SCIENCE PROCESS ACTIVITIES, SELECTED SCIENCE READING MATERIALS AND READING ACHIEVEMENT OF PRIMARY SCHOOL CHILDREN

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A THESIS PRESENTED TO THE FACULTY OF EDUCATION OF MEMORIAL UNIVERSITY OF NEWFOUNDLAND IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

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The purpose of this study was to investigate the effects upon primary level reading achievement that resulted from the use of the Elementary Science Curriculum Study (ESCS) in conjunction with Selected Reading Materials (SRM); the ESCS separately; and, whether socio-economic status interacted with the treatments. The null-hypotheses were tested at the .05 level of significance using the multiple linear regression model and the S-Test of Multiple Comparisons. The 421 subjects were students within 16 randomly selected intact classes of grades one and three. The classes were assigned to 1 of 4 treatment groups: (1) ESCS/SRM; (2) ESCS only; (3) SRM only; and, (4) the control group. Reading achievement was assessed using the Gates-MacGinitie Reading Test. Results indicated that in grade one, reading comprehension achievement was significantly enhanced through the use of ESCS in conjunction with SRM, while in grade three, it was significantly greater in the SRM treatment group. No significant differences were found between groups on reading vocabulary achievement at

either grade level. No interaction was indicated for socio-economic status. Results were assessed in light of design limitations.

CHAPTER I

INTRODUCTION

Over the years many studies have been conducted which analyzed the effects of a variety of variables upon reading achievement. Another large group of studies have investigated the effects of the teaching of science upon achievement. Few studies have investigated the underlying relationships between reading and science.

Those studies that did, however, were more concerned with the effect reading ability had upon achievement in science. Most of these studies were concerned with this effect at the elementary, junior or senior high levels. Only a few investigators were concerned with this relationship at the primary level. This may have been the result of the fact that in some geographical regions little or no science education took place at the primary level.

Many of the primary level classes in the Province of Newfoundland and Labrador have neglected the teaching of science. In 1973 there were approximately 1200 primary classrooms in Newfoundland. A little over 500 Elementary Science Curriculum Study science process kits had been placed in schools for use by primary students. In 1974 the Addison Wesley Elementary School Science program was adopted as an option and made available to more classes,

broadening the base for potential primary science teaching. Even though more children have available to them the materials for science instruction, there are still many who have no provision for science instruction within the curriculum.

Traditionally the greater part of the school day has been involved in teaching skills of the language arts. Indeed, from the beginning of schools in North America, the primary purpose of the school was to teach the child to read. Therefore the "content" subjects such as social studies and science have been given a secondary place in the primary classroom.

Kellogg (1971) found in his review of literature that on the average, first grade teachers spent 30% of their time on reading. Others spent as much as 50% of class time on reading. Yet, the primary causative factor for failure in the first grade was poor reading achievement. It appears then, that the most important variable in the teaching of reading is not necessarily the amount of time spent in direct teaching of "basic reading skills".

Almy (1966) concluded from her research that many reading readiness programs needed reexamination of content and especially the time allotted to it. Newport (1969) indicated that many failures in reading were due to the length and nature of the readiness program. Traditionally these readiness programs have been made up of pencil and

paper pre-reading exercises of approximately six to eight weeks in grade one, after which formal reading begins. This type of pre-reading program has left us with many "slow readers". The subskills of reading are evidently not acquired by these children.

Furth (1970) stated,

> A school whose earliest grades focus primarily on reading cannot focus on thinking... It was assumed the child's thinking is developed adequately before he entered school and continued to do so outside of school.... But today these assumptions are largely irrelevant for a large segment of our population. (p. 4)

Kellogg (1971, p. 39) stated, "A person need not be able to read in order to reason, but he must be able to reason in order to read". From his research he concluded that to best teach reading, first teach reasoning. Newport (1969) indicated that the materials and curriculum were available to primary teachers for the teaching of reasoning and thinking skills in the activity oriented elementary science curriculum projects.

From these and other readings in the fields of science and reading education as well as through personal experience, this investigator came to the conclusion that there may be a relationship between science process skills, learning to read and the reading ability of young children. Some of the skills required for reading are well established. More recently, detailed analysis of aspects of scientific processes have

been made (Newport, 1972; Nay, 1971). These analyses suggest the possibility of a relationship between science process skills and reading skills. It therefore follows that the explicit teaching of science process skills should in some way enhance reading ability. It can be further argued that if science activities are used as starting points to stimulate reading of related interest then this should also form positive effects on reading achievement.

THEORETICAL BASIS

In building a theoretical basis for this study the skills needed for reading were investigated along with the science process skills. From these skills and concepts a hypothetical relationship was drawn.

Reading Skills

Language facility, perceptual skills of visual and auditory discrimination and ability to see relationships are some of the skills needed for reading (Stauffer, 1969 and Loban, 1963). Some skills that are specifically presented in early reading experiences of the child are:

concept building
word configuration
sequence
drawing conclusions
forming judgements
classifying

According to deHirsch et. al. (1966) beginning readers need to be able to comprehend small abstract words and phrases

such as before, after, because, same, different, (etc.).

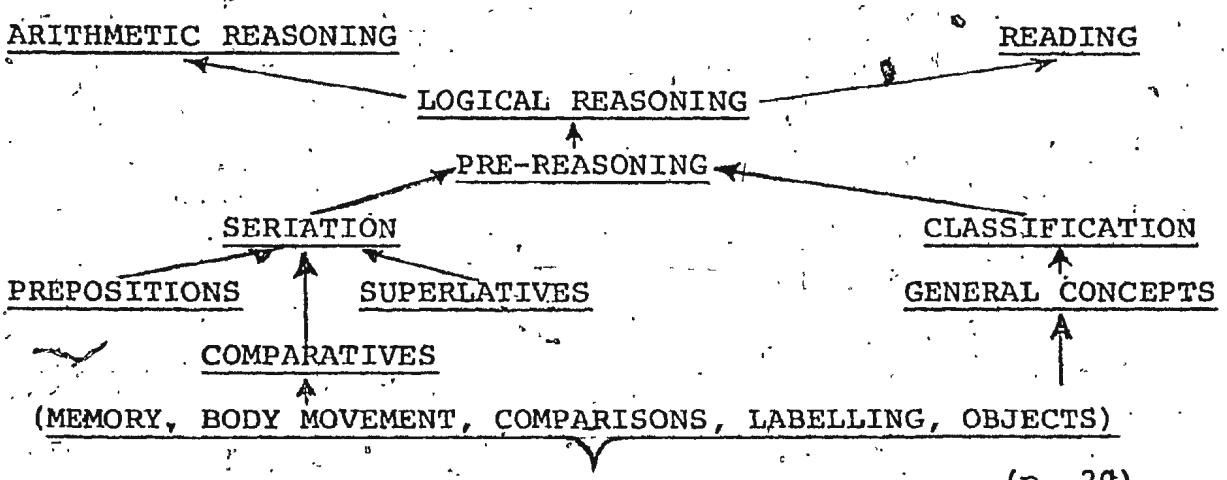
Experience was another factor which was considered vital in learning to read. Stauffer (1969) referred to a need for "examined experience," first introduced by Dewey. Stauffer stated that building and acquiring mental constructs or concepts must be based on examined discriminations and wise generalizations.

According to Barrett (1969) reading has three dimensions, perceptual, cognitive and affective. In discussing what is comprised in reading, he stated:

> Reading involves the visual perception of written symbols and the transformation of the symbols to their explicit or implicit oral counterparts. The oral responses then act as stimuli for a thoughtful reaction on the part of the reader. The type or level of thought induced by the stimuli is determined in part, by the intent and background of the reader and the nature of the materials. In addition, the effort expended in the perceptual act and intellectual impact of the written materials on the reader is influenced by his interest in the specific selection and by his attitude toward reading in general. (p. 28)

The reader then, must be able to perceive the symbols, transform them into words, and through a cognitive process make sense from the words. All of this is influenced by the affective domain of the reader.

An examination of a diagram drawn from the theoretical model of Piaget by Nelson (1971) gives a view of thinking skills that are prerequisite to learning to read.



(p. 20)

Nelson asserted that according to Piagetian theory early reasoning is developed within the child as he works with and acts upon objects by classifying (grouping) and seriating (ordering) them. Nelson further advocated that these important components should be part of reading readiness programs as building blocks of reasoning.

He defined classifying as word training that the teacher does as she attempts to help children develop concepts such as tree, blue, fuzzy, etc. These concepts are usually nouns or adjectives. Seriation was defined as a more relational set of words. These words are helpful in ordering a collection of things. All of the comparatives, i.e. far, hear, taller, shorter, etc., i.e. superlatives tallest, shortest, etc. are relational. Also by definition all the prepositions, eg. over, under, are ordering types of words.

Science Process Skills

Process science is defined as a program designed to teach the various skills involved in the collection and analysis of data in science. Process science does not emphasize subject matter or content in the conventional manner, but is rather an active, manipulatory approach to learning certain science skills (Crocker, 1973). The skills included in the primary grades are: observation and classification using all the senses for discrimination; quantification which includes seriation and seeing spatial relationships using two and three dimensional objects; communication, prediction and inference. Process science leads children though experiences of discrimination, observation, classification and seriation. As they are guided through experiences, the children examine certain objects to ascertain properties of likenesses and differences. They are guided into grouping or ordering objects using stated properties. Rather than a textbook the student uses material objects from his environment for learning these skills. For example, children are asked to sort, classify and describe buttons, geometrics shapes, seashells, leaves, etc.; serial order odours from strong to weak, objects according to size, hardness, lustre, weight, etc.

Science and Reading Relationships

Johnson (1966) asserted that until a child can accomplish classification skills with real objects and make direct observations about particular characteristics or elements, reading teachers cannot expect a child to make classifactory observations about verbal symbols. Process science can give the child the opportunity to learn these skills using real objects. It also gives the child opportunity to make use of "examined experiences" referred to by Stauffer (1969).

Perceptual problems have been one of the causes of difficulty in learning to read for some children (Money, 1966 and Malmquist, 1970). Experiences in process science can give the child a solid foundation in object discrimination by calling attention to comparable likenesses and differences. The student would also be called upon to make use of and test these objects using all his senses. It may be, therefore, hypothesized that these activities may overcome some of the perceptual problems which inhibit the development of reading.

In addition, process science has proven to be an enjoyable experience for children. This could well be promoted by the teacher and used as motivation for reading about the subject matter being observed or studied. The affective response referred to by Barrett (1969) as having an important effect on the effort put forth by the student,

as well as the intellectual impact on the reading material, should be enhanced by experiences of enthusiastic students involved in science.

Language has long been recognized as a dominant factor in reading. Rowe (Neuman, 1970) reported on a study looking at language during science lessons. He found that 200% more language was carried on by children during science lessons than during language arts lessons. The language encouraged in process science curriculum is a precise language. Although other processes are taught, communication is the vehicle by which these processes are shared and understood. Process science asks the student to name properties of objects, to describe, to enumerate, and to use distinguishing words. The student is taught to state in precise terms his observations. (Sears, 1968).

Some basic reading skills introduced in primary reading were listed previously. Process science also attempts to teach these skills. Concept building is an important aspect of this science. Concepts of colour, size, shape, touch, sound, odour and taste are taught to the child in early school through process science. Many of these activities overlap with the activities suggested by Stauffer (1969) for preparing children for reading. These activities include learning opposites such as hard and soft, strong and weak, and big and little. He also recommended activities dealing with colour descriptions and anticipation of events.

Process science seems made to order for teaching the skills Stauffer felt should be taught to young children.

The learning of shapes and their names can easily be related to the learning of word configuration which is introduced to the child who is beginning to read. Sequencing is a skill stressed in both reading and process science. Drawing conclusions and forming judgements are introduced in beginning reading. This is often done through the use of pictures. In process science these skills are taught through the use of concrete objects.

It appears, from observation and the study of literature, that a strong emphasis has been placed upon the teaching of reading at the primary level. Therefore, any connection which could be established between science and reading should have a positive effect upon the attitudes of educators toward the inclusion of science education in the primary programs.

STATEMENT OF THE PROBLEM

The problem of this study was to investigate whether the use of an activity based science program designed to teach science process skills used in conjunction with selected reading materials would affect the reading achievement of primary age children.

STATEMENT OF RELATED PROBLEMS

A related problem investigated by this study was whether the learning of activity based science processes alone would affect the reading achievement of primary children. The question of whether the socio-economic status of children interacted with any specific treatment was also investigated.

LIMITATIONS

This study was limited in that although the classes were randomly selected, the subjects and teachers were not. Ideally, the assignment of teachers and subjects, as well as classes, by randomization would have been desirable. Due to the fact that school was in progress the students and teachers were already assigned to their respective classrooms when this investigation was initiated, the randomization of all three of these variables was impossible. Therefore, this investigator was only able to select classrooms randomly for this study, accepting those teachers and students within each classroom as being randomly selected.

A second limitation involved application of the treatment. While this investigator, through individual conference with each teacher, stipulated the prescribed treatment for the respective class, there was no assurance that the treatment was applied within the same consistency by the teachers within each treatment group.

The results of this study might have been more reliable had the treatment been conducted over a time period of one academic year rather than twelve weeks. The length of time the subjects were exposed to the treatment was considered the minimal amount of exposure from which one could expect to obtain substantive results.

DEFINITION OF TERMS

Elementary Science Curriculum Study (ESCS) referred to a process based science curriculum designed for children in grades one through six and used as the science program in this study.

Process Science referred to a strategy for science teaching which emphasizes manipulation of concrete objects in order to engage in intellectual activities as an investigator. The activities emphasized in the primary grades are the processes of observing, classifying, seeing time-space relationships, using numbers, communication, measuring, inferring and predicting.

Selected Reading Materials (SRM) referred to books selected by the investigator according to topics related to activities and materials of the ESCS kits and reading levels of children in grades one and three.

Reading Achievement referred to the scores on the Gates-MacGinitie Reading Test - Primary Form Vocabulary and Comprehension Subtests.

Primary Level referred to grades one, two, and three of the schools of Newfoundland and Labrador.

CHAPTER II

REVIEW OF LITERATURE

Few investigations have been conducted into the relationship between science skills and reading skills. Those which had, used the investigations and writings of Jean Piaget as their theoretical background and base. Several researchers studied retarded readers and found that some of the skills that are taught in process based activity science were lacking in these students. Several other studies investigated the effect of studying process science on reading readiness or language. No studies could be found which investigated the effect of studying process science on reading achievement of children above grade one.

McProuty (1971) developed and applied a composite test instrument to compare the academic performance and cognitive functioning of educationally handicapped boys in a special class to boys in a regular class as it applied to their reading development. She used 64 subjects, 32 of whom were randomly selected. The remaining 32 were matched according to age, IQ, socio-economic status, and family background. Her test consisted of 10 subtests selected from the Wechsler Intelligence Scale for children (WISC), the Illinois Test of Psycholinguistic Abilities (ITPA), the Wide Range Achievement Test (WRAT), and the Gilmore Oral

Reading Test. She developed two other subtests to assess seriation and classification abilities.

As a result of this study McProuty found that educationally handicapped subjects were significantly deficient in cognitive functioning when compared to the regular class subjects. These deficiencies were assessed by the Arithmetic, Information, Diget Span, and Coding subtests taken from the WISC. The same subjects were also significantly deficient in conceptual abilities when compared with the regular class subjects as tested by Visual Association and Auditory Association subtests of the ITPA. Results of the Seriation Test also indicated the same subjects to be deficient in ordering ability. These findings supported the view that inadequately developed ordering and classifying abilities may represent, at least in part, the underlying skills necessary to cognitive maturation which is sufficient for the mastery of reading.

McProuty concluded that students who were experiencing difficulty in reading may benefit from practice designed to develop underlying cognitive abilities. This was in agreement with the theory of Jean Piaget that students may be assisted in the attainment of operational behavior through experiences in seriation and classification, with the expectation that symbolic achievement may be facilitated.

McProuty (1971) also stated that educationally

handicapped students should be expected to profit from a curriculum which has been systematized by focusing upon ordering of the stimuli within the environment. This curriculum should maximize opportunities for the student to recognize environmental relationships. The student may become operational as he internalizes an ordered world through emphasis upon identification and relatedness of environmental stimuli.

Another suggestion McProuty (1971) made was that the student should be provided with experiences in ordering and classifying and, that these experiences should be included in a reading readiness program. Through many science curriculums available today the student is led to interact with and act upon his environment.

Barron (1971), while comparing poor readers with average readers in first grade, tested his subjects with basically the same tests that McProuty used. He also found that poor readers scored lower on some subtests that seem to be a measure of seriation and classification abilities. The results showed that low readers of both sexes scored significantly lower on the Information, Arithmetic and Vocabulary Subtests, and Verbal IQ of the Wechsler Preschool and Primary Scale of Intelligence (WPPSI). The same subjects also scored significantly lower on the ITPA Auditory Association, Visual Reception, Auditory Memory, Grammatic Closure and Verbal Closure Subtests. These findings supported

McProuty's ideas that poor readers do not have seriation and classification abilities that average readers possess.

Almy (1966) conducted an extensive study of the degree of early school-age children's understanding of conservation. She also investigated the question of whether children who displayed understanding of conservation differed from those who did not in relation to school achievement and other measures of intellectual functioning.

The findings in Almy's study of a rather substantial correlation between performance on tasks of conservation and progress in reading, led her to conclude, that to some extent, similar abilities are involved. She stated that a program designed to nurture logical thinking should contribute positively to readiness for reading.

Using Almy's study as a basis for his study, Kellogg (1971) investigated the effects of studying a process — based science in first grade on reading readiness scores. The science taught was from the Science Curriculum Improvement Study (SCIS) and consisted of a series of activities which cause the child to make observations. Two classrooms were given the SCIS science lessons and no reading readiness program, while two other classrooms were given reading readiness programs with no science. The groups were given a pretest and posttest using the Metropolitan Reading Readiness Tests (MRRT) administered before and immediately after treatment. The results of the MRRT indicated that

the experimental group outgained the control group in total readiness scores. On subtests they were significantly better than the control group in Word Meaning (p. = .1 → .05), Matching (p. = .2 → .1), and Numbers (p. = .2 → .1). The data was tested for significance at the .20 level of significance. His reasoning for this being that even if there were no significant differences in the groups, the science program would have been considered successful since it would have taught readiness at least as well as the readiness program.

Kellogg concluded that teaching science through the inquiry method had served the same means as the readiness program as well as teaching thinking skills. Therefore, school boards and teachers should welcome this type of program. Kellogg's study does to some extent, give support to Almy's conclusions that programs designed to teach logical thinking should also contribute to reading readiness.

Neuman (1970) also studied the effect science lessons made on reading readiness scores. He used two experimental classes and one matched control class of kindergarten age children. For 12 weeks the experimental classes were taught a process science program based upon the SCIS and American Association for Advancement of Science (AAAS) programs. The MRRT was given at the beginning of the first grade. Since this was a pilot study, the level of significance was

set at $p. < .10$. The results of this test indicated that the experimental group scored higher than the control group on total score ($p. = .076$) as well as on the Subtests of Vocabulary ($p. < .001$), Alphabet ($p. = .064$) and Numbers ($p. = .014$). There were no differences in scores on the Listening and Copying Subtests, but on the Matching Subtest the control group scored above the experimental group at $p. < .05$. During the following year, when the subjects moved to first grade, their teachers were asked to rank order all first grade classes according to overall reading achievement. In one class eight out of ten children who were considered the best readers had been in the experimental kindergarten class the previous year. In another, eleven out of thirteen had been in the experimental group.

Neuman concluded that specific science experiences in kindergarten were teachable and fruitful in influencing a child's readiness to read. The specific ways and degree could not be obtained from this study. He also concluded that the influence on vocabulary, alphabet recognition and number concepts carry over into first grade reading.

Ayers and Mason (1969) reported a study investigating the effect of studying AAAS programs on reading readiness test scores of kindergarten children. The study began in October with administration of the MRRT, and concluded in May with the posttest. The experimental group received

science instruction at least one hour a week for a period of 22 weeks.

Gain scores for the experimental and control group were compared and yielded significant differences in favor of the experimental group on Listening, Numbers and Copying Subtests, as well as on total score.

The writers concluded that AAAS apparently made a contribution to the measure of reading readiness by increasing students' scores on the subtests mentioned. This implied that the science program could add to a reading readiness program for kindergarten children. The writers also felt that discrimination, categorization and labelling tasks involved in the science program were apparently contributing factors to success in reading readiness.

Both the Neuman and the Ayers and Mason studies used the AAAS and MRRT. The studies would be expected to show similar results. However, when the results of the two studies were compared, they appeared contradictory to some extent. Neuman showed significant results with the experimental group on the Vocabulary, Alphabet and Numbers Subtests. Ayers and Mason showed significant results on the Listening, Copying and Numbers Subtests. The Numbers Subtest was the only subtest area in which there was a common significance in both studies, although they both showed overall significant differences over the control group.

Huff (1971) investigated the effects of process science activities on oral communication skills of disadvantaged students. The subjects were 113 kindergarten students from an inner city school. Two classes were randomly assigned to treatment groups, one group receiving the AAAS program, the other a teacher demonstrated class discussion science program. Two other classes were used as control groups. The design of the study was a pretest-treatment-posttest design, with the treatment lasting for a period of 12 weeks. The statistical analysis of the data indicated significant differences favoring the experimental group on total output and expressiveness, vocabulary, general meaning and ideas, and defining. Huff concluded that when activities of process science are presented to disadvantaged children, their oral communications are clearly enhanced. With Loban's study (1963) as evidence for the relation between language and reading, Huff's study adds empirical evidence for the use of process science for the enhancement of reading in beginning readers.

Perceptual learning is also an important facet in learning to read. Scott (1968) reported the predictive success of a Seriation Test (ST) on reading and other achievements. The ST which was developed by Scott, et. al., was administered to 365 kindergarten subjects. A significant correlation between the ST and the MRRT was found. When the subjects reached the second grade level, they were tested

using the California Achievement Test (CAT). The scores from the ST administered at the kindergarten level were compared to the CAT scores. A correlation coefficient of .59 was found for the 173 children remaining in the study. This was found to be significant at the .005 level of significance.

Scott felt the Seriation Test should identify children who will be progressing well or experiencing difficulty and appeared to be a good predictor of reading success. Referring to Inhelder and Piaget's theory as reported in The Early Growth of Logic in the Young Child, Scott based the premise of his study on the concept that early seriation tasks are essential to the general intellectual development of the child. He asserted that the results of his study appeared to support the position that compensatory programs with young children which emphasize oral language, while not stressing perceptual learning, may not provide the necessary experiental foundation for future reading success.

THE ELEMENTARY SCIENCE CURRICULUM STUDY

The science program used in this study was the Elementary Science Curriculum Study (ESCS) developed by Crocker (1973). The ESCS is based on the processes of science identified by the AAAS. Those processes developed

in the ESCS are observing, classifying, quantifying, communicating, inferring, predicting and formulating hypotheses. At the primary level children are led to observe, classify and quantify, which includes ordering and seriating. The use and development of all the senses in observing is stressed. Through observation the student is guided in developing classification and seriation abilities. These compentences are developed through direct experience in scientific investigations through the process of inquiry. The children are placed in contact with observable objects and events. They are able to act on and interact with the objects concretely. The activities and experiences were chosen with consideration for the operational level of the child according to Piaget's theory of development. The program is developed for children in first through sixth grades.

SUMMARY

The idea that knowledge of process science skills could enhance the reading ability of young learners seems to be a fairly new line of investigation for educators. Kellogg was unable to find any such studies when he conducted his search of literature in preparation for his study in 1970. This investigator was able to find one study giving empirical evidence published in 1969, after which several others were conducted.

Although the results of the studies did not present conclusive evidence of a relationship between the learning of science process skills and learning to read, they did lend supportive evidence to the concept. Ayers and Mason (1969), Neuman (1970), McProuty (1971) and Kellogg (1971) were all of the opinion that the learning of science process skills would enhance the reading abilities of children. The basic reasoning skills that process science attempted to teach were classification and seriation. According to Piaget (1964), children needed these skills of classification and seriation for the acquisitions and utilization of language. Huff (1971) indicated from her study that the study of process science demonstrated improvement in communication skills. Crocker (1973) developed the ESCS program for the purpose of teaching science process skills to elementary children. Many of these process skills taught seriation and classification abilities.

All of the studies reviewed supported this investigator's prestudy hypothesis that a relationship existed between the learning of science process skills and the development and use of reading skills, and therefore, supported the rational for this study.

CHAPTER III

PROCEDURES

The population for this study was a hypothetical one consisting of all classes of grades one and three with characteristics similar to those chosen for the study. Since there was no reason to believe that the sample classes were atypical, the population may be thought of as representative of most regular first and third grade classes. The sample was randomly selected by assigning numbers to all first and third grade classes located within the Avalon Peninsula geographic region. Random selection was performed using a list of random numbers. A total of sixteen classrooms were selected. Classes were placed into one of eight groups as indicated in Table 1: (I) first grade classes which used the ESCS kit and were provided with selected reading materials; (II) first grade classes which used the ESCS kit only; (III) first grade classes which were provided with selected reading materials only; and, (IV) first grade classes which used neither the ESCS kits nor the selected reading materials. Groups I-IV of grade three classes were classified the same as for grade one classes. The placement of classes in the groups of either grade one or three, which were currently using or had used a process science program in the past, was limited to Groups I or II. A total of two classes were used

for each group. The total number of subjects in the sample was 190 first graders and 231 third graders.

Based on the theory developed in Chapter 1 the following hypotheses were formulated and are stated as null hypothesis form.

Hypotheses

Hypothesis I (a): No significant difference will exist between the reading vocabulary achievement of Group 1, Group 2, Group 3 and Group 4 in grade one.

(b): No significant difference will exist between the reading comprehension achievement of Group 1, Group 2, Group 3 and Group 4 in grade one.

(c): No significant difference will exist between the reading vocabulary achievement of Group 1, Group 2, Group 3 and Group 4 in grade three.

(d): No significant difference will exist between the reading comprehension achievement of Group 1, Group 2, Group 3 and Group 4 in grade three.

Hypothesis II (a): No significant interaction will exist between treatment and vocabulary pretest level for first grades.

(b): No significant interaction will exist between treatment and comprehension pretest level in first grade classes.

TABLE I

Number of Classes by Grade Level, Group and Treatment

Group	Treatment	Number of Classes
	Grade One	
I	ESCS/SRM	2
II	ESCS	2
III	SRM	2
IV	Control	2
	total	8
	Grade Three	
I	ESCS/SRM	2
II	ESCS	2
III	SRM	2
IV	Control	2
	total	8

Note - ESCS=Elementary Science Curriculum Study

SRM =Selected Reading Material

(c): No significant interaction will exist between treatment and vocabulary pretest level for third grade classes.

(d): No significant interaction will exist between treatment and comprehension pretest level for third grade classes.

Hypothesis III (a): No significant interaction will exist between treatment and socio-economic level on reading vocabulary achievement in grade one.

(b): No significant interaction will exist between treatment and socio-economic level on reading comprehension achievement in grade one.

(c): No significant interaction will exist between treatment and socio-economic level on reading vocabulary achievement in grade three.

(d): No significant interaction will exist between treatment and socio-economic level on reading comprehension achievement in grade three.

Treatments and Tests

The classes placed in Group I and Group II of both first and third grades used the ESCS kit a minimum of one period per week with the class period lasting from 30-45 minutes. It also should be noted that these classes had been studying from this curriculum since early in the school year,

although not necessarily on a regular basis. The selected reading materials were placed in the classrooms of Group I and Group III of first and third grades. The classroom teacher provided opportunity for the students to avail themselves to the reading materials which included allowing the students to check out the books and take them home. The treatment period lasted for thirteen weeks, beginning in February and ending in June.

The Selected Reading Materials were books chosen to enhance those skills taught by the ESCS and the topics covered. The level of difficulty of the reading materials was determined by the Fry Method (Fry, 1972). This method requires the counting of the number of syllables contained within a one hundred word passage. An attempt was made to match the reading levels of the children within each class with the level of difficulty of the materials. Material was selected that was either on grade level, slightly above or below. A total of fifty to sixty books were placed within each classroom which were assigned SRM. At the completion of one-half of the treatment period, six weeks, books were interchanged between classrooms in order to provide as wide a range as possible in reading materials. This also provided a uniformity of books in each class. Each teacher in whose classroom SRM were placed received instruction in the use of the reading materials through personal visits by the investigator as well as by

written direction. (See Appendix A) The teacher was requested to use the books in conjunction with the units of study in the ESCS. Books which especially related to certain topics were pointed out to the teachers. For groups not using the ESCS the books were to have been used for recreational reading. The children were to have been given approximately 30 minutes per week for reading at school and were to have been encouraged to take the books home. As a class check on the number of books read, cards were placed in the back for children to sign, but this was unsuccessful.

The Gates-MacGinitie Reading Test was used for testing reading achievement in this study. Primary A, Forms 1 and 2 were used in the first grades. Primary C, Forms 1 and 2 were used with the third grade classes. This test is available in two equivalent forms for each grade level. The reliability and validity of this test had been established by the developers and its use is accepted as valid by reading authorities in the Province of Newfoundland and Labrador.

Form 1 of this test was administered at the beginning of the study. First grade classes were blocked into high, medium and low groups using these pretest scores. Grade three was blocked high and low in order to obtain the most equal distribution possible.

The Blishen Socio-Economic Index for Occupations in Canada (Blishen, 1967) was used for determining the socio-

economic status (SES) of the students. This is an occupational based scale derived by assigning weights to income and education. For this study the scale was collapsed to include numerals 2-7. There was no assigned numeral on the scale for the unemployed. This classification was given the numeral 2 by this investigator, which is the lowest numeral assigned. When the father's occupation was unknown or the father was disabled or deceased, the numeral assigned was 0. The 0 cases were eliminated in the study when the variable SES was used.

The SES was used for blocking when testing null Hypothesis III. The blocking was into four groups for the first grades and three groups for the third grade classes in order to get the most equal distribution possible.

Design and Analysis

The design of this study was the Non-Equivalent Control Group Design using randomly selected intact classes. According to Campbell and Stanley (1963), the design is noted for controlling the main effects of history, maturation, testing and instrumentation. In an attempt to control the effects on intrasession history, two classrooms were selected for each treatment group. This does not guarantee that there was no intrasession history, i.e. that all teachers followed the instructions for the application of the ESCS or the SRM with the same consistency, but tended to neutralize the effect.

In addition, the selection of two classes per treatment group provided a larger sample, thereby reducing the chance of error in the selection factor. This also helped control the interaction between selection and maturation. Interaction between treatment and ability was controlled by separating the subjects into ability levels on the basis of the pretest scores as illustrated in Table II.

Campbell and Stanley (1963) suggest that when selection of subjects is accomplished through random sampling by intact classes, the class means are used as the basic observations. However, the decision was made to use individual scores as the basic observations for this study, the rational for this being: 1) It is common practice to use individual scores; 2) It is assumed that the classes themselves were a random sampling of children within the school, therefore sampling by class would be essentially the same as sampling by individuals; and, 3) As a consequence of using individual scores rather than class means, a greater degree of freedom resulted. This may mean running a risk of over estimation, whereby using class means is an under estimation, with the true degree of freedom lying somewhere in between.

Multiple linear regression was used in a manner essentially equivalent to a series of two-way analysis of covariance, with posttest (vocabulary and comprehension) as criterion variables, and treatment and either pretest

groups or SES blocking variables. Covariates of vocabulary and comprehension pretest scores and sex were used where they were applicable.

TABLE II

Design of the Study

Pretest	Treatment				Posttest
	Group 1	Group 2	Group 3	Group 4	
High Group					
Medium Group					
Low Group					

CHAPTER IV

RESULTS OF THE INVESTIGATION

The subjects selected for this study were children from first and third grade classes in the Avalon Peninsula area. Sixteen selected classrooms were administered the Gates-MacGinitie Reading Test Form 1 as a pretest. Form 2 was administered as a posttest after the treatment of thirteen weeks. Only those subjects administered both forms were included in the study. Certain rearrangements of the data were necessary to facilitate analysis. When pretest scores were used as a blocking variable, a total of 190 first graders and 231 third graders were used in the sample. When socio-economic status (SES) was used as a blocking variable, all subjects who were assigned the numeral "0" were dropped, since the SES for these was unknown or not provided for in the scale. This left a total of 169 first graders and 209 third graders who were used for this sample. Multiple linear regression was used for analyzing the data. This analysis was comparable to a series of two-way analysis of covariance. Comprehension and vocabulary pretests and sex were used as covariates where applicable with sex being treated as a pair of categorical variables in the regression equation. The dependent variables were vocabulary and comprehension posttest raw scores. The overall treatment

means of these scores are given in Table III along with pretest and predicted means. In grade one the subjects were grouped high, medium and low according to raw scores on the pretest. The third grade classes were grouped high and low in order to obtain cell frequencies as nearly equal as possible. When SES was used for grouping, the first grade subjects were separated into four levels and the third grade subjects into three levels. This grouping was an attempt to even out cell frequenices, nevertheless there was an overload in the lower cells. The hypotheses were tested for acceptance or rejection at the .05 level of significance using the F statistic.

TESTING OF HYPOTHESES

Treatment Effects

Hypothesis I (a): No significant difference will exist between reading vocabulary achievement of Group I with Elementary Science Curriculum Study (ESCS) and selected reading materials (SRM), Group II with ESCS only, Group III with SRM only, and Group IV with no specific treatment in grade one.

Results of the test of this hypothesis is given in Table IV. The F value obtained of 2.59 was very near the critical F of 2.60 and was marginally non-significant.

TABLE III

Pretest, Posttest and Predicted Means

Variable	Test	Groups 1	2	3	4
		Grade One[a]			
Vocabulary	Pre	22.31	20.4	20.80	21.14
	Post	31.38	28.53	29.39	28.63
	Predicted	31.47	27.94	29.43	28.89
Comprehension	Pre	11.76	12.11	10.63	10.54
	Post	19.28	17.44	16.37	14.84
	Predicted	18.84	17.68	16.54	14.98
		Grade Three[b]			
Vocabulary	Pre	26.97	29.00	32.36	24.54
	Post	31.19	34.81	37.36	28.46
	Predicted	31.54	34.55	34.49	30.47
Comprehension	Pre	24.37	25.61	30.34	21.01
	Post	26.14	30.22	33.64	21.58
	Predicted	27.38	29.92	30.79	23.42

[a] N=190 [b] N=231

(b): No significant difference will exist between the reading comprehension achievement of Group I, Group II, Group III and Group IV in grade one.

As can be seen from Table IV the results of testing this hypothesis gave an F value of 3.49. The probability of obtaining this value was between .02 and .01. This suggested that there were significant differences between the treatment groups, therefore the null hypothesis was rejected.

Since the hypothesis of equality of group means was rejected, the Scheffé Multiple Comparison Test was used to decide which pairs of means were significantly different at the .05 level of significance. The results of this test, as seen from Table V, revealed that the mean of Group I (ESCS and SRM) was significantly greater than all other means. Means of Group II (ESCS) and Group III (SRM) were also significantly greater than that of Group IV (Control).

(c): No significant difference will exist between the reading vocabulary achievement of Group I, Group II, Group III and Group IV in grade three.

Table V gives the results of the test of this hypothesis. The F value obtained was slightly below the critical F of 2.60. Even though the hypothesis was not rejected, the F value was marginally non-significant.

TABLE IV

Analysis of Covariance on Posttests: Grade One

Source	Sums of Squares	df	Mean Square	F
	Vocabulary[a]			
Pretest level	6864.3587	2	3423.1777	90.36**
Treatment	294.6154	3	98.2050	2.59
Interaction	311.872	6	51.9787	1.37
Error	6667.4561	176	37.8832	
	Comprehension[b]			
Pretest level	233.5071	2	116.7535	3.21*
Treatment	380.6852	3	126.8950	3.49*
Interaction	335.9344	6	55.9890	1.54
Error	6397.1984	176	36.3476	

[a]Sex and comprehension pretest used as covariates.

[b]Sex and Vocabulary pretest used as covariates.

*p <.05

**p <.001

(d): No significant difference will exist between reading comprehension achievement of Group I, Group II, Group III and Group IV in grade three.

As can be observed from Table VI, the obtained F was 6.24. Since the F value was high and the probability of obtaining that value by chance was beyond .001, the hypothesis was rejected. This led to testing the predicted means by use of the Scheffé Multiple Comparison Test. When the means were tested all treatment groups were found to be different at the .001 level of significance, with the exception of Groups II and III, the means of these two groups being essentially the same. This test revealed that the mean of Group I (ESCS and SRM) was significantly higher than that of Group IV (Control) at the .001 level of significance. As can be seen from Table 7, it also revealed that Groups II (ESCS) and III (SRM) were significantly greater than Groups I (ESCS and SRM) and IV (Control).

Interaction Effects

Several hypotheses concerned with interactions were investigated in this study. An interaction was sought between the treatments and reading pretest level using vocabulary and comprehension posttest scores as criterion variables. If an interaction were to be found between the two, it is conceivable that this knowledge could have some

TABLE V

Comparison of Comprehension Mean Differences: Grade One

Group	2	3	4
1	1.16*	2.30**	3.96**
2		1.14	2.70**
3			1.56*

*p <.05

**p <.001

TABLE VI

Analysis of Covariance on Posttests: Grade Three

Source	Sums of Squares	df	Mean Square	F
	Vocabulary[a]			
Pretest level	623.1704	1	623.1704	22.24*
Treatment	213.9220	3	71.3073	2.54
Interaction	87.9904	3	29.3301	1.04
Error	6191.4174	221	29.0154	
	Comprehension[b]			
Pretest level	1369.9473	1	1369.9472	44.24*
Treatment	580.1943	3	193.3980	6.24*
Interaction	93.7022	3	31.2340	1.00
Error	6843.0928	221	30.6942	

[a]Sex and comprehension pretest used as covariates.

[b]Sex and vocabulary pretest used as covariates.

*p <.001

TABLE VII

Comparison of Comprehension Mean Differences: Grade Three

Group	2	1	4
3	.87	3.41*	7.38*
2		2.54*	6.51*
1			3.97*

*p < .001

impact on the selection methods for children of differing abilities. In Table IV the results of testing the interaction hypotheses of pretest level and treatment for grade one is given. In Table VI the results for grade three can be observed. When Hypotheses II was tested, the results did not indicate any significant interactions. Although the F value obtained was somewhat higher in grade one than in grade three, neither was high enough to be considered near significance. Therefore, this hypothesis was not rejected.

An interaction between treatment and socio-economic status was also investigated using the same criterion variables as Hypothesis II. It was considered desirable to test whether SES showed significant interaction with any of the treatments. The results of these tests can be seen from Table VIII for grade one and Table IX for grade three. Since the results of testing these hypotheses did not show any significant F values, Hypothesis III was not rejected.

SUMMARY

Of the null hypotheses tested, two were rejected. Those rejected involved treatment groups and comprehension achievement in both first and third grade subjects. The Scheffé Multiple Comparison Test was used to find treatment group differences. In grade one the mean of Group I with both

TABLE VIII

Analysis of Covariance of Socio-economic Status on Reading: Grade One

Source	Sums of Squares	df	Mean Square	F
	Vocabulary[a]			
SES	435.8136	3	145.2711	3.9296*
Treatment	46.1337	3	15.3779	.4159
Interaction	165.7957	9	18.4217	.4983
Error	5545.1777	150	36.9678	
	Comprehension[a]			
SES	104.8860	3	34.9620	.8862
Treatment	166.6417	3	55.5472	1.4081
Interaction	481.0182	9	53.4464	1.3548
Error	5917.1807	150	39.4478	

[a]Sex and vocabulary and comprehension pretests used as covariates.

*$p < .01$

TABLE IX

Analysis of Covariance of Socio-economic Status on Reading: Grade Three

Source	Sums of Squares	df	Mean Square	F
	Vocabulary[a]			
SES	34.3334	2	17.1667	.8104
Treatment	125.8775	3	41.9591	1.9809
Interaction	172.4740	6	28.7456	1.3571
Error	4109.2167	194	21.1815	
	Comprehension[a]			
SES	44.0976	2	22.0487	.7973
Treatment	537.6504	3	179.2168	6.483*
Interaction	131.3127	6	21.8854	.7914
Error	5364.3591	194	27.6513	

[a]Vocabulary and comprehension pretests and sex used as covariates.

*p <.01

ESCS and SRM was significantly greater than all other groups, with the control group which had no specified treatment showing the lowest mean scores. The results of the test on grade three comprehension achievement means indicated that Group I means were significantly higher than the Control group, but also that means of Group II (ESCS) and Group III (SRM) were significantly higher than Group I and the Control Group.

The results of testing also indicated very near significance in two other Hypotheses which dealt with treatment and vocabulary achievement in both first and third grades. Even though the F value obtained did not meet the .05 level of significance they were considered marginally non-significant.

Results of tests for interactions between treatment and reading level and also between treatment and SES indicated no support for these hypotheses.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

The purpose of this study was to investigate the relationship between beginning reading and science process skills. The major questions investigated were: 1) Would the combination of studying process science skills and having available selected science related reading materials enhance the reading achievement of children over the achievement of those who did not have this combination treatment? 2) Would the achievement of this group be higher than that of children who had only one of these treatments applied to them, and/or higher than that of a control group? 3) Would children who studied process science have greater achievement in reading than children who did not study process science? 4) Would the pre-treatment reading level of children interact with any specific treatment? 5) Would socio-economic status interact with any specific treatment? 6) Would the reading achievement of first and third graders with respect to treatment indicate the same results or trends? These questions were stated in the null hypothesis form and were tested for significance at the .05 level of significance using multiple linear regression and the Scheffe Multiple Comparison Test.

The following four treatment groups were established:

I Elementary Science Curriculum Study (ESCS) and selected reading materials (SRM)

II ESCS only

III SRM only

IV Control

Eight first and eight third grade classes were randomly selected and placed into the treatment groups listed above. Those previously engaged in ESCS were used as the first two treatments, while classes without previous experience with ESCS constituted the last two treatments.

CONCLUSIONS

Two null hypotheses were rejected. Both were concerned with reading comprehension. In both first and third grade classes, treatment groups differed significantly on reading comprehension achievement. Two other hypotheses when tested were very close to indicating significant differences. These hypotheses involved vocabulary achievement for both first and third grades. More specifically, the results of the statistical test led to the following conclusions.

Grade One

Treatment groups for reading comprehension achievement of first graders indicated significant differences. Treatment Group I, which used ESCS as well as SRM, had significantly higher achievement scores than all other groups, with the

biggest difference lying between it and the Control group. This was the result expected; therefore the hypothesis that studying science processes and having available selected reading materials enhances reading achievement does have support. The combination of process science skills and related reading materials in first grades seems to be the factor most influencing in this study. The fact that Group II with ESCS only showed significantly higher achievement in comprehension than Group IV which had no ESCS lends some support to the hypothesis that studying science process skills would enhance reading achievement.

Results of tests for significance of hypotheses involving vocabulary achievement indicated very near significance. If the treatment, i.e. ESCS on a regular basis and SRM available, had begun earlier in the year as the children were beginning to learn to read, and had been longer, then perhaps the results would have been more positive. Learning to classify material objects is taught in ESCS, but for this to transfer to reading, which calls for classifying through hearing as well as sight, may take longer than this study allowed.

Treatment Group I scored higher than the other three groups on both vocabulary and comprehension subtests. The biggest differences lay between Group I and IV, or the group with both treatments and the group with no treatment. A lack of clear support for the research hypothesis on the vocabulary

achievement may be attributed, also, in part to the inability to control certain variables relative to the outcome. One such variable was the classroom teacher. Although the classes were selected randomly, the group size (two classes per group) was too small to insure proper randomization of teachers. Even though the treatment was specifically assigned to groups there was no guarantee that the treatment was applied with equal consistency. From observations of the classrooms by the investigator, it would appear very likely that the treatments were applied differently. In some classrooms ESCS was studied as a separate unit, in others the skills and activities were integrated into the total class setting. In order to make an attempt at recording the number of books read by the students, cards were placed in the back of each book for the child to sign, but this attempt was unsuccessful. Even though the reading materials were fairly equal among groups, the fact remains that all may not have had the same amount of time allotted for reading.

Grade Three

In grade three tests of hypotheses concerned with comprehension achievement indicated significant differences between treatment groups. Rather than Group I showing the highest achievement, as was indicated in the first grade classes and as was expected, Group III (SRM only) displayed the highest achievement. Group III was higher in achievement

than all other groups with the exception of Group II, (ESCS only). All groups were significantly higher than Group IV (Control). Even though Group I (ESCS and SRM) was significantly higher than Group IV, it was lower than Groups II and III.

There are several possible explanations for the unexpected results. Again, the teacher variable, as discussed earlier could have been a significant factor. Because Group III scored higher on the reading pretest, an attempt was made to control this difference by blocking using the pretest scores. It is assumed that reading achievement and IQ are related and therefore the pretest blocking should have controlled for IQ differences as well. However, children with high IQ as it effects their learning ability, have reached a developmental level at which they would already have acquired the ESCS skills and were able to apply these skills to reading. This could account for no differences between Groups II and III. Another factor which could have influenced the differences in Groups III and I is that of time. Even though the students in Group I, whose pretest scores would indicate them to be of average intelligence, learned the ESCS skills, the study may not have allowed them time enough for this to transfer to reading skills and show signficant improvement.

The test on vocabulary differences in grade three was near significance. It followed the same trend as the

comprehension achievement tests. The same arguments would therefore apply to the vocabulary achievement.

First and Third Grade Trends

The hypothesis that the same trends would appear in first and third grade classes was not supported. Several influencing variables have been discussed above, but aside from those there seems to be another alternative. The possibility that learning science process skills is more influential in beginning reading than in later reading seems tenable when considering the statistical results. If skills of classification and seriation are subskills of reading, it is logical to assume that by third grade these skills have already been largely developed in children who are reading on or near grade level. This being the case, the children who had reading materials at their disposal and time to avail themselves of these materials would show achievement in reading. It could be argued as well, that third graders who had ESCS and SRM in combination did not have as much time as the group with SRM only to give to reading the materials. From the statistical results it is concluded that reading achievement may be enhanced by having readily accessible reading materials of interest to and on the reading level of children who have already mastered some of the basic reading skills. These findings at least tentatively support the theory developed in this study.

RECOMMENDATIONS

Implications for Research

Since the present study can be regarded as giving only tentative support to the general theory concerning the relationship between science process skills and reading achievement, other studies similar to this one are needed to give more support to the theory upon which this study was based. Better control of variables such as application of treatment, teacher differences, and group differences prior to the treatment should be of prime concern.

Since the evidence in this study seems to indicate that science process skills are of little importance to reading achievement of third grade readers of higher ability, an investigation into the effect of learning science process skills on slow or retarded readers would appear to be of value. Another area closely related to this would be an investigation into the effect of learning science process skills on educable mentally retarded children who are retarded in many areas. Children who have learning disabilities or perceptual problems could also be the subjects of an investigation in relation to learning skills of seriation and classification through science processes. Any evidence gained from such studies would obviously be of much value to educators of these children.

Implications for Practice

This study adds empirical evidence to the concept that the availability of interesting reading material enhances reading achievement. Reading achievement in both first and third grades was enhanced by reading materials which were selected to enrich the concepts which were introduced in the study of science process skills. Therefore educators should seem inclined to see that these types of materials are made available to primary age children.

The findings in this study, particulary those relating to grade one, lend support to the theory developed in Chapter I based on Nelson's model and Piagetian theory. The results are also consistent with the findings of Kellogg (1971), Neuman (1970), Almy (1966), and McProuty (1971). Notwithstanding the control limitations, which were the teacher variable; intact classes with individual scores treated as the basic observations; and, the time factor, it appears from the results of this study that learning science process skills may enhance reading achievement in beginning readers. When confronted with evidence presented by this study and others mentioned above, educators, teachers in particular, should make readily available the opportunity for primary children to have experiences in basic skills taught through science which uses the process approach. Realizing that the evidence indicated that these skills not only influence the

scientific literacy of children, but can have a positive effect on reading achievement, should lead educators to facilitate the addition of science process curriculum programs into the primary school curriculum.

APPENDIX A

WRITTEN DIRECTIONS FOR TEACHERS PROVIDED WITH SELECTED READING MATERIALS

A number of books are being placed in your classroom. These reading materials have been selected for the purpose of complementing the ESCS kits if they are being used in your classroom. If the kits are not being used, they are placed in the classroom for recreational reading purposes. These books are on the grade level in which they are placed or slightly above or below.

The children should be given as much opportunity for using these books as possible. Cards are placed in the back of the books so they can be checked out much the same as a library book. The children are expected to be allowed to take the books home for reading.

If the class is using the ESCS kits, when a book relates to a particular activity being used in science, this should be pointed out to the children.

Listed below are ways the materials should be used.

1) Give as much opportunity as possible for use of the books.
2) Books may be taken home if checked out with the cards.

3) If using the ESCS kits correlate the reading with activity.

4) The books should be used as outside reading rather than for formal instruction.

APPENDIX B

SELECTED READING MATERIALS*

Grade One

Aliki, My 5 Senses. New York: Crowell, 1962.

Blough, G. Animals Round the Year. New York: Harper & Row, 1966.

Bluff, M. Dash and Dart. New York: Viking Press, 1966.

Board, T. Zoo Animals, Hamlyn, 1971.

Brandwein, P. Concepts in Science. New York: Harcourt, Brace & World, 1970.

Branley, F. What the Moon is Like. New York: Crowell, 1963.

Bronson, W. Turtles. New York: Harcourt, Brace & World, 1945.

Brown, The Important Book. New York: Harper & Row, 1949.

Conklin, G. Elephants. New York: Holiday House, 1972.

Darby, G. What is a Cow? Atlanta: Benefic, 1963.

_____. What is a Frog? Atlanta: Benefic, 1965.

_____. What is a Season? Atlanta: Benefic, 1962.

Frederique & Papy. Graph Games. New York: Crowell, 1972.

Freestrom, H. The Five Senses. Dallas: Benefic, 1970.

Follen, J. Deer. Chicago: Follett, 1967.

Fuchs, E. Journey to the Moon. Delacarte Press, 1969.

Hagaman, A. What is Water? London: Collins, 1962.

Lenski, L. The Little Farm. New York: Walck, 1942.

Lerner, Red Man, White Man, African Chief. Minneapolis: Lerner, 1960.

* A partial list of books were used in classrooms. Due to loss some books are not included.

May, J. Alligators. Chicago: Follett, 1969.

McGovern, A. Black is Beautiful. New York: Four Winds, 1970.

Meeks, E. Something New at the Zoo. Chicago: Follett, 1957.

Miller, P. Joey Kangeroo. New York: Holt, Rinehart and Winston, 1963.

Myrick, M. Ants are Fun. New York: Harper and Row, 1968.

O'Brien, T. To Know a Tree. New York: Holt, Rinehart and Winston, 1963.

Parker, B. Fall is Here. New York: Harper and Row, 1966.

_____. Summer is Here. New York: Harper and Row, 1966.

_____. Winter is Here. New York: Harper and Row, 1968.

_____. Spring is Here. New York: Harper and Row, 1966.

_____. How Animals Get Food. New York: Harper and Row, 1966.

_____. Leaves. New York: Harper and Row, 1966.

Phleger, F. Red Tag Comes Back. New York: Harper and Row, 1961.

Podendorf, I. Sounds All About. Chicago: Children's Press, 1970.

_____. Shapes, Sides, Curves and Corners. Chicago: Children's Press, 1970.

_____. Toby on the Move. Chicago: Children's Press, 1970.

_____. Many is How Many? Chicago: Children's Press, 1970.

_____. How Big is a Stick? Chicago: Children's Press, 1970.

_____. Touching for Telling. Chicago: Children's Press, 1970.

_____. Color. Chicago: Children's Press, 1970.

_____. Food is For Eating. Chicago: Children's Press, 1970.

_____. Every Day is Earth Day. Chicago: Children's Press, 1970.

_____. Magnets. Chicago: Children's Press, 1970.

Polgreen, J. Our Friend the Sun. New York: Holt, Rinehart and Winston, 1963.

Reit, S. Animals Around My Block. Toronto: McGraw-Hill, 1970.

Rush, H. Backyard Trees. Toronto: MacMillan of Canada, 1967.

Schoenknecht, C. Frogs and Toads. Chicago: Follett, 1960.

Selsam, M. Benny's Animals. New York: Harper and Row, 1966.

_____. Greg's Microscope. New York: Harper and Row, 1963.

_____. Maple Trees. New York: Morrow, 1968.

_____. Tony's Birds. New York: Harper and Row, 1961.

Shaw, E. Alligator. New York: Harper and Row, 1972.

Simon, N. How Do I Feel? New York: Whitman, 1970.

Stone, A. and Seigel, B. Have a Ball. Englewood Cliffs, New Jersey: Prentice-Hall, 1969.

Thurber, W. Exploring Science. London: Burke, 1962.

Unknown. Three Little Pigs. New York: Viking, 1962.

Usborne, P. (Ed.) Apples. London: MacDonald Educational, 1971.

_____. Butterflies. London: MacDonald Educational, 1972.

_____. Fish. London: MacDonald Educational, 1971.

_____. Frogs. London: MacDonald Educational, 1971.

_____. Music. London: MacDonald Educational, 1971.

_____. Spiders. London: MacDonald Educational, 1971.

_____. Trees. London: MacDonald Educational, 1971.

Zion. Harry the Dirty Dog. New York: Harper and Row, 1956.

Grade Three

Adler, I. Directions and Angles. New York: Day, 1970.

Allen, G. Birds. London: Oxford University Press, 1968.

_____. Bones. London: Oxford University Press, 1968.

_____. Flowers. London: Oxford University Press, 1969.

_____. Insects. London: Oxford University Press, 1969.

Bampton, B. Alive. Toronto: Macmillan of Canada, 1971.

_____. Babies. Toronto: Macmillan of Canada, 1971.

_____. Growing Up. Toronto: Macmillan of Canada, 1971.

_____. Homes. Toronto: Macmillan of Canada, 1971.

_____. Plants. Toronto: Macmillan of Canada, 1971.

_____. Protection. Toronto: Macmillan of Canada, 1971.

Bentley, L. Plants that Eat Animals. Toronto: McGraw-Hill, 1970.

Behn, H. All Kinds of Time. New York: Harcourt, Brace and World, 1950.

Beiser, A. The Earth. New York: Time-Life, 1968.

Bendick, J. Space and Time. New York: Watts, 1968.

Barter, H. Do You Hear What I Hear? Toronto: Schuman, 1960.

Bradley, F. Timmy and the Tin Cantelephone. New York: Crowell, 1959.

Campbell, A. Let's Find Out About Color. New York: Watts, 1966.

Carona, P. Crystals. Chicago: Follett, 1971.

_____. Earth Through the Ages. Chicago: Follett, 1968.

Carrington, R. Mammals. New York: Time-Life, 1967.

Cavanna, B. The First Book of Wild Flowers. New York: Watts, 1961.

Chapman, C. Clean Streets, Clean Water, Clean Air. New York: Whitman, 1970.

Darling L. Penguins. New York: Morrow, 1956.

Dean, H. Fish. New York: Lippincott, 1971.

Dempsey, B. Air. London: MacDonald Educational, 1970.

_____. Water. London: MacDonald Educational, 1970.

_____. Electricity. London: MacDonald Educational, 1970.

Dennis, R. Fractions Are Parts of Things. New York: Crowell, 1971.

Elgin, K. The Skim. New York: Watts, 1970.

Earle, O. Junior Book of Trees. New York: Morrow, 1964.

_____. Peas, Beans and Licorice. New York: Morrow, 1971.

_____. Robins in the Garden. New York: Morrow, 1953.

_____. Squirrels. New York: Morrow, 1955.

_____. Squirrels in the Garden. New York: Morrow, 1963.

Fehr, H. Number Patterns. New York: Holt, Rinehart and Winston, 1965.

Ford, H. Fun With the Calendar. New York: Holt, Rinehart and Winston, 1964.

Froman, R. Bigger and Smaller. New York: Crowell, 1971.

Gendron, V. Whales. Chicago: Follett, 1965.

Gibson, D. How Big Can I Grow? Chicago: Reilly and Lee, 1971.

Gorden, K. Space and Time. New York: Crowell, 1971.

Graham, L. A Road Down in the Sea. New York: Crowell, 1970.

Green, M. Everybody Has a House. New York: Scott, 1950.

Hader, B. The Big Snow. Toronto: Macmillan of Canada, 1948.

Hammond, W. The Riddle of Seeds. New York: Coward McCann, 1965.

Hawes, J. Birds. New York: Crawl, 1972.

_____. Spiders. New York: Crawl, 1972.

Hawkins, G. The Sun and Its Planets. New York: Holt, Rinehart and Winston, 1964.

Hornblow, L. Fish Do the Strangest Things. New York: Random House, 1968.

_____. Insects Do the Strangest Things. New York: Random House, 1968.

Horwood, B. Bicycles. Toronto: Macmillan of Canada, 1969.

_____. Trees. Toronto: Macmillan of Canada, 1973.

Jacobson, W., Lauby, C. and Koincek, R. Distances in Space. New York: American Book Company, 1968.

_____. Weather. New York: John Day, 1962.

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