solve problems better now than before.	86	96	30	20	14	12
10. My friends enjoy doing science experiments.	63	75	45	43	21	12
11. What I am learning in science will be useful when I am playing and at home.	61	74	26	25	43	31
12. I think about things we learn in science class when I'm in school.	59	78	25	0	46	52

*13. I do not want to have to take any more science classes than I have to.	74	83	21	20	35	27
*14. Science experiments or activities are hard to understand.	62	36	0	25	68	69
15. Reading about science is more fun than it used to be.	66	76	27	27	37	27
*16. Science is dull for most people.	110	74	0	41	20	15
*17. The things we do in science class are useless.	38	24	22	15	70	91
18. I learn a lot from doing science experiments.	99	120	19	0	12	10
19. Most people like science class.	57	81	42	36	31	13
20. The kinds of experiments I do in class are important.	58	91	50	24	22	15

Note: n-130 Pre = Pretest Post = Posttest

Total positive responses on Pretest = 1,339.

Total positive responses on Posttest = 1,575.

Total possible responses on Pretest and Posttest = 2,600.

* indicated items worded negatively

The total number of positive responses to each statement in Table 6 was calculated. Six statements on the CATSS were negative. For these negative statements, "disagree" responses counted as "positive" responses on the Pretest/Posttest. The other 14 statements were positive and the "agree" responses counted as positive responses. Only two statements (16 and 17) reported declines in positive responses on the pretest/posttest. Eighteen of the 20 items showed positive gain. The cumulative total of positive responses on the pretest was 1,339 while the cumulative total of positive responses on the posttest was 1,575. The total number of positive responses possible on the CATSS was determined by multiplying n-130 times 20 statements to yield a total of 2,600. Pretest/posttest percentages of positive responses were calculated by dividing 2,600 into 1,339 for pretest and 2,600 into 1,575 for posttest. The percentage of positive responses for the pretest was 51.5% and was 60.6% for the posttest. There was a 9.1% increase in positive responses on the posttest of the CATSS.

Patterns of Response Analysis

Responses to the 20 pretest/posttest items were categorized into three clusters: interest in science, enjoyment of science, and curiosity for science. Each response category was defined by the nature of the statement. There were five statements in the "interest" category, ten in the "enjoyment" category and five in the "curiosity" category.

The interest in science category was identified by statements (#3, #7, #9, #18, #20), whose responses indicated the amount of learning that is occurring or has occurred in the classroom. The examples of statements for the interest in science category that students responded to were as follows:

"I am learning a lot about science in school this year," "I can solve problems better now than before," and

"I learned a lot from doing science experiments."

The pretest/posttest responses were added together under the agree column in the table for the five statements indicating an interest in science. A total of 417 pretest responses showed some positive interest in science while a total of 506 posttest responses indicated greater positive interest in science. The enjoyment of science category was identified by statements whose responses indicated a desire to or a like for total involvement with classwork. Ten items (#1, #2, #6, #8, #10, #13, #14, #15, #16, and #19) in Table 7 represented the "enjoyment" category. Examples of statements for the enjoyment for science category that students responded to were as follows:

"I do not like coming to science class,"

"I enjoyed doing the science experiments," and

"Most people like science class."

To assess student pretest and posttest responses for enjoyment of science an average of pretest/posttest positive responses were calculated. The pretest positive response total for the ten enjoyment items was 637 and the posttest positive response total for the same items was 695. Posttest responses indicated a positive gain in student enjoyment of science.

In Table 6, five items (#4, #5, #11, #12, #18) represented the "curiosity" category. The curiosity for science category was indicated by statements whose responses indicated that science lessons were related to daily living. Examples of the statements that indicated the students curiosity for science were as follows:

"What we do in science is what real scientists do,"

"In science class, we study 'today's problem' related to science," and

"What I learn in science will be useful when I am playing and at home."

The pretest positive response total for the five curiosity items was 326 while the posttest positive response total for the same items was 400. These results suggested that students had more curiosity for science when the posttest was given,

The responses for the 20 statements indicated that hands-on science in summer school had a positive change on students' attitude toward science. Results indicated that students demonstrated that summer school remedial science classes who were taught CEPUP hands-on science showed a positive gain in attitude toward science in all categories.

Analysis of Written Responses

The Children's Attitude Toward Science Survey (CATSS) asked students to write responses to the following prompt: "I think science class...".

This last question on the (CATSS) was open-ended. The completion question was provided to offer all students the opportunity to describe their attitude toward science on the pretest and posttest. Examples of expected words that students would use to describe a positive attitude towards science were: "interesting," "exciting," "like science," or "it's cool." Examples of expected words that students would use to describe a negative attitude toward science were: "is boring," "waste of time," and "dull."

These comments supported the hypothesis that the remedial summer school students liked the CEPUP hands-on activity-based approach for learning science. Students thought that it was "interesting" and "fun" to learn science by doing experiments. The word most frequently used to describe CEPUP hands-on activities was "fun". Of the 130 students surveyed, 30 students on the pretest described science as "fun", and 70 students used the word "fun" to describe science on the posttest. The CATSS results showed that 53 students described science as "boring" on the pretest and 32 students described science the same way on the posttest. Other results indicated that 24 students had negative responses such as "dull," "boring," and "a waste of time" on the pretest and 16 students had similar negative responses on the posttest. There were no written response from 23 students on the pretest and no response from 12 students on the posttest.

Student Achievement

Hypothesis 2

> Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher gain in achievement as measured by process-oriented science test scores expressed in numerical grade averages.

Science test mean scores were calculated for summer school students by class. Teachers administered three CEPUP process-oriented tests in summer school. They recorded student test scores and computed mean scores for each class.

The teachers reported a mean test score range of (73.0 - 86.4) for classes of students who were taught CEPUP hands-on science. All classes mean scores for tests were within the Greensboro Public Schools passing grade range (70 - 100) for summer school students.

The Student Information Management System (SIMS) for Greensboro Public Schools was used to get final science grades for students who participated in this study. Two sets of final grades (1991 - 92 regular school and 1992 summer school) were retrieved and printed out from SIMS for the 130 subjects used in this research. The grades reported by SIMS measured students' achievements on a scale of A, B, C, D, and F. The highest passing grade on the scale was an A and a grade of F was failing. A grade distribution chart in Table 7 was made to illustrate the differences between regular school and summer school student achievement.

Table 7

Student Achievement Results: A Comparison of Student Grade by Percent Between Regular School and Summer School for 130 Research Subjects From SIMS

Grade	1991-92 Regular School		1992 Summer School	
	Student	Percent	Student	Percent
A	0	(0.0%)	18	(13.8%)
B	0	(0.0%)	34	(26.2%)
C	12	(9.2%)	62	(42.7%)
D	32	(24.6%)	11	(8.5%)
F	86	(66.2%)	5	(3.8%)
Total	130	100.0%	130	100.0%

Note:

A - Superior B - Above Average C - Average

D - Below Average F - Failed

Table 7 suggested an increase in achievement for summer school students compared to their performance during the regular school year. Eighteen summer school students made a final grade of A, while none of these students received a final science grade of A for the regular school year. Thirty-four summer school students had a final science grade of B while none of these students received a grade of B for the regular school year. Sixty-two summer school students had a grade of C while twelve of these students received a C grade for the regular school year. Eleven summer school students received a final science grade of D while 32 of these students received the same grade for the regular school year. Five summer school students received a grade of F while 86 of these students failed science with a grade of F for the regular school year.

Students were relatively more successful in summer school than regular school as shown in Table 7. A comparative analysis of student achievement indicated approximately 87% of summer school students received a final science grade of A, B, or C compared to about 9% of regular school students who received the same final science grades. Only 3.8% of summer school students received a failing grade of F. Conversely, 66% of these same students failed science for the regular school year. Approximately 96% of the middle school students in the study passed science in summer school. Results indicated an additional 62% increase in students with final passing grades when compared to regular science.

Student Goal Orientation

Hypothesis 3

> Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher goal orientation toward task-mastery as measured by the Goal Orientation Scale of the Science Activity Questionnaire (SAQ).

The Science Activity Questionnaire (SAQ) was the instrument used to measure student goal orientation. This instrument consisted of 39 items rated on a four-point scale. The purpose of the Science Activity Questionnaire was to determine the student goal orientation of the 130 students represented in the research sample.

Student goal orientation was analyzed and classified as task-mastery, ego-social or work-avoidant by the mode frequency of pretest/posttest responses. The mode frequency of response represented the highest number of repeated responses of the same answer choice by the students. In cases of bimodal response choices the highest numbered item response choice was indicated.

Analysis of Pretest/Posttest Frequency of Responses For Student Goal Orientation

A frequency of student pretest and posttest responses for goal orientation were calculated and graphed by percentage for task-mastery, ego-social, and work-avoidant goal orientation. Table 8 shows the pretest and posttest frequency of responses for the 130 subjects in this study.

Table 8

Pretest/Posttest Student Goal Orientation Responses For the (n-130) Students in the Study by the Amount of Positive Gain on (SAQ)

Goal Orientation	Students Pretest	Students Posttest	Students Positive Gain
Task-Mastery	16	49	33
Ego-social	72	62	
Work-Avoidant	42	19	
Total	130	130	

As indicated in Table 8, an analysis of the goal orientation for the study indicated that 33 of the 130 students became more oriented toward task-mastery. Posttest response frequency for task-mastery rose from 16 to 49. Pretest/Posttest frequency of responses indicated that ten students moved on the pretest from ego-social to task-mastery on the posttest. Twenty-three students moved from work-avoidant on the pretest to task-mastery on the posttest. At the end of the summer, only 19 of the 130 students indicated work-avoidant responses. These results suggested that hands-on science has a positive effect on student goal orientation.

Pretest/posttest student goal orientation by SAQ results by percent are indicated in Table 9.

Table 9

Pretest/Posttest Goal Orientation by Percent

Goal Orientation	Pretest	Posttest	Difference
Task-mastery	12.3%	37.7%	25.5%
Ego-social	55.4%	47.7%	-7.7%
Work-avoidant	32.3%	14.6%	-17.7%

There was a 25.5 % increase in task-mastery goal orientation from the pretest to the posttest. Ego-social goal orientation showed a decrease of 7.7% and work-avoidant goal orientation showed a decrease of 17.7%. These results showed a shift toward task-mastery.

(For a visual display of these results see Student Goal Orientation Graphs for Pretest and Posttest in the Appendix.)

Student Engagement in Science

Hypothesis 4

Middle school students in summer school remedial science classes who are taught CEPUP hands-on science would show more active engagement in science as measured by the Cognitive Engagement Scale component of the SAQ and student interviews.

Students' active engagement to obtain an understanding of the science concept describes the cognitive process. The Cognitive Engagement Scale was used to measure the degree of cognitive engagement on the pretest and posttest for students participating in this study. Answers were given on a three point (1-3) scale. The mean scores were calculated and used to assess differences by comparing pretest and posttest scores.

The *t*-test was used as the statistical treatment to assess change for student cognative engagement. Results of the *t*-test in Table 10 was calculated by computer (SAS) for the (n-130) students. The mean score for the pretest was 2.47. The mean score for the posttest was 2.77. The pretest standard deviation value was 0.55. The posttest standard deviation value was 0.44.

A two-tailed *t*-test was computed to determine if difference between the means of the pretest and posttest scores were statistically significant at $p<0.05$. The mean difference between the pretest and posttest was 0.30, which resulted in a probability of 0.001 and a degree of flexibility of 0.05 with a *t*-test value of 2.50. The probability value of 0.001 is significant beyond the accepted level of confidence and supports the research hypothesis that students were more engaged in science when a hands-on approach was used.

Table 10

Paired t-Test for Student Cognitive Engagement Results on (SAQ)

Variable	Mean	SD	Paired t-Test
Pretest	2.47	.55	
Posttest	2.77	.44	2.50

Note. n-130

Student Interviews: Related to Engagement

The study consisted of 30 student interviews as a part of a qualitative measure to assess the effectiveness of the hands-on activity based science approach as related to student engagement. Each of the four teachers who were asked to identify three students representative of each of their ten classes. The 30 students interviewed represented 23.07% of the total sample of 130 students who participated in this study. Middle school students from grades 6th, 7th, and 8th were interviewed. Students interviewed responses were examined to describe how hands-on science fostered student engagement in science for the following questions:

1. "Were you involved or not involved in the lesson, why or why not?"
2. "Did you understand the goal of the lesson?"

3. "What strategies did you use during the lesson?"

4. "Did you think it was important to understand the material and do well?"

Words students used to describe task-mastery responses were: "fun," "yeah," "think," "like science," and "like experiments." Words students used to describe ego-social responses for goal orientation were: "we," "teacher," "passing grade," and "test." Words students used to describe a task-avoidant goal orientation were: "not involved," "boring," and "don't like science."

<u>Student Interview Responses</u>

The student interview addressed four questions about the degree remedial students were more actively engaged with science due to the hands-on approach used in summer school. Examples of student interview responses were given for each of the four interview questions.

The first question asked, "Were you involved or not involved in the lesson, why or why not?" Examples of students' responses to this question were as follows: "yes, it was real fun,' it was better than working in the books;" "yeah, we made lot of experiments and I like that;" and "yes, just doing the work was fun." These responses described that 29 of the 30 student responses were positive to this question. The one negative response was; "no, I was not involved because science is boring."

The second question asked, "Did you understand the goal of the lesson?" Examples of students' responses to the question were as follows: "yeah, it was fun and I learned;" "yes, I understood that we were to complete the experiment;" and "yes, I understood what to do and how to do it." Of the 30 students, 29 responses indicated that they understood the objective of the lesson and how to complete the hands-on activity. The one negative response was; "no, I didn't know what to do or how to do it because I wasn't interested in science."

The third question was; "What strategies did you use during the lesson?" Examples of students' responses to the question were as follows: "well, I was reading the directions and telling the other students what was to be done and they followed the directions; "yeah, we read the directions and they followed the directions;" "well, first I read it to the group and explained all the rules to them and then went step by step;" and "we had one person to read off the sheet of paper so I was doing the experiment and my friend was reading off the paper and we just went step by step." Twenty-nine students responded in this manner. The one negative response was; "I didn't use a strategy because I didn't do the experiment."

The fourth question asked; "Did you think that it was important to understand the material and do well?" Examples of the students' responses were as follows: "uh, really, because I like science and I like doing experiments and I wanted to get a good grade on it;" "because I like doing the experiments and I wanted to get a good grade on it;" "I thought it was important because it was a good way to see how does the food color really change and second to get a good grade;" and "so I can pass summer school." All of the 30 student responses indicated that they thought science was important.

Summary of Student Interviews

The results of the student interview suggested that middle school remedial science students preferred hands-on activity based science over the traditional textbook approach because they were more physically active and involved with learning. Of the 120 responses, 117 were viewed positively which supported hands-on activity-based science as an effective approach that increased manipulative and cognitive engagement for remedial middle school science students. Generally, students interview results suggested that students were engaged in science because they enjoyed doing the CEPUP hands-on activities.

Instructional Environment Scale

Hypothesis 5

> Students in the classes of teachers who incorporated hands-on science to teach summer school remedial students in their classrooms will

demonstrate a high level of cognitive engagement as measured by the Instructional Environment Scale (IES).

The researcher observed the classroom environment of the four teachers and ten science classes who participated in this study. The purpose of these classroom observations was to determine the quality of the instructional environment. The Instructional Environment Scale (IES) in Appendix (p.12) was used to calculate and rate each teacher by science period. Each teacher was observed three times by the researcher, once during each hands-on activity, using IES. A mean score was determined for each teacher. The range of the scoring scale was 1.0 - 5.0. A rating od 1.0 indicated the least favorable response and a rating of 5.0 indicated the most favorable response. This instrument was composed of 14 items to assess the instructional environment. The researcher's ratings for each teacher on each item are represented in Table 11.

Table 11

The Observers Ratings: The Performance of Four Teachers on The Instructional Environment Scale

Item	Teacher A	Teacher B	Teacher C	Teacher D
#1	5.0	5.0	4.0	3.0
#2	4.0	5.0	3.0	3.0
#3	5.0	5.0	5.0	4.0
#4	4.0	4.0	4.0	3.0
#5	5.0	5.0	4.0	3.0

#6	5.0	5.0	5.0	5.0
#7	4.0	4.0	4.0	4.0
#8	5.0	5.0	5.0	5.0
#9	5.0	5.0	5.0	5.0
#10	4.0	4.0	4.0	3.0
#11	4.0	4.0	5.0	4.0
#12	4.0	4.0	4.0	3.0
#13	5.0	5.0	5.0	3.0
#14	5.0	5.0	5.0	5.0
Total	64.0	65.0	54.0	53.0
Mean	4.57	4.64	3.86	3.78

Note. Mean Score Standard 2.5

The observer's mean score range (3.78 - 4.64).

Analysis of ratings across all three observations indicated that the observer recorded relatively high rates of cognitive engagement as reported in Table 9. Teacher A received a mean score of 4.57 on the IES for the 14 items evaluated. Teacher B received a mean score of 4.65. Teacher C had a mean score of 3.86, and Teacher D had a mean score of 3.78. All four teachers scored above the mid-point score of 2.4 - 2.6 range on the 1 - 5 scale established by the Blumenfeld, Hoyle, and Meece Study (1988).

The researcher rated teachers in the present study well above the standard mean score. Results indicated the perception of the researcher that teachers who incorporated CEPUP hands-on science did demonstrate a high level of cognitive engagement. Hands-on activity-based science was viewed as being an effective approach for maintaining a good conducive instructional environment that encouraged a high level of cognitive engagement for teachers.

Teacher Interviews

Hypothesis 6

> Teachers in this study who used CEPUP hands-on science activities to teach remedial summer school students will express the perception that hands-on science is an appropriate teaching approach for these students.

To assess teacher perceptions of hands-on activity-based science approach for remedial students in summer school, the researcher interviewed all four teachers. The teacher interview instrument was composed of 14 questions related to the instructional environment within the classroom (See Appendix for teacher interview questions).

The purpose of the teacher interviews was to describe how teachers who incorporated CEPUP hands-on science activities viewed the appropriateness of the hands-on approach for summer school students. All four teachers were certified science teachers who were hired to teach science to middle school remedial students in summer school. All teachers received a 10-hour in-service on how to teach 3 CEPUP hands-on activity-based science activities used in this study. These teachers implemented the hands-on activities as directed. At the end of the four-week summer school term, they were interviewed to describe their views of hands-on science as an effective approach for remedial students.

Table 12 presents illustrations of teacher responses. These illustrations represented excerpts from actual teachers' comments for the 14 interview questions.

Table 12

Typical Illustrations of the Four Teachers Responses by Question

Question	Response
1. Was the hands-on teaching approach appropriate for the objectives of the summer school science remedial student and the classroom environment?	"It was good for them to have these hands-on activities. It made them think."
2. What suggestions do you have about concrete materials and instructional aides used to teach these at-risk students in summer school science remediation classes?	"The only concrete material needed was running water in the classroom."
3. Did the instructional materials used provide the learner with appropriate practice on objectives?	"Yes, I think so. Everything was laid out very well as far as the objectives, the materials, and procedures."
4. What was done to interest students in the activities and to make sure they understood the purpose of the activities and how to carry them out?	"I give a description of what will go on the next day. the day before, we had a little puzzle related to the hands-on activity topic to get them thinking."
5. How was feedback provided throughout the lesson to affirm correct answers and to correct mistakes?	"I just encouraged them to just do it again and see if they got the same results. The activity sheets led them to what their answers should be."

6. Explain the variety of teaching methods used in a particular class period.	"The teaching methods I used mainly were hands-on, class discussion, group work and a lot of open-ended discussion questions which related the activity to everyday life to enhance understanding of the concept."
7. How did you provide opportunities for individuals, small and large group work?	"Large group work was our class discussion. Students worked in small groups to solve the problem of the hands-on activity. Each student in the group was assigned individual tasks: reader, recorder, and experimenter."
8. How was each learner encouraged to participate and provided the opportunity to participate in various learning strategies?	"They were guided. I let them pretty much investigate own. they didn't disappoint me. The CEPUP activities caught and maintained their curiosity."
9. Describe how you provided positive reinforcement for learners and encouraged the learner to maintain involvement.	"The papers were graded and given back promptly. Positive words of praise were given like 'that's great'. I let the under-achiever help another student."
10. What techniques did you use to involve all learners?	"I interested the learner by posing a natural disaster situation and allowing them to discuss possible solutions. I introduced the hands-on CEPUP science activity that they had to solve."
11. How did you attend to routine tasks, such as organizing the materials, distributing materials and collecting the supplies?	"I appointed one person from each group to come up to the kit and get whatever was needed out of the kit, and to bring it back, then to clean it up and return it to its appropriate place when they finished."

12. How did you know if the student had mastered the material or scientific concept?	"Of course, I'd given two major tests and included that material on the tests. I had them turn in lab reports, and I graded them."
13. How did you maintain appropriate classroom behavior?	"I maintained good classroom behavior by letting the students know that I expected them to behave well and learn.
14. What did you do to model cognitive strategies for students?	"I joined in with them. I worked with each group. I would sort of give them a nudge or a push when I thought they were going off the wrong way."

The teacher interview responses suggested that the teachers who facilitated the hands-on science approach in summer school viewed it as an effective teaching strategy for remedial students.

Teachers generally agreed that hands-on activity-based science facilitated by CEPUP was appropriate for the objectives of the summer school remediation program. The teachers interviewed cited three reasons that supported hands-on science for summer school students.

1. Students needed hands-on activities to integrate hands-on/minds-on science.
2. Hands-on science enhanced students' thinking skills.
3. The hands-on activity-based approach fostered better understanding of the environmental issues for the world in which we live.

Subsequently, all teachers interviewed provided the perception that remedial students benefitted educationally from the hands-on activity-based CEPUP science teaching in summer school.

The teachers responses suggested that they thought that CEPUP kits were well organized and made it easy to teach hands-on activity-based science. Teachers responses offered suggestions to improve the implementation of CEPUP hands-on science for at-risk students who attended summer school. Some of the suggestions for improvement that teachers offered were:

1. lengthening summer school,
2. providing running water in each classroom, and
3. offering simpler hands-on activities for remedial students.

An analysis of responses further indicated that most teachers thought that CEPUP hands-on science provided appropriate practice for students to meet the objective of the summer school remediation program.

All of the teachers generally agreed that they made the CEPUP activities interesting to their students and made sure each student knew how to participate in the activities. Teachers indicated that they provided a variety of teaching methods for teaching hands-on activity-based science in the summer school remediation program. They provided various opportunities for individual small group and large group cooperative work. All of the teachers organized class peer tutoring groups and cooperative learning groups to facilitate the implementation of the CEPUP hands-on science program.

Teachers thought that they encouraged students to participate and provided them various opportunities to demonstrate learning through hands-on science. All of the teachers encouraged their students to participate in hands-on science by actively monitoring performance, providing time for class discussion and problem solving, and promptly returning all classwork graded.

All teacher responses also suggested that they provided positive reinforcement for the learner and encouraged the learner to maintain classroom involvement. Positive reinforcement was maintained by praise given to students for good performance, self-reinforcing lessons designed (CEPUP) outside hands-on/minds-on activities, and returned work promptly. Teachers definitely felt that they did a good job to maintain student involvement with hands-on science in summer school.

Teachers described various techniques were used to involve all learners in hands-on CEPUP science activities. All of the teacher responses suggested that they performed various tasks to encourage full student involvement. Some of the techniques used to involve the learner were posed natural disaster situations for discussion, provided open-ended questions for discussion, required everyone to participate verbally, and introduced hands-on activities.

All of the teachers suggested that the students had mastered the material or scientific concept. Teachers generally agreed they knew their students' progress by verbal responses, performance-based responses, and tests scores. Their responses suggested that the students maintained appropriate classroom behavior. Teachers generally agreed that they set behavior expectations, monitored behavior, and rewarded students for good working behavior. All of the teachers surveyed responded positively about classroom behavior.

Teachers modeled cognitive strategies for students by demonstrating hands-on techniques, asking probing questions, and encouraging discussion. All of the teachers felt they demonstrated good cognitive role models for teaching the CEPUP hands-on science approach to remedial summer school students.

Generally, the teachers interviewed supported hands-on activity-based science as an effective approach for teaching remedial, middle school students who were in summer school. They agreed the CEPUP activities used were well-organized and made it easy to teach hands-on science. Each teacher interviewed expressed that students were interested and involved in the hands-on activities. They generally agreed that these hands-on CEPUP activities allowed for the development of problem-solving skills that enhanced students' cognitive thinking skills. The content of the teachers interviewed supported hands-on as an effective approach in maintaining students' interest and involvement in science while increasing the problem solving skills for the student.

The teachers generally agreed that hands-on activity-based science fostered student development of the following skills in summer school science remediation classes:

1. observational skills;
2. process skills:
3. communication skills; and
4. thinking skills.

Students had to manipulate concrete materials to perform hands-on activity. They had to make observations as they performed experiments. These observations that the students made determined the outcome of experiments. The process skills were developed. Students followed the procedure and made observations to arrive at solutions to science problems. Students worked in groups to perform hands-on. They talked about procedures, observations and results. They also wrote their observations and results on the activity sheet. Students developed thinking skills by applying the lesson concept to daily environmental issues.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATION OF RESULTS, AND DIRECTIONS FOR FUTURE RESEARCH

This study investigated, assessed, and evaluated the appropriateness of hands-on activity-based science used with middle school students for summer school remediation. The study examined the effects of CEPUP hands-on science instruction for a pure at-risk middle school population who had failed local or state standards and were required to have summer school remediation in science in order to be promoted. A pretest/posttest method was facilitated to assess progress or change as were student and teacher interviews. The impetus for this study was the desire to create an instructional environment to foster remedial students success with hands-on science which enhanced students' attitudes toward science, achievement in science, goal orientation, and cognitive engagement in science.

In-service staff development was provided for all teachers who participated in this study. The purpose of staff development was to provide teacher with training and materials on how to implement CEPUP hands-on activities selected for this study. This teacher training included techniques used to increase student task-mastery in a supportive instructional environment.

Importance of Instructional Environment

The context of the instructional environment was essential to student motivation, student attitude, student cognitive engagement and restricted or enhanced student learning. The structure of the instructional environment and the kinds of interactions that occurred determine the context for learning within the classroom. Teachers served as facilitators; demonstrating procedures, providing materials and monitoring behavior to keep students engaged in hands-on processes. Students were involved in hands-on problem-solving in the Chemical Education Program for Understanding Project (CEPUP) science activities. Students worked in pairs to complete these activities. Students approached classroom tasks with different attitudes and varying degrees of motivation and different cognitive interpretations of tasks to be performed. The instructional context of the classroom represented the quality of learning produced from the interactions between teacher, students, and objects designed to meet learning objectives. The structural elements of the instructional environment included the teacher, student, content, and CEPUP Kit. The process of interaction that resulted identified relationships between structure and process which described the context for learning.

The structure of the instructional environment was essential to student motivation, student attitude, and student cognitive engagement. The systems of interaction between students, teachers, and materials to achieve learning described the instructional context of the classroom. In the hands-on approach, students were involved with problem-solving activities or tasks that were structured, organized, and monitored by the teachers. This approach allowed for students with varying degrees of motivation and different levels of cognitive engagement to experience success. This required the teacher to set the stage for the science activities by exciting the students' curiosity with puzzling questions, statements, situations, or demonstrations. The teacher's role in implementing hands-on science was that of a facilitator. He or she provided materials within a structured learning environment and monitored students' actions to keep them engaged in the learning process. It was hoped that active student involvement through hands-on activities would increase student participation, allowing students to experience greater success in science. This success should result in an improved attitude toward science. The context of hands-on activities was designed to give students a positive attitude toward science and to enhance problem-solving skills.

Summary of Results

The summary of findings for the study was reported by each hypothesis.

Hypothesis 1

> Middle school students in summer remedial science classes who were taught CEPUP hands-on science would show a positive gain in attitude toward science by the Children's Attitude Toward Science Survey.

The hypothesis was supported by the results of data collected. Students' survey results indicated an increase and involvement with science. Posttest scores on the CATSS showed an increase of 9.1% for positive responses. Most students responses to the open-ended question, "I think science is...", on the CATSS described hands-on science as "fun", "exciting", or "interesting". Generally, students comments suggested that hands-on CEPUP science activities were fun and enhances their cognitive involvement. These results supported a positive change in gain in attitude toward science after students were taught CEPUP hands-on science in summer school.

Hypothesis 2

> Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher gain in achievement as

> measured by process-oriented science test scores expressed in numerical grade averages.

The hypothesis was supported by the data results of this research. Results indicated that there was a relationship between student achievement and the CEPUP hands-on science approach facilitated in summer school. Only 9% of the students who attended summer school had received a grade of C or better during the regular school. During summer school, 87% of these same students received a grade of C or better. The CEPUP hands-on approach used in summer school accounted for a 96% success rate for at-risk remedial science students who had failed to meet state or local promotion standards during the regular school. Summer school science classes test scores ranged from 73.2 - 85.5. These scores showed that at-risk students who had failed to meet promotional standards during the regular school year, did well during the summer. These mean scores were based on cumulative averages of student test scores of three process oriented tests used to measure the effect of hands-on activities for teaching science.

Hypothesis 3

> Middle school students in summer school remedial science classes who were taught CEPUP hands-on science would show a higher goal orientation toward task-mastery as measured by the Goal

> Orientation Scale of the Science Activity Questionnaire (SAQ).

The hypothesis was supported in the present study. Thirty-three more students were classified as achieving task-mastery on the posttest than were on the pretest. These results demonstrated that hands-on science had a positive effect on student goal orientation. These posttest results indicated a shift in goal orientations. Task-mastery increased 25.5%. Ego-social decreased 7.7% and work-avoidant decreased 17.7%. These results indicated a shift toward a task-mastery goal orientation when a hands-on approach was used to teach science.

Hypothesis 4

> Middle school students in summer school remedial science classes who are taught CEPUP hands-on science would show more active engagement in science as measured by the Cognitive Engagement Scale of the SAQ.

The hypothesis was supported in the present research. Statistical analysis of the posttest results indicated that student cognitive engagement increased significantly. The posttest means scores increased 0.30. The *t*-test was 2.5. This result demonstrated that hands-on activity-based science promoted more cognitive engagement for remedial students during summer school.

Hypothesis 5

> Students in the classes of teachers who incorporated hands-on science to teach summer school remedial students in their classrooms will demonstrate a high level of cognitive engagement as measured by the Instructional Environment Scale (IES).

The hypothesis was supported in this research. All four teachers used in this study had an instructional environmental range mean score 3.78 - 4.64 on a 5 point Likert scale. Their range mean scores were well above the mid-point score of 2.5. The results of this study suggested the degree of an effective instructional environment was determined by the amount of cognitive engagement. Students were more independent learners and more cognitively engaged when the teacher served as a facilitator to enhance the learning process.

Hypothesis 6

> Teachers in this study who used CEPUP hands-on science activities to teach remedial summer school students will express the perception that hands-on science is an appropriate teaching approach for these students.

The hypothesis was supported in the study. The teachers supported hands-on CEPUP activities as an effective teaching approach for remedial students who attended summer school.

Out of 123 actual responses, 117 were positive. This represented 95.12% of positive responses in support of CEPUP hands-on science as an effective method teaching method for remedial students.

Conclusions

The hypotheses presented in this study, hands-on activity-based science for summer school remediation, suggested that hands-on science instruction had a relatively positive effect on student attitude toward science, student achievement, goal orientation, and cognitive engagement. The hypotheses further suggested that CEPUP hands-on science instruction was an appropriate teaching approach for summer school remedial students. Furthermore, the study suggested that there was a positive relationship between the quality of the instructional environment to student attitude, student achievement, goal orientation and cognitive engagement. Unlike the Miller Study (1990) and the Blumenfeld, Hoyle and Meece Study (1988), the present research suggested that attitude, achievement, goal orientation, and cognitive engagement were positively related to student achievement.

Students who participated in the CEPUP hands-on activity-based science for summer school remediation demonstrated a positive change in attitude toward science. Some of the things that indicated a change in attitude were:

they liked doing science, they liked working with other students, they found that they were more interested in completing science work, the teacher had to put in less effort to keep them on task. Results were consistent with the findings of earlier investigations with the SCIS program which concluded that students learn more when they experience the components of the learning cycle. Cognitive domain, affective domain, and psychomotor domain (Piaget 1967; Bloom, 1967; and Bruner, 1968). This learning cycle approached involved multi-sensory experiences meaning to the conceptual framework of the lesson.

The changes in student attitude toward science supported CEPUP hands-on instruction for teaching remedial students. Hart (1983) explained that the teacher must create a supportive environment where students do not feel threatened. He suggested that when students feel threatened, they reduce their ability to learn. In order to improve the student attitude, the source of the threaten must be removed (p. 64). Results may illustrate Hart's "Brain-Antagonistic" theory (1983) as well as the findings of Barell and Bronowski (1982).

This study suggested that summer school students' attitude toward science improved. This change in student attitude may have resulted from the removal of several possible "threats". Summer school students were more homogeneously grouped. The threat of being labeled as a failure was removed. They worked cooperatively to perform hands-on activities. The threat of competition was removed. These factors reduced the threat of failure and increased opportunities for successful experiences.

The hypotheses suggested that cognitive engagement supported that hands-on activity-based science as a means to increase student and teacher involvement. There was an increase in student interest, involvement, and participation with the hands-on CEPUP activities which enhanced the understanding of science concepts as indicated by greater student achievement. These remedial students were not only using their hands but their minds for problem solving. The research suggested that hands-on activity-based science promoted more cognitive engagement for remedial students.

Observed increases in cognitive engagement supported the findings of Brown, (1976); Ennis, (1985); Flavell, (1976); and Margano, (1990) who documented that activity centered teaching promoted student involvement and enhanced cognitive thinking skills. When students became more cognitively engaged, their goal orientation shifted more toward task-mastery. An observation which supported Barrell (1985) was an emphasis on creating a supportive instructional environment of trust and open communication to encourage thinking and learning.

This investigation concluded that hands-on science affects students achievement, cognitive engagement, and attitude toward science. Students enjoyed doing hands-on science more than the traditional learning approach. Students were more involved and interested in completing science activities. Students acquired a greater understanding and appreciation of science concepts and how they were related to the world in which they lived. Students also developed more problem-solving skills based upon their involvement with manipulatives that forced them to think logically. CEPUP hands-on science tended to be suitable for teaching remedial science to summer school students.

Implication of Results

Results of the study suggest four major implications for science educators who wish to encourage success among at-risk students. Teachers should be trained to create a supportative environment for teaching hands-on science. Hands-on science uses a multi-sensory approach that enhances cognitive thinking skills which promotes student academic achievement. Hands-on science can increase students involvement and improve their attitudes toward science. Hands-on science can reduce classroom discipline problems.

Staff development is essential to the construction of a supportative instructional environment for the successful teaching of hands-on science. Staff development provides the teacher with material, equipment, and training on how to concrete a classroom environment that encourages learning and promotes scientific illeracy. Teachers are trained to actively monitor students progress and performance through observations, questions and answers, and discussions. Teachers are also trained to structure student cooperative learning groups where each student in the group can contribute to solving the problem. The teachers in this study felt that they were trained to concrete an appropriate instructional environment for teaching hands-on science to remedial students in summer school. The students in summer school generally felt that the instructional environment in their science classes encouraged their success.

Hands-on science can promote student academic achievement. Hands-on science is a multi-sensory approach to learning that requires students to perform various process skills and cognitive thinking skills to solve a problem. Students are tested and evaluated on process skills and cognitive thinking skills acquired by doing the hands-on activity. The students academic achievement are based on their first hand experience of science concepts learned by performing experiments. Generally, students in this study felt that they experienced academic success because hands-on science allowed them to learn by doing.

Hands-on science can improve student attitude toward science. Generally, students are actively involved with learning science when a hands-on approach is used. Some of the ways that they are involved are they manipulate concrete objects, make observations, make predictions, and draw conclusions. Students gain more self-confidence as they become more involved with hands-on. This study suggests that students attitude toward science improves with increased hands-on involvement.

Hands-on science can reduce discipline problems. middle school at-risk students are very energetic. If the energy of these students is channeled constructively, they would be involved and focused on the lesson objective. If their energy is not focused, they would be easily distracted, and involved in disruptive classroom behavior. In this study, teachers generally felt that the hands-on activity-based approach increased student involvement and reduced classroom discipline problems.

A hands-on approach with proper teacher training should be appropriate for teaching at-risk students science. Preservice and inservice training should be provided to all middle school teachers using CEPUP or some other hands-on teaching strategies and activities. Teachers need to experience and practice in using the hands-on approach in order for it to be successful with students. A major part of the suggested appropriateness of CEPUP hands-on science can be contributed to a well planned and executed teacher in-service prior to using the CEPUP kits to teach science.

Administrators, principals, and support research supervisors should collaborate to encourage and support research projects, staff development, or the implementation of new programs and strategies that can better meet the needs of a diverse student population. The school administration needs to provide awards and recognition for employees who have completed research projects on student achievement.

Teachers of at-risk students should have self-discipline students in classes with open communications. At-risk students need their performance and progress closely monitored by the teacher. Hands-on science facilitated a multi-sensory approach that enhanced thinking skills. Teachers should allow for open communication in the form of peer-tutoring discussions and collaborative decision making.

Directions for Future Research

Results of this study suggests that year-long study on CEPUP hands-on science activities with students who repeatedly fail to reach local and state promotional standards during the regular school year would be very productive. Some of the results for the four week study could have been caused by the new hands-on approach. A year long study could add valuable information about the appropriateness of CEPUP hands-on in the regular school curriculum for at-risk students.

A second direction for future research was a follow-up study to assess the transference of students attitudes, student achievement, task-mastery orientation, and cognitive engagement in science during the regular school year. Such a study might determine whether or not students would sustain the attitude toward science and goal orientation they acquired in summer school during the regular school year. Results of this research would add understanding to why at-risk students were successful in summer school.

A third direction for future research recognized was the effect of block scheduling for successful teaching of hands-on science for middle school at-risk students. Students in summer school science class had a class schedule that was 20 minutes longer than a regular school schedule. This increase time cold have accounted for summer school students completing the class assignments. Block scheduling for science classes during the regular school year might increase class time for hands-on activities.

A fourth direction for future research suggested was that there be case studies of the instructional environment of remedial, middle school students who receive hands-on activity-based science instruction. Case studies could provide an indepth understanding of how at-risk students learn hands-on science. The specific classroom conditions for successful teaching could be examined and documented for practical instructional use.

Another direction for future research recognized was a series of hands-on science lessons analyzed to assess students responses in the cognitive domain, affective domain, and psychomotor domain. This would require a clinical approach. Students would perform a series of hands-on activities as the behavior would be observed and analyzed by the observers. Students will be questioned as they perform and complete each of the activities for thought, feeling, and understanding.

Finally, studies of staff development in creating a conductive atmosphere for hands-on science might help extend this approach. Many teachers are apprehensive about teaching hands-on science because they lack training in this approach. Teachers are often uncomfortable in an instructional environment where students are talking and moving. A study on a systemwide staff development program to train teachers on how to construct an instructional environment to direct students energy to learning science when a hands-on is used would be meaningful.

Summary and Closing Statement

This study assessed the effect of hands-on activity-based science for remedial students in summer school. This at-risk group of students showed a positive gain in the following areas:

1. attitude toward science,

2. cognitive engagement, and
3. achievement

The students who participated in the hands-on approach used in summer school enhanced their science knowledge. This notion was substantiated by student achievement. Teachers felt that the hands-on approach indicated more student task involvement and cognitive engagement which made it a pleasure for teachers to be in the classroom. Both teachers and students felt that they benefitted by the hands approach used in summer school. In this study, teachers and students supported hands-on science as an appropriate approach to teach at-risk students.

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APPENDIX A

ASSESSMENT INSTRUMENTS ADMINISTERED

Miller; 1990

CHILDREN'S ATTITUDE TOWARD SCIENCE SURVEY

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

Directions:

Following are some statements concerning how you feel about science and your science class this year. You will see that there are no correct (or right) answers or no incorrect (or wrong) answers. This is NOT a test or exam. We are only interested in your honest opinion.

Please indicate how you feel about each statement by drawing a circle around one of the five (5) answers underneath. Please tell us how you really feel. Your cooperation is appreciated greatly. Your response will remain confidential and your science teacher will not see your paper.

CIRCLE YOUR ANSWER

1. Reading about science is hard for me.

Strongly Agree Agree Undecided Disagree Strongly Disagree

2. I would like to spend more time doing science experiments.

Strongly Agree Agree Undecided Disagree Strongly Disagree

3. I am learning a lot about science in school this year.

Strongly Agree Agree Undecided Disagree Strongly Disagree

4. What we do in science class is what a real scientist would do.

Strongly Agree Agree Undecided Disagree Strongly Disagree

5. In science class we study "today's problems" related to science.

Strongly Agree Agree Undecided Disagree Strongly Disagree

6. I do not like coming to science class.

Strongly Agree Agree Undecided Disagree Strongly Disagree

7. I read more science materials than I did in the fifth grade.

Strongly Agree Agree Undecided Disagree Strongly Disagree

8. I enjoy doing the science activities.

Strongly Agree Agree Undecided Disagree Strongly Disagree

9. I can solve problems better now than before.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

10. My friends enjoy doing science experiments.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

11. What I am learning in science will be useful to me when I am playing and at home.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

12. I think about things we learn in science class when I'm not in school.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

13. I do not want to have to take any more science classes than I have to.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

14. Reading about science is more fun than it used to be.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

15. Science experiments or activities are hard to understand.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

16. Science is dull for most people.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

17. The things we do in science class are useless.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

18. I learn a lot from doing my science experiments.

Strongly Agree Agree Undecided Disagree Strongly Disagree

---

19. Most people like science class.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

20. The kinds of experiments I do in class are important.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree

21. Please complete this sentence. Write your answer on this paper.

I think science class ____

Miller; 1990

SCIENCE ACTIVITY QUESTIONNAIRE

PART I

DIRECTIONS:
Students have a lot of different thoughts and feelings while they are doing their science work. We want to know how true each of these things below was for you. If the sentence describes you a lot, circle VERY TRUE. If the sentence is pretty close to how you felt but not exactly, circle SOMEWHAT TRUE. If the sentence describes you only a little, circle A LITTLE TRUE. Circle NOT AT ALL TRUE if the sentence does not describe you. Remember, there are no right and wrong answers. Circle the answer that best describes your feelings. Be sure to circle only one answer for each sentence.

		VERY TRUE	SOMEWHAT TRUE	A LITTLE TRUE	NOT AT ALL TRUE	
1.	I put a lot of time and effort into my work.	4	3	2	1	(11)
2.	The work made me want to find out more about the topic.	4	3	2	1	(12)
3.	The directions were clear to me.	4	3	2	1	(13)
4.	I felt involved in my work.	4	3	2	1	(14)
5.	I liked what we did in science today.	4	3	2	1	(15)
6.	I understood what we were supposed to do.	4	3	2	1	(16)
7.	I wish we had more time to spend on science today.	4	3	2	1	(17)
8.	I can use what I learned today later on.	4	3	2	1	(18)
9.	The purpose of today's work was clear to me.	4	3	2	1	(19)
10.	I was daydreaming about other things during science.	4	3	2	1	(20)
11.	I would like to do another activity like this sometime.	4	3	2	1	(21)
12.	The work really made sense to me.	4	3	2	1	(22)

PART II

DIRECTIONS:
These sentences describe different reasons for doing schoolwork. Different kids have different reasons. We want to know how true each of these reasons was for why you did your science work. If the sentence describes you a lot, circle A LOT LIKE ME. If the sentence does not describe you at all, circle NOT AT ALL LIKE ME.

		A LOT LIKE ME	SOMEWHAT LIKE ME	A LITTLE LIKE ME	NOT AT ALL LIKE ME	
1	I wanted to learn as much as possible.	4	3	2	1	(23)
2.	I wanted to work with my friends.	4	3	2	1	(24)
3.	It was important to me that the teacher thought I did a good job.	4	3	2	1	(25)
4.	I wanted to do as little as possible.	4	3	2	1	(26)
5.	I wanted to find out something new.	4	3	2	1	(27)
6.	I wanted to talk with others about the work.	4	3	2	1	(28)
7.	It was important to me to do better than other students.	4	3	2	1	(29)
8.	I just wanted to do what I was supposed to and get it done.	4	3	2	1	(30)
9.	It was important to me that I really understood the work.	4	3	2	1	(31)
10.	I wanted to help others with their work.	4	3	2	1	(32)
11.	I wanted the others to think I was smart.	4	3	2	1	(33)
12.	I wanted to do things as easily as possible so I wouldn't have to work very hard.	4	3	2	1	(34)

PART III

DIRECTIONS:
There are many different ways students do their science work. We want to know how much each of these things are like what you did in science. Circle A LOT LIKE ME if the sentence is very much like what you did. If the sentence is sort of like what you did, circle A LITTLE LIKE ME. Circle NOT AT ALL LIKE ME if the sentence does not describe what you did.

		A LOT LIKE ME	A LITTLE LIKE ME	NOT AT ALL LIKE ME	
1.	I followed the directions.	3	2	1	(35)
2.	I tried to figure out how today's work fit with what I had learned before in science.	3	2	1	(36)
3.	I guessed a lot so I could finish quickly.	3	2	1	(37)
4.	I asked myself some questions as I went along to make sure the work made sense to me.	3	2	1	(38)
5.	I wrote some things down.	3	2	1	(39)
6.	I did my work without thinking too hard.	3	2	1	(40)
7.	I explained or wrote down some things in my own words.	3	2	1	(41)
8.	I checked to see what other kids were doing and did it too.	3	2	1	(42)
9.	I paid attention to things I thought I was supposed to remember.	3	2	1	(43)
10.	I skipped the hard parts.	3	2	1	(44)
11.	I checked my science book or used other materials like charts when I wasn't sure about something.	3	2	1	(45)
12.	I just did my work and hoped it was right.	3	2	1	(46)
13.	I tried to figure out the hard parts on my own.	3	2	1	(47)
14.	I copied down someone else's answers.	3	2	1	(48)
15.	I went back over the things I didn't understand.	3	2	1	(49)

STOP HERE

Sample Test Items from <u>CEPUP</u>

Problem I

A student added lemon juice to a cup containing a precipitate formed with copper chloride solution and sodium carbonate. As the lemon juice was added, the precipitate appeared to dissolve. When ammonia was added, the filtrate turned a blue color. Lemon juice is more acidic than vinegar.

1. Which of the following is the <u>most important</u> conclusion based on the student's observations?

   a. Both vinegar and lemon juice can be used to dissolve copper precipitates.
   b. The chemistry of copper precipitates is very complicated.
   c. Lemon juice contains hazardous chemicals.
   d. Disposal of copper precipitates in a landfill might allow copper to enter the groundwater.

2. Copper metal reacts with clear silver nitrate solution to form a silver solid and a blue solution. Which of the following is the <u>most</u> likely explanation for the blue color?

   a. Copper ions replace the silver ions in solution.
   b. Silver ions react to turn the solution blue.
   c. Aluminum ions replace the silver ions in solution.
   d. Solid copper metal turns the solution blue.

3. Which of the following is a true statement about the interaction between the used copper chloride solution and various metals? <u>You may check more than one answer.</u>

   a. Aluminum is the only metal that will remove copper ions from solution.
   b. Some metals tested were more effective at removing copper ions from solution than others.
   c. The reaction between copper chloride and each metal produced a dark brown solid.

   d. Adding ammonia caused precipitates to form in the solution remaining after all the metals reacted.

Problem II

Imagine you work as an environmental safety engineer with an electroplating plant located in an area of the country that may have an acid rain problem. Your company produces monthly between 100 to 1000 liters of a waste water solution whose chromium concentration is 50,000 ppm. They have asked you to recommend a treatment method.

1. Many communities do not permit treatment of wastes by dilution. Why do you think dilution is not permitted? Give at least two reasons.

2. Which would you recommend to your company - metal replacement or precipitation?

   Explain the reason for your choice.

3. Would your recommendation change if your company were located in an area of the country that is unaffected by acid rain or similar conditions?

   Explain your answer.

Problem III

Acid rainfall in the northeastern part of the United States and in Canada has apparently caused some of the freshwater lakes to become acidic. Fish and other aquatic animals and plants in these lakes are dying.

Something must be done about this problem. You have been asked to prepare a plan to correct the acidic condition of the lake.

1. What information would you need to prepare your plan?

2. What main ideas in the Solutions and Pollution Module might you consider for your plan?

3. Besides scientific evidence and information, what other factors might influence your plan?

(Miller, 1990)

Goal Scale Items
(Meece, Blumenfeld, & Hoyle, 1988)

Mastery Orientation (alpha = .94)	Factor Loadings
1. I wanted to find out something new.	.97
2. I wanted to learn as much as possible.	.96
3. The work made me want to find out more about the topic	.81
4. I felt involved in my work.	.75
5. I wish we had more time to spend on science today.	.72
6. It was important to me that I really understoon the work.	.72
7. I liked what we did in science today.	.64
8. I would like to do another activity like this one.	.59
9. I put a lot of time and effort into my work.	.53
Ego/Social Orientation (alpha = .85)	
1. I wanted others to think I was smart.	.89
2. It was important to me to do better than the other students.	.84
3. It was important to me that the teacher thought I did a good job.	.70
Work-Avoidant Orientation (alpha = .77)	
1. I wanted to do things as easily as possible so I wouldn't have to work very hard.	.84
2. I just wanted to do what I was supposed to do and get it done.	.69
3. I wanted to do as little as possible.	.64
Affiliative Goals (alpha = .75)	
1. I wanted to talk to other about the work.	.77
2. I wanted to work with my friends.	.72
3. I wanted to help others with their work.	.54

(MILLER, 1990)

INSTRUCTIONAL ENVIRONMENT SCALE

TEACHER________________________ CLASS ______________

OBSERVER ________________________ DATE ______________

MEAN RATING ______________

This instrument is used to rate the instructional environmental factors of a classroom. The fourteen items are rated on a scale of 1 to 5. The ratings or descriptors are listed under each item. In the cases where descriptors are listed, the items are rated on a scale of 1 to 5, with 1 assigned when no descriptors of the item are evident to 5 when four of the descriptors are evident. For this scale, 1 is the lowest rating a 5 is the highest.

A mean score is obtained for each use of this scale.

Ratings:
1. None of the descriptors is evident.
2. One of the descriptors is evident.
3. Two of the descriptors are evident.
4. Three of the descriptors are evident.
5. Four of the descriptors are evident.

---

1. Teaching methods used are appropriate for the objectives, learners, and the environment.

1. <u>Descriptors</u>:
   a. Teaching methods are matched to objectives.
   b. Teaching methods are matched to learners.
   c. Activities are compatible with the learning environment.
   d. Lesson is well-coordinated.

---

2. Concrete materials, supplies, instructional equipment and/or instructional aids are used.

2. <u>Ratings</u>:
   1. Instructional equipment, concrete materials, objects, activities are not used.
   2. Instructional equipment, instructional aids, concrete materials and supplies are used, but has trouble which causes delays or materials do not fit planned lessons.
   3. Effectively uses equipment, concrete materials, activities at appropriate

time in lessons.

4. Highly skillful use of instructional equipment, concrete supplies, activities, or aids at appropriate times.
5. In addition to items in 4, shows evidence of skillfully preparing original instructional materials and/or activities.

---

3. Instructional materials are used that provide learner with appropriate practice on objectives.

3. Ratings:
   1. Materials and activities chosen are irrelevant to the topic or objective or no materials or activities are used.
   2. Materials and/or activities chosen are related to the topic being studied but not to the objective.
   3. Most materials chosen provide for practice on specific objectives. Some of the practice may be insufficient in quantity to achieve the objective.
   4. Materials chosen are relevant to the objectives. Learners are given ample opportunity to practice and achieve the objective.
   5. In addition to the items in 4, formal or informal progress assessment techniques are used to determine whether the practice individual learners receive is sufficient.

---

4. Clear, frequent directions and explanations related to lesson content and purpose are given.

4. Ratings:
   1. Teacher fails to give any direction or explanations either written or oral when there is an obvious need to do so (i.e., demonstrating proper use of equipment).

      OR

      Directions and explanations are difficult to understand and no attempt is made to remedy the confusion.
   2. Directions or explanations are difficult to understand. Attempts to clarify confusion are largely ineffective.
   3. Although most learners appear to understand, the teacher works with the entire group to clarify misunderstandings.
   4. Only a few learners misunderstand. The teacher identifies specific learners who have difficulty with directions and explanations and helps them individually.
   5. No evidence of learner confusion about directions or explanations is evident.

---

time in lessons.

4. Highly skillful use of instructional equipment, concrete supplies, activities, or aids at appropriate times.
5. In addition to items in 4, shows evidence of skillfully preparing original instructional materials and/or activities.

---

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---

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      OR

      Directions and explanations are difficult to understand and no attempt is made to remedy the confusion.
   2. Directions or explanations are difficult to understand. Attempts to clarify confusion are largely ineffective.
   3. Although most learners appear to understand, the teacher works with the entire group to clarify misunderstandings.
   4. Only a few learners misunderstand. The teacher identifies specific learners who have difficulty with directions and explanations and helps them individually.
   5. No evidence of learner confusion about directions or explanations is evident.

---

5. Feedback is provided throughout the lesson to affirm correct answers and to correct mistakes.

5. Ratings:
   1. Accepts learner comments or performance without feedback about their adequacy.
   2. Responds to negative aspects of student work, but few comments are made about positive aspects.
   3. Informs students of the adequacy of their performance. Affirms correct responses. Few errors pass by without being addressed.
   4. Helps learners evaluate the adequacy of their own performances.
   5. In addition to 4, the teacher probes for the source of misunderstandings which arise.

---

6. Within a particular class period a variety of teaching methods are used.

6. Ratings:
   1. Within a class period no teaching method is used acceptably.
   2. One teaching method is used acceptably.
   3. Two teaching methods are used acceptably.
   4. Three teaching methods are used acceptably.
   5. Four teaching methods are used acceptably.

   Teaching methods may include: drill, inquiry, discussion, role-playing, demonstration, explanation, problem-solving, experimentation, hand-on activities, games.

---

7. Teacher provides opportunity for individual, small group, and large group work.

7. Descriptors:
   a. Group size for instruction is matched to the objectives.
   b. Teacher's role is appropriate to each group size being used.
   c. Transitions from one sized group to another are smooth.
   d. Different group sizes that are matched to the objectives are used.

---

8. Learners are provided with opportunities to participate.

8. Ratings:
   1. Class activities require passive commitment.
   2. The class is organized so that only a few learners participate actively.
   3. Most learners have opportunity for active participation at some time in the

class (e.g., small group discussion, physical manipulation of materials, physical movement, individual work with concrete objects, etc.)

9. Teacher provides positive reinforcement for learners and encourages the efforts of learners to maintain involvement.

9. Descriptors:
   a. Uses activities, or concrete materials or objects which are appropriate for learners.
   b. Varies pace and nature of activity.
   c. Responds positively to learners who participate, and/or encourages the efforts of learners to maintain involvement.
   d. Identifies and responds to learners who are off task.

---

10. Teacher presses for wide class participation.

10. Ratings:
   1. Teacher accepts student answers but does not call on individuals.
   2. Teacher calls on students who raise hands or indicate willingness to answer or allows a few students to dominate.
   3. Teacher calls on many students including some who have not volunteered or raised hand.
   4. Teacher calls on most students in the class at least once during the class period.
   5. In addition to 4, teacher uses strategies that encourage wide class participation.

---

11. Teacher attends to routine tasks.

11. Ratings:
   1. Teacher does not attend to routine task.
   2. Teacher attends to routine task in a disruptive or inefficient manner (e.g., learners need special permission for many routine tasks).
   3. Teacher anticipates routine tasks and attends to them efficiently (e.g., having equipment, materials, supplies ready).
   4. Routine tasks are handled smoothly. Teacher delegates many tasks to the students.
   5. In addition to 4, learners are responsible for various dimensions of the task (e. g., distributing materials, equipment, picking up work area, returning supplies, etc.).

---

12. Teacher presses for mastery of materials by asking students to explain, justify or use meta-cognitive strategies.

12. Ratings:
   1. Teacher does not press for student mastery of materials.
   2. Teacher presses some students for mastery of materials.

      OR

      Teacher infrequently presses for student mastery of material.
   3. Teacher routinely presses students for mastery by asking students to explain or justify answers or reasons.
   4. In addition to 3, teacher uses strategies that encourage students to explain or justify.
   5. Teacher presses or requires all students to use meta-cognitive strategies.

---

13. Appropriate classroom behavior is maintained.

13. Descriptors:
   a. Uses techniques (e.g., such as approval, contingent activities, punishment, etc.) to maintain appropriate behavior..
   b. Overlooks inconsequential behavior problems.
   c. Reinforces appropriate behavior.
   d. Maintains learner behavior that enhances the possibility for learning for the group.

---

14. Teacher models cognitive strategies for students.

14. Ratings:
   1. Teacher does not model cognitive strategies for students.
   2. Teacher models cognitive strategies one time during a lesson.
   3. Teacher models cognitive strategies more than once during a class period.
   4. Teacher models cognitive strategies at least once, and has students model cognitive strategies.
   5. In addition to 4, teacher frequently refers to cognitive strategies, and uses techniques to encourage student use of these strategies.

APPENDIX B

ORAL PRESENTATION

Oral Presentation to Student Participants

I am, Leon H. Sturdivant, a graduate doctoral student at the University of North Carolina at Greensboro. To complete my doctorate degree in Curriculum and Teaching, I have to design and implement a research project. I have received permission from Greensboro Public Schools to conduct my research project during the 1992 summer school program.

My research project deals with how hands-on science effects students learning and students attitude toward science. The basic question for this research is "Do students learn more science and enjoy science better when a hands-on approach is used?" I will be here to observe you as you complete three science hands-on activities to determine if hands-on science is a good teaching approach for students attending summer school.

I expect you to take these hands-on science activities seriously and do your best on all three of them. A pretest and a posttest will be given for hands-on activities to determine how much you learned and how much you enjoyed doing these activities.

Teachers and students will be interviewed to evaluate the success of hands-on science as an effective learning strategy. Thirty students will be selected to be interviewed. Each student interview will last five minutes. Each interview will be done by the researcher and recorded on cassette tape. To protect identity the person interviewed, no names will be used with comments.

Thank you for consenting to participate in this educational research to learn more about what teaching approach is better for students learning science.

APPENDIX C

RESEARCH LOG AND DISCUSSION

Research Log and Discussion

June 30, 1992	Turned in research proposal for final approval. Submitted human subjects study to UNC-G. Rewrite of oral presentation.
July 1, 1992	Resubmitted oral presentation for final approval. Teacher in-service at Allen for teachers. All three science teachers participated. All teachers expressed a willingness to participate.
July 2, 1992	Contacted Mendenhall to establish a time for teacher in-service. Mrs. Fagan suggested that I call her on Monday.
July 3, 1992	Got all CEPUP material at Allen. Ran and stapled 150 pretest and posttest.
July 5, 1992	Received phone call from Mrs. Fagan. She wanted to have her science teachers in-serviced Tuesday, July 7, 1992, at 9:30 to 10:30 a.m. She would arrange for her teacher assistants to cover.
July 6, 1992	I talked with Mr. Lewis at Allen about scheduling Mrs. White to do the in-service at Mendenhall. I suggested that a teacher assistant cover her class for about 1 1/2 hours. He expressed a concern about assigning a teacher assistant for this length of time. He said he would call Harold Fields

for approval. I told him that I would cover for her in her absence. He later reported that Mr. Fields approved my covering for her. I informed Mrs. White. She suggested that we use two CEPUP Kits at Mendenhall and two at Allen. I arranged to transport two kits to Mendenhall. Developed CEPUP pretest/posttest orientation schedule.

White - 7/7/92 - 9:00-10:30

Hardy - 7/8/92 - 9:00-10:30

James - 7/9/92 - 9:00-10:30

Teachers selected three students to be interviewed after each science activity (per class). Met the three science teachers at Mendenhall and scheduled for teacher interviews.

July 7, 1992 Reported to Allen Middle School. Conducted first and second period science classes for Mrs. white as she went to Mendenhall to in-service three science teachers. I administered the pretests to the two classes. Circled all of the pretest answers in red. White - scheduled activity on solutions on Wednesday, 7/8/92.

July 8, 1992 Reported to Allen Middle School. Administered pretest to Ms. Hardy's classes

	first and second periods. Observed Mrs. White's first period science class. Hands-on activity - Teacher gave the procedure orally to facilitate reading.
July 8, 1992	11:00 a.m.
	Reported to Mendenhall to distribute pretests.

<u>Student Interviews</u>

July 14, 1992

<u>Student</u>	<u>Teacher</u>	<u>Sex</u>	<u>Race</u>
9:00 a.m.:			
6th Shea Eleazer	Hardy (A-1)	F	B
6th Ricky Bass	Hardy (A-1)	M	W
6th Stephen Posey	Hardy (A-1)	M	B
9:30 a.m.:			
7th Shannon Pucket	White (B-1)	M	W
7th Shawn Steens	White (B-1)	M	B
7th Joshereece Blackstock	White (B-1)	F	B
10:30 a.m.:			
6th Malcolm Murray	Hardy (A-2)	M	B
6th Richard Cunningham	Hardy (A-2)	M	B
6th Michelle Game	Hardy (A-2)	F	W
10:30 a.m.:			
7th Elizabeth Cherry	White (B-2)	F	W
7th Billy McGirt	White (B-2)	M	B

7th Carlos Gregory	White (B-2)	M	B
11:00 a.m.:			
8th Rosalind Moore	James (C-2)	F	B
8th Anita Broadway	James (C-2)	F	B
8th Greg Caviness	James (C-2)	M	B
11:15 a.m.:			
8th Johnie Cowell	James (C-2)	M	B
8th Delane Smith	James (C-2)	F	W
8th Michael Tucker	James (C-2)	M	B
11:30 a.m.:			
8th Paul Gourley	James (C-1)	M	W
8th Joseph Poorman	James (C-1)	M	W
8th James Manual	James (C-1)	M	B

Total interviewed: 21 students

7/14/92 - Allen

12 to be transcribed

School	Teacher	Science	Period	Enrollment
Allen	Hardy-A	6th	1st	13
Allen	Hardy-A	6th	2nd	9
				22
Allen	White-B	7th	1st	11
Allen	White-B	7th	2nd	11
				22
Allen	James-C	8th	1st	17
			2nd	9

	3rd	12
		38
Total		82

Student Interviews

7/15/92

Student	Teacher	Sex	Race
9:00 a.m.:			
8th Coris Hunt	Heldreth	M	B
8th Kristie Elkins	Heldreth	F	W
8th Nelson Jackson (absent)	Heldreth	M	B
9:15 a.m.:			
8th Lee Allred	Heldreth	M	B
8th Erica Capers	Heldreth	F	B
8th Quincy Snipes	Heldreth	M	B
9:45 a.m.:			
6th Tiffany Shuler	Barten	F	B
6th Lisa Haskins	Barten	F	B
6th Steven Alston	Barten	M	B
10:15 a.m.:			
7th Keisha Sutton	Johnson	F	B
7th Claude Gardner	Johnson	M	B
7th Gary Baker	Johnson	M	B

11:00 a.m.:

8th Michael Hooker	Hilreth	M	B
8th Sherman Johnson	Hildreth	M	B
8th Larina McNamarth	Hildreth	F	W

11:30 a.m.:

6th Walter Woods	Barton	M	B
6th Tamara Cole	Barton	F	B
6th Shanta Durham	Barton	F	B

July 21, 1992

11:00 a.m.:

8th Clinton Jackson	Hildreth	M	B
8th Laura McNamara	Hildreth	F	W
8th Tasha Peoples	Hildreth	F	B

July 15, 1992 Met with Dr. Strahan to discuss progress. Reported that I am collecting too much useless information. I suggested that only one pretest and one posttest be given. Dr. Strahan agreed. I suggested that 30 student interviews and four teacher interviews be sufficient for this study. Dr. Strahan agreed that I could limit the number of interviews. He suggested that I begin getting data analyzed. He gave me the phone number of Mary Panter.

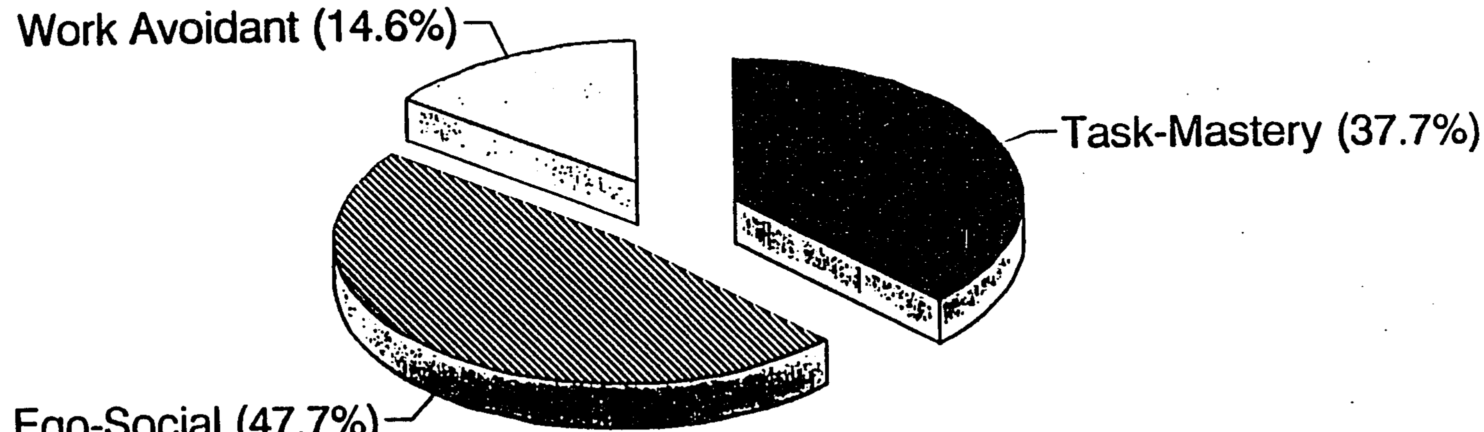
July 16, 1992	I did not report to summer school site instead I had some personal things to do.
July 17, 1992	I called the following about gathering assistance with analyzing statistical information: Regina Lane - statistics, Jonathan Tyler - tapes, Dr. Dave Strahan formatting disc. Observed the following classes and teachers at Allen: Hardy, James, and White (absent). Played tapes with student interviews to determine if everything was recorded. The first tape was fine. The second tape had no recording. Planned to retape Mendenhall's 8th graders on Wednesday, July 23, 1992.
July 20, 1992	Classroom visitation at Allen 9-12. Mr. White was still absent. Made arrangement to do copper plating hands-on activity on Thursday, July 24, 1992. Scheduled for posttest survey. Visited Dr. Penda at UNC-G to arrange for statistical analysis.
July 21, 1992	Interviewed six students at Mendenhall. These interviews were the ones that did not come out on tape. Interview results were positive in favor of hands-on class. Math Department, Computer Services, Consultation UNC-G

July 22, 1992	Visited Jackson Middle School and spoke to principal, Mr. Hairston, about getting his SIM operator to put dissertation data on the computer disk. Mr. Hairston said that his SIM operator was on vacation and would not be back until late August. I went to UNC-G to see Julie Tenant in the research development. She was absent. I was referred to someone else. I signed up for a research computer account using the SAS program. I met with Dr. Strahan briefly and scheduled a meeting for next Tuesday at 1:30 p.m. to discuss program.
July 23, 1992	Visited Mendenhall to collect pretest results.
July 24, 1992	Completed the hands-on science activity on copper plating for Mrs. White. Students were cooperative and engaged in the activity. Most students completed the activity without any difficulty.
July 27, 1992	Posttest was administered to 6th graders.
July 28, 1992	Posttest was administered to 7th graders.
July 29, 1992	Posttest was administered to 8th graders.

APPENDIX D

GRAPHS ON GOAL ORIENTATION

Student Goal Orientation
by Percent - Posttest



Student Goal Orientation
by Precent - Pretest