The Influence of Program Sequence, Past Performance, and Participation in Group Activities on Achievement in the Use of the Science Curriculum Improvement Study (SCIS)

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THE INFLUENCE OF PROGRAM SEQUENCE, PAST PERFORMANCE, AND PARTICIPATION IN GROUP ACTIVITIES ON ACHIEVEMENT IN THE USE OF THE SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS)

by

Rita Perron Howe

A Dissertation Submitted to the Faculty of The Graduate College in partial fulfillment of the Degree of Doctor of Education

Western Michigan University Kalamazoo, Michigan August 1979

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Rita Perron Howe
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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Elementary school science, in the United States, has been influenced by the needs of society. In an attempt to meet those needs, after the launching of Sputnik in 1957, many elementary school science curricula were developed. Three of the major programs developed during the late 1950's and early 1960's are: Science--A Process Approach (S-APA); Elementary Science Study (ESS); and Science Curriculum Improvement Study (SCIS).

S-APA offers the student a hierarchical structured sequence of activities, based on predetermined objectives. It is suggested that the teachers of S-APA have some specific training in a process approach to science. The goal of the program is to assist the child to develop skills that lead to mastery of basic scientific processes. What the child can do is the key focus of the program.

ESS, a nonsequential, nondirective approach to science, requires no specialized science content training for teachers. Teachers who are comfortable being nondirective are recommended for the success of this program. The goal of ESS is to encourage the setting of individual goals by each student.
SCIS is a sequential program of classroom/laboratory experiences in physical and life sciences. No specialized science content training is necessary, but training in the specific instructional strategies of the SCIS program is desirable for continued success of the program. The goal of SCIS is to assist the child to develop scientific literacy by viewing the world as a scientist. SCIS developers view science as an activity that involves the interaction of living and nonliving things, and consider the classroom/laboratory to be a small version of a scientific community.

Purpose of the Study

The purpose of this study was to examine the variables influencing the predictability of scores on student achievement in the SCIS. The influencing factors considered were: the degree to which the suggested sequence in the sixth-grade program was followed, past performance in SCIS, and the degree to which students participated in group activities.

In the development of SCIS, the sequence was thought to be a controlling variable in the success of the program. Some concepts of SCIS are built one upon the other. This provides a continuity and serves as reinforcement of the concepts. The program is structured in such a way as to maximize the stage of development of the age group which it serves. According to Jacobson and Kondo (1968), the units of the program are sequenced with the intent to nurture and
facilitate the child through preoperational thought to concrete thought. Each grade level includes sequential unit parts in life and physical science.

Piaget (1972) suggested that there are hierarchical processes through which individuals must pass in order to acquire knowledge. According to Karplus and Lawson (1974), "The SCIS program attempts to present scientific concepts consistent with the children's intellectual growth, developing gradually higher levels of abstraction" (p. 3).

On this theoretical basis, the program sequence structure of one grade level was considered as a factor influencing the prediction of achievement scores in SCIS. Since achievement is built on performance of previous years and there is a sequential structure from grade to grade, past performance in SCIS was also considered as an influencing factor.

SCIS was designed to assist the child to see the world from a scientist's perspective and to provide the child with an environment that would encourage the development of scientific literacy. The program is concept-oriented and the child is the center of activity, according to Jacobson and Kondo (1968). The SCIS approach is one that allows the child to experience a thought process that is similar to that of the scientist. This scientific participation leads to a way of internalizing scientific concepts, according to Atkin and Karplus (1962). Group activity is one means of providing an
environment that may foster scientific participation. Group activity, in this study, is defined as two or more students working together on the same task. The degree to which the class participated in group activities was used as a predictor variable in this study.

This investigation was undertaken to determine the degree of accuracy, using certain variables, in the prediction of achievement scores in SCIS. The major purposes were to examine the extent to which the variables of program sequence structure at one grade level, recent past scores, and the degree of participation in group activity influenced the prediction of achievement scores in SCIS. In order to examine the applicability of the prediction formula, the multiple regression equations were developed for the sample.
CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The object of this study was to examine the influence of past performance in the Science Curriculum Improvement Study (SCIS), content sequence structure of sixth-grade SCIS, and participation in group activities on the prediction of achievement scores in SCIS. A major goal of SCIS was to provide for scientific literacy and to improve interest and attitudes in science at the elementary school science level. In order to establish the means to the desired ends, SCIS was designed to include activities and the structure that reflected the philosophies of the times.

The learning and development theories of Piaget, Bruner, and Gagné have made an impact on elementary science. They have impacted the content, the sequence of the content, and the teaching methods used. The major learning theories drawn upon in the development of SCIS were those of Piaget and Bruner (Victor, 1975).

The purposes of this chapter are to discuss the learning theories, the SCIS program, SCIS at the sixth-grade level, the influence of past performance, group activity and sequence structure, and to present a summary.
Learning Theories

Teaching methods and curriculum design hope to promote student learning. The degree of student learning which is possible at different ages, from the methods and designs, is of great interest to philosophers and researchers. The philosophers and researchers in turn have influenced the construction of new programs. SCIS, during its development, was influenced by teachers, scientists, and science educators as well as philosophers and researchers. In addition, SCIS embodies scientific concepts consistent with the child's intellectual growth (Jacobson & Kondo, 1968). The purpose of this section is to discuss the learning theories of Piaget, Bruner, and Gagné.

Piaget

The studies of Piaget (1970) have generally identified developmental stages of thought processes in children. These major stages of intellectual development govern the child's perception of reality and his/her ability to learn. The major stages of Piaget given in Athey and Rubadeau (1970) are sensory-motor, concrete operations, and formal operations.

Sensory-motor, the first stage, is usually developed by the time the child is 2 years old. At the end of this stage the child has no problem seeing a continuum, but does have difficulty with perceptions involving space and time.
Perceptual images only are constructed at this time.

Concrete operations, the second major stage, is divided into three substages: preoperational thought; intuitive thought; and concrete operations, as a substage. From ages 2 to 4, the child can make unorganized attempts at mental imagery. Preoperational thought (Inhelder & Piaget, 1958) occurs when the child explains actions and situations based on his/her perceptions alone. There seems to be no reversibility. As a child begins to express the possibility of future actions and situations based on past perceptions, he/she moves into intuitive thought. The concrete operations substage occurs between 7 and 11 years of age, when the child is capable of coordinating and internalizing action taken on material objects. It is the period when the child develops a communications system consisting of words and symbols that provide a means of relating the child's inner world to the outer world. The child constructs his or her own way of viewing sequences and relationships. Once the child can retrace the steps in the construct, the child is said to enter the concrete operational substage. This is the stage where the child gradually becomes capable of dealing with abstractions. The child, in the process of developing fine motor skills, is beginning to think in an organized, systematic manner and can handle problems concerned with sequence, time, and space. To fully develop this conceptual structure, the child must have guided exploratory experiences with
material objects and natural phenomena (Piaget, 1970).

Formal operations, the third stage, occurs between ages 11 and 15. The child can, at this time, deal with abstractions, and the child has a concept of the consequences of actions. The child can more accurately visualize relationships between material objects and phenomena and can transfer knowledge. According to Shulman and Tamir (1973), much of recent science curricula has been impacted by the Piagetian theory of development.

In a review of research on cognitive development and science achievement of junior high, high school, and college students, Chiappetta (1976) found the Piagetian developmental levels to be broader than reported by Piaget. "At first glance, the research of Jean Piaget might lead many educators to believe that most individuals are formal operational thinkers by 15 or 16 years of age. This may be a misconception" (p. 253). There seem to be consistencies with the stage order and abilities of the student in a defined stage, but exactly when that stage will occur varies. Chiappetta did find that students at the formal operations stage achieve higher scores on tasks when the directions are given at the concrete operational level. Concrete operational thinkers could not follow directions given at the formal operations level. Therefore, he stated that curricula should consider the developmental level of the student, and teachers should accept these curricula and not consider them too simplistic.
Caution in curriculum development must be taken. In a study by Blake, Lawson, and Nordland (1976), it was found that tasks designed with the Piagetian developmental stages in mind may not measure what Piaget's tasks themselves measured. However, in a study by Elkind (1961), it was found that repeating Piaget's tasks as described did produce results consistent with the expectations of Piaget's findings.

Bruner

Bruner (1966) did not divide the developmental stages into distinct categories, but did encourage the use of these external classificatory stages as guides that can assist us in the preparation of curricula. Bruner (1961) believed that students should be challenged and encouraged and also should be led to discoveries. Activity on the part of the student, or the handling of material objects, assists the child in his/her development of awareness and understanding of abstractions. It takes more than the presentation of ideas from teachers to instill a positive attitude among students. They must be involved in the process (Bruner, 1973). Learning involves the acquisition of knowledge, the process of manipulating this knowledge to make it fit new situations, and evaluating the acquisition and manipulation of that knowledge. The child can learn through discovery, and should be involved in problem-solving and inquiry (Bruner, 1961). There were no relevant empirical studies that supported
Gagne

Gagne (1977) stated that learning takes place in a combination of prerequisites. For instance, prior learning acts as a support for new learning. This learning hierarchy, or sets of prerequisite skills, must be mastered before another set of skills can be achieved. It provides a process for success experiences based on past experiences. Curricula should reflect a logical ordering of activities to insure that the prerequisite skills have been previously learned (Gagne & Briggs, 1974).

In an early study, Gagne (1962) derived a hierarchy for the task "finding formulas for sum of \( n \) terms in a number series" (p. 356), beginning with this task and asking what an individual would have to be able to do before attaining success on this task. As each subordinate task was defined, the question was repeated. At the lower end of the hierarchy was the learner's entering competencies. A significant number of instances of correct solutions to the task followed learning at subordinate levels. A planned sequence of skills, according to Gagne (1977), is a plan leading to possible success in attaining the upper levels of the hierarchy of process skills. The sequencing is considered an important contribution in curriculum development, yet the amount of detail in the sequencing could pose a problem.
since the detailed problems may be extended into future achievement. Students should be given instruction in skills or competencies during their elementary school years. These skills will allow the students the opportunity to acquire knowledge and participate in activities with understanding (Gagné, 1977).

A number series program was administered by Gagné and Brown (1961) to ninth- and tenth-grade students. The number series was presented to three groups using three programs. The program styles were: rules and examples, guided discovery, and discovery. The students were scored on the basis of the time it took them to complete the program, and the number of hints that were needed for them to complete the program. It was found that scores were significantly higher in the group who used the guided discovery program. In an experiment by Niedermeyer, Brown, and Sulzen (1969), the number series program from Gagné and Brown's 1961 study was administered to ninth-grade algebra students in logical, scrambled, and reverse sequence versions. The logical group performed significantly better on a test of concepts and problem-solving, but there was no significant difference on a performance posttest. However, the number series program was developed prior to Gagné's derivation of a learning hierarchy.
The SCIS Program

According to Karplus (1973), major learning theories were drawn upon in the development of SCIS. The Piagetian theory of development greatly influenced the content and sequence structure of the SCIS program. The Brunerian theory, that children can be taught anything, influenced SCIS by inclusion of certain science concepts. However, SCIS embodies science concepts taught to the child at his/her developmental stage. The purpose of this section is to discuss the history of SCIS, the goals of SCIS, the methods of SCIS, and a description of the program.

History of SCIS

Science education, before the International Geophysical Year and the launching of Sputnik I, had its focus on content at the secondary school level. There was a fear that science interest, attitudes, and knowledge were deficient and that the United States was falling behind other countries in science content, research, and space exploration. The 1957 satellite provided an added stimulus to the examination of elementary science and mathematics programs. SCIS was established in 1962. SCIS evolved from the Elementary Science Project, a National Science Foundation-funded project.

SCIS began as a 6-year program where the child is assisted in the development of some basic knowledge and
understanding of the major scientific concepts of matter, energy, organisms, and ecosystems. The child is assisted in some basic understanding by learning to function with processes such as observing, measuring, interpreting, and others. Teachers of SCIS act as facilitators and observers and guide students through the processes of SCIS. Teachers are advised to incorporate their own ideas and adapt the program as they deem necessary.

Goals of SCIS

SCIS, a science program established in 1962 at the University of California at Berkeley, was designed to assist the child to develop scientific literacy and to improve interest and attitudes. The SCIS program was developed with activities that would emphasize the opportunity for students to have experiences with material objects and their properties.

A main goal of SCIS was the development of the use of inquiry methods and a sense of understanding of the conceptual structure of science. This conceptual framework could provide a basis for a reliable perception of the nature of the world (Karplus, 1964). According to Karplus, the concepts included in SCIS are arranged in a hierarchy of levels of abstraction. Understanding comes only after much time has been spent on concrete experiences. By the time a student completes the SCIS program, he/she should have the
basis to begin to understand the conceptual schemes of science (Hurd & Gallager, 1968). In a survey by Moon (1977), teachers felt that conceptual schemes were interwoven throughout both the physical and life science units of SCIS. In a study by Yoder, Long, and Enderlein (1977), it was found that students who had had a blend of physical and life science in junior high achieved higher scores in biology than those who had 1 year of life science and 1 year of physical science.

Methods of SCIS

There have been many methods used to teach science in the past, such as demonstrations and lectures. SCIS attempts to (1) present the elementary student with situations that provide an opportunity for active participation in the study of science, (2) nurture the child in his/her wonderment, and (3) provide the best environment to facilitate transition from the substage of preoperational thought through the sub-stage of intuitive thought to the substage of concrete operational thought. It would be important that the child have contact with material objects and discuss, with guidance, their relationships with other objects. According to Hurd and Gallager (1968), these concrete experiences would provide students with the concepts and communication skills essential to the development of scientific literacy.

The SCIS program includes three kinds of lessons:
exploration, invention, and discovery. The exploration lesson is one that provides the student with an enriched environment where he/she may have a variety of opportunities to explore or play with materials and equipment. This is a structured environment with no predetermined structured child behavior. The invention lesson, a teacher-dominated lesson, is one where the teacher presents a science concept and gives a demonstration that will assist the child in his/her understanding. The teacher may formulate hypotheses based on the student's experiences. During discovery lessons, the students are encouraged to apply the learned concepts in a variety of situations. At this time the students may test their hypotheses. There are times when each lesson type is used in a single class period and there are very few times when all three are incorporated during one class period (Jacobson & Kondo, 1968). The lesson types are woven through the program activities.

Description of SCIS

The basic structural sequence of SCIS is a series of physical science and life science units during a 6-year period with a readiness unit presented at kindergarten level. The grade unit sequence is as follows: grade 1, "Material Objects" and "Organisms"; grade 2, "Interaction and Systems" and "Life Cycles"; grade 3, "Subsystems and Variables" and "Populations"; grade 4, "Relative Position and Motion" and

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"Environments"; grade 5, "Energy Sources" and "Communities"; grade 6, "Models: Electric and Magnetic Interaction" and "Ecosystems." Each unit is divided into parts which are subdivided into chapters. Each chapter contains activities for the students. The Teacher's Guide provides the teacher with learner objectives, background information, advance preparation information, and teaching suggestions.

The integration of scientific concepts and content, through processes in science in keeping with the developmental stages and interests of the child, also helps to develop a more positive attitude towards science (Karplus & Lawson, 1974). The developmental transition from pre-operational thought through concrete operational thought is facilitated throughout the program. The sixth-grade units are the highest level units and the final units in the SCIS program.

SCIS at the Sixth-Grade Level

SCIS was planned with the intellectual development of the individual in mind. It would be far too expensive to design a curriculum for each individual child. Therefore, SCIS focused on the developmental stages. The adherence to the stages of the developmental process is more readily observed in a group situation. The sixth-grade units are the culminating units of SCIS, introduced at the final substage of the concrete operational stage of the Piagetian theory.
of development.

The sixth-grade units are divided into parts. Each part, with its learner objectives, is divided into chapters that contain activities for the students. These activities are designed to increase the students' awareness and understanding of magnetic and electrical phenomena and ecosystems. These desired outcomes are the result of several activities that offer the child concrete experiences that provoke abstract thought at a time when the child is developmentally ready. The children work individually in small groups or teams and as a class. The activities are designed to enable the child to obtain knowledge and to make interpretations. The unit titles of the sixth-grade units are "Models: Electric and Magnetic Interactions" and "Ecosystems."

In the physical science unit, the student begins by reviewing the concepts introduced in SCIS during earlier grades (Berger, Bunshoft, Karplus, & Randle, 1971). Through the use of models, either presented to or designed by the students, the students gain a better understanding of interaction and circuits. Models of magnetic and electrical systems are used to assist the students in their development of the concept of scientific models. The students develop a sense of the interdependence of the parts of a system in relationship to the whole system. The activities provide the students with the opportunity to test out their own ideas by constructing their own models.
In the unit on "Ecosystems," the children build aquarium-terrarium systems. The students observe and record the interactions in the systems. Earlier concepts introduced in SCIS are related to the events observed in the systems. A better understanding of exchange and cycles is gained at this time, and the students are encouraged to examine the ecological cycles. The students also have the opportunity to observe changes in an ecosystem by introducing a pollutant. These concepts assist the child in making interpretations and predictions of outcomes based on more than intuition and magic (Conrad, Knott, Lanier, Lawson, Peterson, & Sheehan, 1971).

The sixth-grade units finalize a process which began in the first grade. At the end of the sixth grade, the students should have developed scientific literacy and an interest in science. It was hoped that this would become an ongoing process and that the desire to continue study in science would prevail.

Dependent Measures

Past performance

Past achievement seems to be linked with basic sequence structure since achievement one year provides the conceptual framework for another year. In a study by Stevenson, Parker, Wilkinson, Hegion, and Fish (1967), it was found that past
performance was a most effective predictor of achievement. In a study by de Bottari (1969), third-grade final marks and achievement test scores were found to be predictors of twelfth-grade achievement scores. In a longitudinal study by Peterson and Kellam (1977), it was found that first-grade scores, as measured by the average of all teacher-given grades and standardized tests, were predictors of seventh- and eighth-grade achievement test scores. Success or failure in achievement in 1 year were used to predict future success or failure in achievement.

Activities

The activities of SCIS are designed to involve the students in the process of science itself (Karplus & Thier, 1967). Learning is an active and dynamic event, and the curriculum and environment should also be active and dynamic (Childs, 1931; Williams, 1971). Students work more vigorously when there is less one-to-one pupil-teacher contact during an activity (Shymansky, 1976). According to a study by Weber and Renner (1972), SCIS groups develop more creative solutions to problems than textbook groups when given process-oriented tasks.

SCIS promotes activities where students have the opportunity to exchange ideas with peers, and the teacher becomes a facilitator and asks open-ended questions. Yet, there seems to be some controversy concerning the relationship...
between open-ended questions and achievement. A study by Wright and Nuthall (1970) suggested that achievement may be slowed down by open-ended questions. A cooperative situation promotes interaction among the students and encourages divergent thinking and creativity, according to Johnson and Johnson (1975). The goal of the group participation in SCIS is to foster peer sharing and divergent thinking. Along with satisfying the science needs of children, the group participation helps to improve self-concept and increase a sense of belonging (Dinkmeyer & Dreikus, 1963; Pearl, 1972; Shaw, 1976). "It is natural that at the beginning the children will have a much greater commitment to the other children than to the teacher. This can be utilized to the advantage of the teacher" (Dinkmeyer & Dreikus, 1963, p. 105).

Participation in group activities can improve the conditions for learning (Pearl, 1972). "Allowing students to be responsible for each other's academic progress also builds feelings of belongingness" (Pearl, p. 247). According to Dewey (1944), the environment "is truly educative in its effect in the degree in which an individual shares or participates in some conjoint activity" (p. 22). In addition to Dewey, Dinkmeyer and Dreikus (1963) took the position that schools can provide the social setting where acceptance and cooperation can be achieved. Schools can offer the group setting that is informative as well as social (Gnagey, Chesebro, & Johnson, 1972; Johnson & Johnson, 1975; Shaw,
1976). If SCIS can provide a setting where education is accomplished, it will have reached its goal of providing an environment that induces scientific literacy.

**Sequence structure**

SCIS is a sequential science curriculum that is consistent with the structure of science itself and with the development of the child, according to the Piagetian theory of development. SCIS provides students with an enriched environment where they actively participate in the learning of science. It was hoped that this environment would be useful and intellectually stimulating to the elementary school student, and if followed as suggested, achievement should be influenced. The program embodies science concepts and provides for experiences of three lesson types: exploration, invention, and discovery.

The program sequence structure of SCIS can sometimes present a problem, according to Karplus and Thier (1967), since work in one unit may well set the stage for other units stretched over a period of 3 or 4 years. If there is only partial understanding one year and concept development is dependent on a more complete understanding, the sequence may be a deterrent to success in SCIS for the individual student.

SCIS has a sequential order of units of study that are designed to take advantage of the developmental stages as described by the Piagetian theory of development, and also
to provide a building of skills using past experience.

Summary

A basic understanding of how children learn is essential to the development of science curricula and the teaching methods of science. The theories of Piaget, Bruner, and Gagné have had a major impact on elementary science programs.

SCIS, an elementary science program, was greatly influenced by Piaget and Bruner. SCIS offers students the opportunity to experience the process of science. The sixth grade is the last year of the program, assisting the child through the concrete operational stage of development.

Bernard (1972) likened developmental stages to an inclined plane and stated that growth is a continuum and that curricula should also reflect a continuum. Many theories support sequencing the content of curricula and the building of skills toward mastery at a point in development. There is some controversy, however, concerning this topic. The importance of sequencing, according to the hierarchy of learning based on Gagné, is on shaky ground due to the weakness in the designs of Gagné's studies (White, 1973). Beeson (1977), in his study, suggested evidence and support that sufficient learning is assisted by ordering the intellectual skills in a hierarchical sequence.

Children are quite consistent in their individual developmental growth, and it would be presumptuous of
educators to believe that they could provide a curriculum that responds to each individual. They can, however, respond to the group (Johnson & Johnson, 1975). Group activities assist the child in developing a purpose which may promote success (Humphrey, 1975). The activities of SCIS offer an environment where experiences with concrete materials are provided along with a conceptual framework. The content sequence structure of SCIS is in keeping with the Piagetian theory of development.

The purpose of this study was to examine the influence of past achievement in SCIS, sequence structure of the content of sixth-grade SCIS, and participation in group activities on the prediction of achievement scores in SCIS.
CHAPTER III

DESIGN AND METHODOLOGY

The purpose of this study was to examine the degree to which the following variables influence the prediction of present achievement scores in the Science Curriculum Improvement Study (SCIS): suggested sequence in sixth-grade SCIS was followed, past performance in SCIS, and degree to which students participated in the group activities. The purpose of this chapter is to describe the sample, the operational variables, the procedures of data collection, and the analysis procedures.

Sample

The sample for this study was the sixth grade in a school system in a Midwestern community. The school system was chosen because of its participation in the SCIS program and SCIS testing over a period of at least 2 years. The upper elementary schools, grades 4-6, implemented SCIS during the 1975-76 school year.

The sixth grade was selected as the sample grade since the sixth grade had been in the program throughout the upper elementary grades. The sixth graders in this study did have a minimum of 2 years of experience in SCIS testing. The sixth grade was also attractive because it is the final grade
served by SCIS and the SCIS Objectives Test was designed to be used in grades 4-6.

Three criteria were used to select the sixth-grade classes for this study: (1) the class was not considered to be a multi-grade or alternative class, (2) the principals agreed to have their school participate in the study, and (3) teachers of the classes were volunteers as part of the study. The rationale in excluding multi-grade and alternative classes was to reduce the number of uncontrollable variables. It was assumed that those classes were quite different in structure from the so-called regular classroom situations. The rationale for the two last criteria were the conditions set by the administrators of the school system. Without those conditions, the study could not have taken place. These limits did decrease the number of possible observations by 18. There were two schools eliminated at the principal level, reducing the possible sample size by eight classes. There were 10 classes eliminated at the teacher level. A positive aspect was that the teachers in the study were willing participants. Volunteers, however, could be too willing and unconsciously try to help out the researcher by providing a less than real situation.

There were 29 sixth-grade classes located in nine different schools in the system. Eleven sixth-grade classes in seven different schools met all the criteria for this study. A fourth criterion was added for the SCIS achievement testing
once the classes were made available. This was that only the data from students who participated in the two sets of testing would be considered as the students making up the class. This reduced the class size, but it did increase the chances that the class mean did not include scores of students in the system for less than 1 year. The class sizes, after meeting that criterion, ranged from 10 to 21. When using the observation instrument, in this study, there was no way to separate the students who had had 2 years of SCIS testing from those who had not. There is no need to describe the particulars about each participating school, since there is no way to link any class with any school.

Operational Variables

Program sequence structure

The program sequence structure of SCIS was considered as a predictor variable in this study. There were no available instruments designed to measure the degree to which the sequential nature of sixth-grade SCIS was followed. Thus, an instrument was developed as part of this study. The instrument, based on the SCIS Teacher's Handbook (Karplus & Lawson, 1974), was developed by the researcher and examined by two teachers of SCIS. The recommended changes were included in the final instrument given to teachers of the sample classes.
The instrument was designed so that teachers could self-report the sequence in which the units were presented to the class during the 1977-78 school year. Upon the recommendation of two of the participating teachers, the instrument included parts of the fifth-grade level, one physical science unit, and one life science unit. Each unit is divided into parts and each part contains chapters. The instrument listed 15 parts, 9 of which were sixth-grade parts. The remaining parts were those of the fifth grade. The SCIS Unit Sequence Instrument is in the Appendix.

The list was scored by comparing the teacher's rank order with the suggested order in the SCIS Teacher's Handbook (Karplus & Lawson, 1974). A score of 1 was assigned for each item that was in the suggested sixth-grade order in relation to the preceding part. A score of zero was given for each item not in the suggested sixth-grade sequence in relation to the preceding part. A score of zero was given to all fifth-grade parts since they were not in the suggested sixth-grade sequence. The instrument was assumed to yield interval data with a possible range of 0-9.

The content validity of the instrument developed to measure sequence structure was verified by group consensus, by two teachers of sixth-grade SCIS (at a meeting with the researcher), and was checked by the researcher against the following teacher's guides: Energy Sources (Berger, Karplus, Randle, Thier, & Webb, 1971), Communities (Knott, Lanier,
Lawson, & Sheehan, 1971), Models: Electric and Magnetic Interactions (Berger, Bunshoft, Karplus, & Randle, 1971), and Ecosystems (Conrad et al., 1971), all published as part of SCIS by Rand McNally and Company. In an effort to establish the reliability of the Unit Sequence Instrument, a second administration of the instrument followed the first by approximately 1 week. The second instrument was given to 5 of the 11 teachers in the study. This reliability check was to locate the inconsistencies between the first and second administrations. The inconsistencies were considered to be errors of the measure due to the instrument. The teachers were asked to order the parts of the units presented during the 1977-78 school year. A Pearson \( r \) was applied to the two sets of scores, obtaining an \( r \) of .97. Therefore, the instrument was deemed a consistent measure.

Achievement in SCIS

The variable considered next was performance in SCIS as measured by the SCIS Objectives Test 4-6 (Christensen, Larsen, & Larsen, 1977). The SCIS Objectives Test 4-6 was developed through a grant from the National Science Foundation (NSF) and was based on SCIS objectives designed to meet the needs of the school system used in this study. The objectives, written in performance terms, were developed particularly for this school system, but they were consistent with the goals and philosophy of the SCIS Project (Larsen, 1977).
The objectives are grouped using the same headings and in the same sequence as the parts at each grade level as listed in the teacher's guides. The pilot tests were administered during 1975-76. The test was reevaluated with the assistance of consultants, rewritten, and administered during May 1977 and May 1978. The scores of the 1977 fifth graders who were in the sample sixth-grade classes were retrieved by the researcher using the data bank on file with the NSF project director.

The current SCIS achievement scores that were used as criteria in the prediction equation were also obtained by using the SCIS Objectives Test 4-6.

The scoring was accomplished by assigning a value of 1 for each correct answer and a value of zero for each incorrect answer. The scores for each item were then added. The scores for the class were then averaged and the class mean was used in the prediction equation.

According to the NSF report (Larsen, 1977), testing and research consultants were brought in to make recommendations during the construction of the test. Instructional specialists, principals, and teachers were also utilized to assure the content validity of this instrument. The objectives of the program developed by this system were outlined, and an item pool was generated from the objectives. A selection of items was made from the item pool.

As part of the NSF grant program, some teachers attended
special orientation workshops that were designed specifically to instruct teachers of SCIS on the procedures for the administration of the SCIS Objectives Test.

The reliability of the SCIS Objectives Test 4-6 was examined using Kuder-Richardson Formula 20. The coefficient of internal consistency was .76 for the 1977 administration of the SCIS test. This measure of reliability is for the individual student and not necessarily a measure of reliability of the group mean, yet it seemed to follow that it was indicative of the reliability of the group measure. There is, however, some controversy concerning these approaches to reliability in that they lack theoretical support (Subkoviak, 1976).

Participation in group activities

The degree of participation in group activities was a variable that was measured by the Lindvall Point-Time Sample Test (Simon & Boyer, 1974). Although this observation instrument was designed to be used in an individualized science setting, it did seem to be the best observation instrument available for this study. The instrument included five categories: (1) Independent Work, (2) Teacher-Pupil Work, (3) Noninstructional Use of Pupil Time, (4) Pupil-Pupil Activity, and (5) Group Activity. Each category was divided into specific activities to be checked by an observer. The observer was to observe the class for a 2-minute period and record the
activity of each individual on the instrument. This process was repeated 10 times during the class. There was no technical manual available indicating how to score the instrument. Therefore, scoring was defined by totaling each category, by counting the number of individuals participating in each of the activities of the category. The group activity score used for this study was a score derived from the ratio of group activity to the total activity. It was assumed that if it could measure individual work with the variety of categories, then it must measure group activity as well.

There was no training manual available for this instrument. Therefore, observers were trained to use the instrument in three training sessions, each training session lasting approximately 1 hour. The first session consisted of describing the uses and problems of observation instruments, presenting two examples and a brief "how-to" exercise in using the Lindvall observation instrument presented by the researcher. The prospective observers were given a copy of the instrument and 2 days to become familiar with the categories, and the activities within each category. During the second session, the use and application of the instrument was reviewed and then used in a college classroom setting. Thirteen observers categorized the activity in the classroom situation for approximately 45 minutes. The last session was used to tally the scores and select the observers for this study. The important criterion was that the observers viewed the
situation in the same manner. According to Medley and Mitzel (1958), observation instruments are biased by observers. In order to examine inter-rater reliability and to reduce the error due to the inconsistencies of the bias factor, and since there were seven schools involved in the study, the seven raters who scored closest to the observer group mean in the test observation were selected to make the observations for this study.

The seven observers were assigned to the seven schools according to the accessibility of the school and the availability of the observer. The observation time schedule had been determined by the participating teachers prior to the final training session. Due to the predetermined time schedule of the observations and the observers' personal academic schedule, five observers made one observation only, and two observers made three observations each. Each observer was given a kit containing a set of guidelines, a map, observation instruments, a copy of the Unit Sequence Instrument, and his/her scheduled assignment. Each observer, upon returning the observation instruments, was paid $3.00 per observation, with the exception of one who was paid $4.00 since the school was some distance away. On the day of the observation, teachers turned in the completed Unit Sequence Instrument to the observer, with the exception of one teacher who mailed the instrument to the researcher that day because it was not complete at the time of the observation.
Data Collection Procedure

Once permission was obtained from the central school administrators, sample classes were sought. Personal contact was made with each school principal. The researcher carried a letter of permission from the office of administration. Permission to gather data was granted by eight of the nine building principals. One school was not part of the study because of the lack of access to the 1977 SCIS scores. Another school was not part of the study because the principal felt that SCIS was not used regularly or with confidence at the school, and did not want to be part of the study. Subsequent discussions were held with sixth-grade teachers of SCIS by the building principals of participating schools. It was pointed out that the data collected for the purpose of this study would be used for research purposes only and that the sequence should not be discussed with one another before completing the sequence instrument.

During the week of May 15, 1978, approximately 1 week before the class observations were to begin, a Unit Sequence Instrument was placed in each participating teacher's school mailbox. The note at the bottom of the instrument instructed the teachers to return the instrument, when completed, to the observer.

The present scores for achievement were obtained on the May 1978 administration of the SCIS Objectives Test 4-6.
Each sixth-grade student's test in the participating classes was hand-corrected by the researcher. The students' names were then sought in the data files from the May 1977 testing. Only students with both scores were considered as part of the classes in this study.

The observation scores were taken from the measure of activity recorded on the observation instrument. The observation instrument was used by trained observers during one SCIS lesson. During the week of May 22, 1978, 10 observations were made, and 1 observation was made on June 1, 1978. Each observation lasted one school period and was scheduled by the participating teacher.

Analysis Procedures

The first step in the analysis procedure was to calculate the first-order correlations of the variables. The scores obtained from the variables were then entered into a stepwise multiple regression equation according to their correlation with the present scores (Dixon, 1971). Past scores ($X_1$) were entered first, sequence structure ($X_2$) second, and group activity ($X_3$) last. The values for $a$ and $b$ were established for each variable at each step and were applied to each class in search of a predicted $Y$. Using multiple regression, knowing the values of the constants $a$ and $b$, we can predict from $X_1$, $X_2$, and $X_3$ to $Y$ using the following formulas:
\[ \hat{\gamma}_1 = a_1 + b_1 x_1 \]
\[ \hat{\gamma}_2 = a_2 + b_1 x_1 + b_2 x_2 \]
\[ \hat{\gamma}_3 = a_3 + b_1 x_1 + b_2 x_2 + b_3 x_3 \]

where \( \hat{\gamma} \) is the predicted mean, \( x_1 \) is class mean on the 1977 SCIS test, \( x_2 \) is the sequence structure score, and \( x_3 \) is the score on the group activity measure.

Summary

In an effort to study the influence of the variables of past performance in SCIS, sequence structure, and group activity on the prediction of achievement scores in SCIS, the sixth-grade classes of a Midwestern community were observed and tested. Only classes meeting the preset criteria were used in this study.

The achievement in SCIS was measured by the SCIS Objectives Test 4-6 as part of the regular testing program during the school years 1976-77 and 1977-78. The sixth-grade program sequence structure was measured by an instrument that offered teachers the opportunity to rank-order the parts covered in the 1977-78 sixth-grade SCIS class. The self-report instrument was developed as part of this study. Group participation was measured using the Lindvall Point-Time Sample Test, originally developed to be used in an individualized science setting.

In May and June 1978, after receiving permission from
the school administrators, teachers were contacted in search of volunteers for this study. Students were tested, teachers completed the sequence structure instrument, and classes were observed by trained observers. Data from these sources and from the data file containing the 1977 scores were used to derive the prediction formula, using stepwise multiple regression.
CHAPTER IV

ANALYSIS RESULTS

The primary concern of this study was to establish the predictability of a second year's achievement in Science Curriculum Improvement Study (SCIS) testing. The predictor variables used were past scores in SCIS achievement, the degree to which the suggested sequence structure of sixth-grade SCIS was followed, and the degree of group activity in the classroom. The purpose of this chapter is to present the descriptive data and correlations, and to report the results of the stepwise multiple regression.

Descriptive Data

The class was the unit of analysis in this study; there were 11 observations. Only scores from those students in the sample sixth grades who had participated in the 1978 testing on the scheduled test day, and who had also participated in the SCIS testing in this school system during May 1977, were included in the class mean for past and present scores. The sequence structure variable was obtained by scoring the Unit Sequence Instrument for each class. Group activity was measured using the Lindvall Point-Time Sample Test and did not specify which SCIS-tested students participated in the activities and which did not.
The variable means and variance are shown in Table 1.

### Table 1
Descriptive Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>Variance</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>11</td>
<td>13.44</td>
<td>.94</td>
<td>11.8 - 14.9</td>
</tr>
<tr>
<td>$X_2$</td>
<td>11</td>
<td>3.36</td>
<td>9.45</td>
<td>0.0 - 9.0</td>
</tr>
<tr>
<td>$X_3$</td>
<td>11</td>
<td>40.09</td>
<td>588.49</td>
<td>6.0 - 74.0</td>
</tr>
<tr>
<td>$Y$</td>
<td>11</td>
<td>23.28</td>
<td>4.69</td>
<td>19.1 - 26.0</td>
</tr>
</tbody>
</table>

The mean of past scores ($X_1$) is 13.44, sequence structure ($X_2$) is 3.36, group activity ($X_3$) is 40.09, and present scores ($Y$) is 23.28. The variance and range of each variable were determined. The variance of past scores is .94, with a range of 11.8 to 14.9; the variance is slight due to the small range of scores. Sequence structure has a variance of 9.45 and a range of 0-9, the full range possible. Group activity, with a range of 6-74, has a variance of 588.49; this extreme variance is possibly due to the large range possible and the small number of observations producing the wide range. Relatively speaking, the variance of sequence structure, which is based on the sample reaching the extremes, is of more interest than group activity variance. The range of present scores is 19.1 to 26, with a variance of 4.69.
Correlation of the Variables

A correlation matrix is shown in Table 2. The variable past performance ($X_1$) has the highest correlation with the present scores ($Y$), and the lowest correlation with group activity ($X_3$). Group activity ($X_3$) has the lowest correlation with present scores ($Y$). It is interesting to note that the best correlate to present scores also has the same correlation with group activity as does present scores. However, when a Fisher's $Z$ transformation (Glass & Stanley, 1970) is used to determine whether the correlation differs from zero, it is found that past scores and present scores are the only two variables with a correlation that differs from zero at the .05 level of significance with 9 degrees of freedom. Past performance does become the best predictor.

Table 2
Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>1.00</td>
<td>-0.06</td>
<td>-0.27</td>
<td>0.70*</td>
</tr>
<tr>
<td>$X_2$</td>
<td></td>
<td>1.00</td>
<td>-0.04</td>
<td>0.30</td>
</tr>
<tr>
<td>$X_3$</td>
<td></td>
<td></td>
<td>1.00</td>
<td>-0.27</td>
</tr>
<tr>
<td>$Y$</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

*$p < .05.$
As the literature indicated, all of the predictor variables should have contributed to the predicted mean. When the individual predictor variables were introduced in the forward solution, they were introduced in the order of the correlations indicated in Table 2, with past scores being introduced first, unit sequence structure second, and group activity third. The importance of this study was to make as good a prediction as possible on the SCIS test on the basis of three predictor variables. The three variables were selected due to their assumed importance to the success of SCIS. It was hoped that they were all predictors, that they would not correlate with one another, and that their independence would increase the accuracy of prediction. According to Kerlinger and Pedhazur (1973), the importance of the variables gets greatly distorted when there are few observations.

Regression Equations

Once the correlations of all the variables were calculated, the variables were entered into the stepwise multiple regression in the following order: (1) past scores, (2) sequence structure, and (3) participation in group activity. Performance for an individual class, as predicted by this formula, was compared to its present scores on the SCIS test. The coefficient of correlation was squared to establish the percentage of the variance explained by each step of the equation. The percentage of explained variance is called the
coefficient of determination. The best predictor, as shown in Table 3, is past scores, explaining 49.4 percent of the variance, significant at the .05 level. Past scores and sequence structure together explained 61.2 percent of the variance, which is a significant increase in the amount of variance explained. Group activity was entered and contributed less than 1 percent to the explained variance. The coefficients of determination, the $F$ values, the degrees of freedom, and the probabilities are shown in Table 3.

Table 3  
Coefficients of Determination

<table>
<thead>
<tr>
<th>Formula</th>
<th>$R^2$</th>
<th>$F$</th>
<th>df</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{Y}_1 = a + b_1X_1$</td>
<td>.49</td>
<td>8.81</td>
<td>1, 9</td>
<td>.02</td>
</tr>
<tr>
<td>$\hat{Y}_2 = a + b_1X_1 + b_2X_2$</td>
<td>.61</td>
<td>6.34</td>
<td>2, 8</td>
<td>.02</td>
</tr>
<tr>
<td>$\hat{Y}_3 = a + b_1X_1 + b_2X_2 + b_3X_3$</td>
<td>.61</td>
<td>3.77</td>
<td>3, 7</td>
<td>.07</td>
</tr>
</tbody>
</table>

Table 4 shows the intercept weights ($a$) and the regression weights ($b$) applied during the stepwise multiple regression to obtain the predicted $Y$ for each step. The intercept weights, ranging from .77 to 2.19, and the regression weights, ranging from -0.006 to 1.61, were used in the computations, for each observation at each step. The intercept and weights were used to predict a $Y$ for each step.
Table 4

Intercept and Regression Weights for Each Stepwise Regression Equation

<table>
<thead>
<tr>
<th>Equation</th>
<th>a</th>
<th>b</th>
<th>b</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>Weight</td>
<td>Weight</td>
<td>Weight</td>
</tr>
<tr>
<td>$\hat{Y}_1 = a + b_1X_1$</td>
<td>1.57</td>
<td>2.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\hat{Y}_2 = a + b_1X_1 + b_2X_2$</td>
<td>1.61</td>
<td>.77</td>
<td>.24</td>
<td></td>
</tr>
<tr>
<td>$\hat{Y}_3 = a + b_1X_1 + b_2X_2 + b_3X_3$</td>
<td>1.57</td>
<td>1.57</td>
<td>.24</td>
<td>-0.006</td>
</tr>
</tbody>
</table>

The discrepancy between the present score and the predicted score was calculated for each variable. The range of the discrepancy score, shown in Table 5, for past scores is from $-2.10$ to $2.57$ with a mean of $-0.53$ (the mean should be zero and differs only due to rounding). The range of the discrepancy scores when past scores and sequence structure are entered into the equation is from $-1.78$ to $2.44$ with a mean of $-0.22$. The range of the discrepancy scores when past scores, sequence structure, and group activity are entered into the equation is from $-1.89$ to $2.46$ with a mean of $0.20$.

Table 5

Difference Between Predicted and Actual Means

<table>
<thead>
<tr>
<th>Equation</th>
<th>$\bar{d}$</th>
<th>Range $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{Y}_1$</td>
<td>-0.53</td>
<td>-2.10 to 2.57</td>
</tr>
<tr>
<td>$\hat{Y}_2$</td>
<td>-0.22</td>
<td>-1.78 to 2.44</td>
</tr>
<tr>
<td>$\hat{Y}_3$</td>
<td>.20</td>
<td>-1.89 to 2.46</td>
</tr>
</tbody>
</table>

$\bar{d} = Y - \hat{Y}$

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Summary

The predictor variables used in this study were past performance scores, the degree to which the sixth-grade sequence structure of SCIS was followed, and the degree of participation in group activity. There was little correlation among the predictor variables, which was a desirable feature. However, past scores was the only predictor variable that correlated significantly from zero with the criterion variable in the first-order correlation. It would have been more desirable to have a stronger relationship between each predictor variable and the criterion variable. The predictor variables contributing significantly to the prediction equation, when entered in order of their correlation to the criterion variable, were past performance, and past performance and sequence structure. Statistically, there was enough of an increase in the explained variance when sequence structure was added to include the variable in predicting scores. However, since there was a weak relationship at best, with the criterion variable, it is questionable whether or not the minor contribution made by sequence structure should be considered in future educational research.
CHAPTER V

DISCUSSION

The main purpose of this study was to establish the predictability of present achievement in the Science Curriculum Improvement Study (SCIS) using past performance, unit sequence structure in sixth-grade SCIS, and the degree of group activity as predictors. This chapter includes a summary of the study, a discussion of the major conclusions, and recommendations for further research.

Summary

During May and June 1978, sixth-grade students in a Midwestern community were tested in SCIS, sixth-grade SCIS classes were observed, and teachers rank-ordered the sixth-grade SCIS part sequence as presented to the sixth grade during the 1977-78 school year, as part of the study.

The sample chosen for this study was the sixth grade, selected because of its participation in SCIS during the upper elementary school years (grades 4-6). The sixth grade, being the final grade to use SCIS, also seemed to be a favorable situation since the test was designed to test grades 4-6. Only sixth-grade students who had participated in SCIS testing for a 2-year period were considered to be the sample for this study. Principals had to agree to have their

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schools participate in the study. Teachers had to be volunteers. There were 29 possible sixth grades in the system, but only 11 were made available for data collection.

Students were tested on the SCIS Objectives Test 4-6 during May 1978. All of the students' 1977 scores were retrieved from the data file and were used in the analysis with their 1978 scores.

The participating classes were observed by trained observers to establish the degree of group activity, using the Lindvall Point-Time Sample Test. Each student's activity was categorized by the observer during one class period of the SCIS program.

The teachers self-reported the SCIS part sequence presented during the 1977-78 school year on an instrument designed as part of this study. The instrument contained the titles of the fifth- and sixth-grade SCIS parts.

The unit of analysis was the class. The purpose was to examine the accuracy of prediction of achievement using past scores in SCIS, sequence structure of the sixth-grade parts, and the degree of group activity during one SCIS lesson. The variables were correlated. Past scores was the only predictor variable to correlate with the criterion variable. The stepwise entry of the variables did yield an assessment of the relative contribution of each variable, and a prediction equation for each step was established. The variance accounted for was examined for statistical significance. It was found
that past performance was the best predictor of achievement. Sequence structure, as measured by the SCIS Unit Sequence Instrument, added to the prediction, but it may have been a random event. Group activity, as measured as part of this study, was found to be of little use when added to the existing predictor variables.

Limitations

The criteria for the selection of the sample did limit the number of observations to 11. As a result of those restrictions, however, the sample consisted of willing participants who had used SCIS for more than 1 year. The restrictions may have affected the study since volunteers may be too willing to "help out" the researcher. The classroom situations may have been less typical due to the teachers' willingness to participate.

The criterion requiring the 1977 and 1978 SCIS testing information to make up the class did exclude three classes due to unavailable data. When the criterion was established, it was expected to limit the class size, but not the number of classes. This criterion could not be eliminated without resulting in a reduction of the number of predictor variables.

The SCIS Objectives Test 4-6 was chosen over standardized testing because it was designed to meet the needs of the system. The SCIS program does not provide performance objectives. Performance objectives were developed in the school
system, with the help of consultants, to assist with the implementation of the program. The SCIS test was developed to test the school system's SCIS objectives, and the method may be more of a didactic nature than if there were no objectives. The teachers were familiar with the test itself, and it may have influenced their content teaching. There is no empirical validation study available on the objectives or on the objectives test. The SCIS Objectives Test 4-6 was the identical test used in the fifth grade; it seemed quite reasonable, if the test was reliable, that the scores on one year of testing would correlate with the scores of a second year of testing with the same instrument. After seeing the test items during the fifth grade, the students may have unconsciously focused energies toward finding the answers during the following year. This is true particularly if emphasis on mistakes was given by teachers in the previous grade.

The Unit Sequence Instrument was organized using the parts listed in the fifth- and sixth-grade SCIS unit guides. The instrument was given at the end of the school year and may have caused confusion since ordering, based on the year's work, was requested. It may not have been the best measure of what was actually covered during the school year. Perhaps a list of the objectives would have been more specific.

The contribution to the explained variance by sequence structure seems questionable since, having no significant
correlation to the criterion variable, it may have been a random event. There are no empirical data upon which to validate this instrument. Conclusions drawn using this instrument are reported with some conservatism. The scoring of this instrument did limit the contribution since there was no credit given for fifth-grade units or parts presented, whether or not they were in order.

The Lindvall Point-Time Sample Test, designed to be used in an individualized science setting, provided the observer with 33 activities grouped into five categories in which to assign the individuals in the classroom. A problem was that with 21-28 students in an activity-oriented class, it was difficult for the observer to be sure each student's activity was recorded. The group activity was recorded. The group activity was not specific to SCIS. Group activity may have consisted of a group of students viewing a film loop, whereas in SCIS a group activity would be more of a sharing of ideas.

The results of this study were influenced by the small number of observations, the confidence and comfort of the observer in the classroom situation, and whatever unique events may have taken place in the sixth grades on any one particular day. The observation component in this study did not contribute enough to consider it to be an important variable in predicting scores in SCIS. There are no empirical data to support the assumption that this was even a valid instrument to measure group activity in SCIS. Since group

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activity may be defined so differently by this instrument, it is reasonable to assume that a different instrument may be more sensitive to group activities in SCIS.

Using all predictors does not seem worth the effort since past scores alone predicted within 2 score points and was the only predictor variable that correlated with achievement. A prediction within 2 score points is a valuable prediction. Data on past scores are generally available on students, and may be used with confidence as a prediction of future achievement of a class. It was interesting to note the lack of correlation between achievement and the predictor variables of sequence structure and group activity since, theoretically, there should have been a correlation. SCIS attempted to improve scientific literacy and improve interest and attitudes in science. Perhaps the sequence and group activity contributed more toward the interest and attitude component than to achievement.

Recommendations

Although the major purpose of adding predictor variables was to increase the accuracy, the number of predictor variables in relation to sample size affecting the prediction was much too small, introducing chance into the results. Increasing the sample size in future studies should offer more credence to the prediction. If the class is maintained as the unit of analysis, a greater number of classes should be
observed.

Changing the unit of analysis to the individual student would also increase the sample size. Problems would arise in the development of instruments to measure sequence structure and group activity. Record books kept by each individual may be employed as the measure, but this would require constant supervision by the teacher. With the individual as the unit of analysis, there may be a better opportunity to obtain a random sample versus a selected or volunteer sample, which would offer more generalization.

The study might be repeated using a ranking of the SCIS objectives rather than the parts. There would be more of a selection of items to rank-order. The teachers might also have kept a record of the objectives covered over the year.

There could be a design to purposefully alter the presentation order of the parts of SCIS. An experimental study of the units presented in order, randomized or reversed, may provide valuable information concerning the influence of sequence structure on achievement.

There is the possibility that the observed day was not a typical day. To reduce this source of error, observations could be made on several days and an average score could be used as the measure. The rater bias is also a concern; a greater number of observers could be used for each observation. A different observation instrument, one whose activities are more aligned with SCIS activities, might be
developed.

Although this study did not concern itself with attitudes, it was felt after the study that they may have been influenced by SCIS. Perhaps sequence structure and group activity affected or was affected by attitudes. Perhaps a prediction of achievement using a measure of attitude and interest may be attempted. Attitudes may influence student achievement. Attitudes toward SCIS might be measured with instruments for teachers and students. Comparison studies could attempt to locate relationships and possible predictors of achievement.

The same variables might be used to compare SCIS students with non-SCIS students. The instruments, two developed with SCIS in mind, may be compatible with other science programs. It would be interesting to see if there is a difference in achievement between SCIS and non-SCIS students' performance on the SCIS tests. It would be interesting to see if the prediction equation would work equally as well with non-SCIS students' achievement scores.

Conclusion

This study had some inherent limitations. These limitations should be considered by the reader in interpreting the results of the research. The sample size was the major concern; with such a small number and the lack of randomization, caution must be taken in making generalizations.
There were interesting relationships, or a lack of relationships, to note. Although sequence structure and group activity were thought to affect achievement, there seemed to be no apparent relationship.

Past performance in SCIS is a predictor of achievement in SCIS. Since past performance is an indicator of future achievement, when changes are made it is difficult to make early predictions of success. Educators would do well to keep in mind that expected increases in achievement with curriculum changes may be better met over a period of time.
APPENDIX

SCIS UNIT SEQUENCE

Date ________________

Chapter title: _______________________________________________

Kind of lesson:   ____ Exploration   ____ Invention   ____ Discovery

Assign numbers from 1 to ___ to the following units that were covered during the 1977-78 school year in Grade Six. Please assign the numbers in the order that the units were presented with 1 being assigned to the first unit introduced during the school year.

____ Energy Transfer
____ Energy Receivers
____ Energy Chain
____ Photosynthesis
____ Food Transfer
____ Raw Materials
____ Classroom Ecosystems
____ The Water Cycle
____ The Oxygen-Carbon Dioxide Cycle
____ Cycles in an Ecosystem
____ Pollution
____ Review of Electric and Magnetic Interaction
____ Scientific Models
____ A Magnetic Field Model
____ An Electricity Model

Please return this completed form to the SCIS observer on the observation day. Thank you!

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REFERENCES


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