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THE INFLUENCE OF THE FIRST GRADE PROGRAM OF THE SCIENCE CURRICULUM IMPROVEMENT STUDY ON THE RATE OF ATTAINMENT OF CONSERVATION

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CHAPTER I

INTRODUCTION

Background of the Problem

> "Behind a self-confident exterior, he (modern man) conceals a great inward lack of confidence. In spite of his great capacity in material matters, he is an altogether stunted being because he makes no use of his capacity for thinking."[1]

The foregoing passage is a strong indictment against modern man, but it is perhaps an even stronger indictment against the educational system which spawns him. The problem is further intensified by the fact that most present-day educators, products themselves of the same educational system, are also intellectually stunted beings. They do not actively strive to help their pupils develop their capacity for thinking because, first, they do not accept this as a primary goal, and second, they do not know how! Furthermore, since original thinking is not rewarded in the present-day content-centered curriculum, the learner has little chance, or reason, to develop his capacity on his own. In fact, many educators who are overly concerned with transmission of content have a negative effect and act as a damper on the learners' thinking since they place far too much emphasis on memorization.

[1]Albert Schweitzer, Out of My Life and Thought (New York: Holt and Company, 1953), p. 172.

Fortunately, even though the general state of education at present is not cause for optimism, there is reason to hope that a period of educational enlightenment is emerging. During the past decade, many professional educators and others interested in the improvement of education have begun to express the view that not only can thinking ability be taught, but it should become the focal point of education. This view was summed up by the Educational Policies Commission of the National Education Association when it said:

> "The purpose which runs through and strengthens all other educational purposes--the common thread of education--is the development of the ability to think. This is the central purpose to which the school must be oriented if it is to accomplish either its traditional tasks or those newly accentuated by recent changes in the world."[2]

In order to achieve the stated central purpose of American education, i.e., the development of the ability to think, the educator must be something other than a purveyor of information. He must see his job as that of providing opportunities for experiences that require, or at least allow, thinking at the level at which the learner is capable of operating successfully. He must also create an intellectual atmosphere in the classroom conducive to logical thinking. Because there is no evidence that the ability to think can be developed in any other way, the educator must consciously strive toward the goal of maximum mental development or maximum logical thinking capacity for each learner in his class.

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[2]Educational Policies Commission, The Central Purpose of American Education (Washington, D.C.: National Education Association, 1961), p. 14.

There is, however, a known developmental prerequisite to the attainment of even the initial stage of logical thinking. This prerequisite, which can be considered the first of the learner's hurdles in his climb toward the goal of maximum mental development, is the attainment of the ability to conserve.[3]

The ability to conserve is revealed when a child grasps the mathematical idea that number is not changed when a set of objects is partitioned into subgroups, and the physical idea that mass or substance does not change when the shape or appearance of an object is transformed.[4] Prior to the attainment of this developmental stage, labeled "concrete operations" by the Swiss psychologist Jean Piaget, a child does not, in general, apply logic in problem solving. He is limited in his explanations to " . . . a simple report of what he perceives . . ."[5], and his judgments are greatly influenced by single pronounced perceptual cues such as color, height or length, and shape. Also, he does not appear to be at all disturbed by apparent contradictions in his reasoning. For example, volumes of liquids, amounts and weights of plasticene, length of a string of beads, and even the number of checkers in a row are thought by the child to change with spatial arrangement. The "pre-logical" or preoperational child lives in

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[3]Millie Almy, Young Children's Thinking (New York: Teachers College Press, Columbia University, 1966), p. 9.

[4]Ibid.

[5]Barbel Inhelder and Jean Piaget, Growth of Logical Thinking (New York: Basic Books, Inc., 1958), p. 48.

a " . . . kind of Alice in Wonderland world."[6]

A child begins to emerge from this pre-logical or preoperational stage at about seven years of age when he begins to take into account perceptual cues other than the most striking one. This allows him to equilibrate or balance one change against another. For example, he begins to realize that if a piece of plasticene is rolled into an elongated form, the greatly increased length is balanced by a compensating decrease in cross section. He almost suddenly comes to realize that if nothing is added or taken away, the amount or number remains constant--is conserved.

The development and refinement of these logical operations on bodies of matter and situations continues over the next several years influenced, according to Piaget, by maturation, experience with the physical world, social transmission (including education), and equilibration.[7] Each step or stage in the development and/or refinement of these logical operations is dependent on the development of the preceding ones. During the stage called "concrete operations", the first level of logical thought usually considered to extend from the age of approximately seven years to the age of eleven to twelve years, the child's thought processes are bound to a great extent to the struc-

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[6]Joachim F. Wohlwill, "The Mystery of the Pre-Logical Child" Psychology Today (July, 1967), p. 32.

[7]Barbel Inhelder and Jean Piaget, The Early Growth of Logical Thought in the Child (New York: Harper and Row, 1964), p. 8.

turing of " . . . immediately present reality."[8]

The attainment of the stage of concrete operations can lead to the next higher stage of development, the ability to use propositional logic, if the individual has the right kind of educational experiences. This ability to use formal or propositional logic makes available much greater intellectual power and greatly enhances the individual's mental abilities. The "development of the ability to think," the stated central purpose of American education, is obviously contingent on the stepwise attainment of the stages of logical thought which begins when the child conserves. This, then, provides a point of focus for the educator who is more interested in teaching children to think than in transmission of information.

In light of the knowledge that the initial step into logical thinking is preceded by the attainment of the conservations, two related questions emerge. (1) Can the attainment of the conservations be significantly accelerated by experiences, especially classroom experiences, or is the change to logical thinking preset in a child's development? (2) If the attainment of the conservations can be accelerated by experiences, what kinds of experiences are needed?

The opinions of recognized authorities provide at least a partial answer to each of these questions. For example, Piaget, in collaboration with Inhelder, suggested that a " . . . progressive

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[8]Inhelder, op. cit., Growth of Logical Thinking, p. xvii.

[9]Willard Jacobson and Allan Kondo, SCIS Elementary Science Sourcebook (Berkeley: University of California, 1968), p. 34.

acceleration of individual development might occur under the influence of education."[10] On another occasion, Inhelder suggested that "concrete activity that becomes increasingly formal" might allow children to advance more rapidly from one stage of intellectual development to another.[11] Lovell stated the case more strongly for experience and more specifically for conservation than either Piaget or Inhelder. He said: "Piaget underestimates the part played by the child experimenting with plasticene, sand, water, etc., in many and varied situations. Sheer experience with the physical world seems to be affecting conservations more than Piaget reckons."[12]

Jerome Bruner suggested that school experiences of the right kind might be an important influence on the rate of intellectual development.[13] He states:

> " . . . the intellectual development of a child is no clockwork sequence of events; it also responds to influences from the environment. . . . Experience has shown that it is worth the effort to provide the growing child with problems that tempt him into the next stage of development."[14]

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[10] Inhelder, op. cit., p. 337.

[11] Jerome S. Bruner, The Process of Education (New York: Vintage Books, 1960), p. 42.

[12] K. Lovell, The Growth of Basic Mathematical and Scientific Concepts in Children (London: University of London Press, Ltd., 1966), p. 67.

[13] Jerome S. Bruner, Toward a Theory of Instruction (Cambridge: Belknap Press, 1966), p. 27.

[14] Bruner, op. cit., The Process of Education, p. 39.

Joachim F. Wohlwill of Clark University, who is currently involved in a two-year study which is designed to isolate possible relationships between activities such as counting, measuring and sorting to concepts like conservation and class inclusion,[15] offers this opinion:

> "Our finding that children's scores (on conservation related tasks) could be raised by intensive experience suggests a profitable focus for instruction in the primary grades when little attention is usually given to cultivating the child's measuring and classifying skills. Our guess is that concerted efforts to encourage and guide children's activities in this area might pay handsome dividends . . . "[16]

Although the authorities quoted unanimously support the idea that educational experiences can accelerate the attainment of the conservations and/or move the child into the next higher stage of intellectual development, an attempt to verify these opinions using the results of experimental studies reported in the literature does not prove very fruitful. Taken as a whole, the experimental studies that have attempted to accelerate the understanding of conservation in young children who are clearly non-conservers have been rather unsuccessful.[17]

Review of Related Research

Educational and psychological literature contains a considerable

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[15] Letter from Jerome S. Bruner, September 25, 1967.

[16] Wohlwill, op. cit., p. 31.

[17] Almy, op. cit., p. 42.

number of conservation related studies. Each of these studies, generally speaking, deals with only one aspect of conservation, that is, with only one conservation task.

The studies will be grouped according to the particular conservation task with which the experimenter worked and, generally, in the chronological order in which the conservations are normally attained; i.e., number (6-7 years), substance (7-8 years), length (7-8 years), area (8-9 years), and weight (9-10 years).[18]

The first of the number studies was done by Churchill in 1958.[19] She administered a pretest battery of Piaget number tasks to sixteen five-year-olds and used their scores to divide them into two equal groups. The experimental group met twice weekly for four weeks in sessions giving practice in groupings, serialization, and matching and ordering various objects. The control group received no training. A posttest with the same battery of tests indicated that the experimantal group improved considerably more on the number tasks than the control group. Flavell pointed out what he considered to be a major shortcoming of the study when he said, " . . . the training was too global and heterogeneous to permit any definite conclusions as to precisely what experience did and did not influence precisely what numerical skill."[20] Millie Almy suggests that the effectiveness of Churchill's

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[18] Wohlwill, op. cit., p. 27.

[19] E. Churchill, The Number Concepts of the Young Child (Researchers and Studies, Leeds University, 1958), Part I, pp. 34-39, Part II, pp. 18, 24-46.

[20] J. H. Flavell, The Developmental Psychology of Jean Piaget (Princeton: D. Van Nostrand Co., Inc., 1963), p. 371.

technique might be due to the fact that a variety of different kinds of experiences was provided.[21]

A study by Wohlwill and Lowe in 1962 was much more specific with respect to the training provided than the one conducted by Churchill. Seventy-two public kindergarten children of low middle class and with a mean age of five years were given a pretest on both verbal and non-verbal conservation of number. More specifically, the pretests were designed to determine whether the child could reproduce a particular cardinal number, establish a numerical relationship of equivalence between two collections, and respond to the dimension of number independent of irrelevant perceptual cues; i.e., length.[22]

The subjects were divided into four subgroups each consisting of eighteen children. Training procedures with the children were directed toward the acquisition of conservation of number only. One group was given the same treatment as the first group, but, in addition, were shown that adding and subtracting from the group did change the number. A third group's training attempted to dissociate number from perceptual configuration. The subjects were allowed to see different sets of elements made into long and short rows without changing the value. A fourth group served as a control. Both experimental and control groups

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[21]Almy, op. cit., p. 41.

[22]J. F. Wohlwill and R. C. Lowe, "An Experimental Analysis of the Development of the Conservation of Number," Child Development (1962), pp. 153-167.

showed significant improvement from pretest to posttest in non-verbal conservation--that is, the ability to physically manipulate groups of objects and determine if two groups have the same or different numbers of elements. There were, however, no statistically significant differences in the improvement in non-verbal conservation of the experimental groups over the control groups. There was virtually no discernible training effect on any of the groups in terms of verbal number conservation--the traditional way of measuring conservation in which the child is allowed to use only visual and mental perception.[23]

The conservation of quantity has been studied extensively by Jan Smedslund of the University of Oslo. He published a series of six research reports describing attempts to teach conservation of substance and weight. The first report of the series reviews the theory and experimentation relative to the formation of Piaget's concepts with special emphasis on the apparently related areas of substance and weight conservation.[24]

The second article of the series reports an experiment during which the experimenter attempted to teach forty-eight five to seven-year-old children to conserve weight.[25] The children were pretested

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[23]The description of the training experiences given each group and the conclusion were taken from Flavell, op. cit., pp. 371-372.

[24]Jan Smedslund, "The Acquisition of Conservation of Substance and Weight in Children," Scandinavian Journal of Psychology, I. Introduction (1961), pp. 11-20.

[25]Ibid., II. External reinforcement of conservation of weight and of the operations of addition and subtraction, pp. 71-84.

on conservation of weight and divided into two groups. One group was given a series of thirty-two reinforced trials on conservation of weight in this manner. Two pieces of plasticene of equal size and shape were presented to the child. One of the pieces was then deformed. When the child made a prediction concerning the weights of the two pieces of plasticene, his prediction was tested on a scale balance. The second group was given training using scale balances, but in this group the amount of plasticene was changed by adding or taking away from one of the pieces. A third group served as a non-trained control. All three groups showed improvement on the posttest, but there were no statistically significant differences among groups.

The second experiment reported by Smedslung gives strong evidence that short-term training does not produce lasting results even where conservation is indicated by a posttest.[26] This experiment utilized two groups of subjects five to seven years of age. One group (N=13) consisted of children who conserved weight on a pretest. Another group (N=11) was made up of children who showed no conservation on a pretest, but who gave only correct conservation responses on a posttest. The two groups were then subjected to a modification of the training procedure. One of the plasticene objects was deformed. After the child made his prediction, a piece of the plasticene was surreptitiously taken before the child attempted to verify his pre-

[26] Ibid., III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance scale, pp. 85-87.

diction on a scale balance. This caused the results to be contrary to the conservation prediction. Those children who had attained conservation "normally" argued with the experimenter that something must have been taken away. The children who had been taught to conserve reverted in every case to non-conservation based on perceptual appearance of the objects.

Another experiment by Smedslund was designed to overcome or extinguish the reliance of a group of children on perceptual cues in weight conservation tests.[27] No control group was used. The training consisted of allowing each child in the group to manipulate and compare thirty-six objects of different sizes. The sizes of the objects did not correlate with their weights. It was thought by the experimenter that the children would discover that the larger objects do not always weigh more, thereby reducing their reliance on size as a perceptual cue on a weight conservation posttest.

The fifth article of the series reported on an experiment in which teaching of the conservation of substance was attempted in an unusual way.[28] Smedslund hypothesized that the essential condition for the development of conservation is a state of cognitive conflict--a condition in which the child's mental impression of a situation produces contrary conclusions in his thinking. To test this hypothesis,

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[27] Ibid., IV. An attempt at extinction of the visual components of the weight concept, pp. 153-155.

[28] Ibid., V. Practice in conflict situations without external reinforcement, pp. 156-160.

he subjected thirteen five-and-a-half to six-and-a-half-year-old children who had been determined on a pretest to be non-conservers to a complicated conflict-training procedure. The essence of the procedure was that two factors were varied simultaneously. For example, if a child believed that elongating a piece of plasticene increased its quantity, the experimenter would roll it into a sausage and subtract a piece. This procedure was designed to force the subject to take into account the addition or subtraction idea relative to the amount of substance originally present.

Five of the thirteen subjects consistently took into account primarily the addition and subtraction of plasticene. The other eight were influenced predominantly by the deformation. None of these eight showed conservation on a posttest. However, four out of the five who took the addition and subtraction into account showed posttest conservation. In a sixth experiment in which Smedslund used the cognitive-conflict technique, an experimental group did show a significant enhancement of conservation of quantity over a control group.[29]

An experiment was reported by Bruner in which an attempt was made to accelerate the acquisition of the conservation of liquid through experience with beakers of varying diameters and height.

The subjects, five- and six-year-olds, started with a standard beaker of water and poured the water back and forth from one beaker to

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[29]Ibid., VI. Practice on continuous versus discontinuous materials in conflict situations without external reinforcement, pp. 203-210.

the next. They learned empirically that in the thinner beakers the water rose higher and in the wider ones it would go down. Even though the children learned to predict which way the water would go, they fell back immediately into non-conservation when a standard beaker was used with six small ones.[30]

Another experiment reported by Bruner dealt with a comparison of three techniques used in attempting to teach the conservation of solid substances. Eighty-one first graders with a median age of seven years were chosen as subjects. Each child was determined in advance to be a non-conserver.[31] One group (N=41) was allowed to manipulate and transform pieces of clay themselves after which the child was questioned concerning the amount of clay. A second group (N=40) only watched a demonstrator manipulate the clay. Some of the children of each group were given labels that they could understand such as fatter, shorter, skinnier, to help describe the pieces of clay after transformation.

The overall results were quite satisfactory. Thirty-five out of eighty-one subjects learned conservation based on the criterion that a child gives a conservation answer on a posttest. The most revealing results, however, came from a comparison of the groups given different treatments. Twenty-two of forty-one children learned to conserve in the group which manipulated the clay themselves, whereas only thirteen

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[30]Jerome S. Bruner, Rose Oliver, and Patricia Greenfield, Studies in Cognitive Growth (New York: John Wiley and Sons, Inc.), p. 206.

[31]Ibid., pp. 222-224.

out of forty learned to conserve in the group which was given a demonstration. Another important fact was discovered when the group which manipulated the clay themselves was subdivided on the basis of whether or not labels were supplied. Sixteen out of twenty-one of the children from the group who manipulated the clay and to whom labels were supplied learned to conserve but only six out of twenty became conservers in the group which were not given labels. No appreciable difference was noted among the children in those groups which did not manipulate the clay. Apparently manipulation and labeling together are very effective!

Bielin and Franklin investigated the effects of instruction on length and area measurement.[32] Twenty-seven first graders with a mean age of six years and six months and thirty-three third graders with a mean age of eight years and eleven months were initially pretested for their ability to conserve and measure lengths and areas. Half of each grade group was then instructed in measurement concepts. The other received no training. The general intent of the instructor was to demonstrate and explain measurement by superposition and unit iteration methods as well as conservation of length and area. The general method was to ask questions of the children which would elicit the appropriate answers leading to measurement concepts which could then be generalized and applied to specific problems.

Both experimental and control groups showed improvement in

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[32]H. Bielin and I. Franklin, "Logical Operations in Length and Area Measurement: Age and Training Effects," Child Development (1962), pp. 607-618.

length measurement. Bielin and Franklin suggest that the pretest itself may have facilitated learning. In the case of area measurement, some improvement was shown by the third graders but the first graders showed complete lack of operational measurement before and after instruction.

While the studies reported do not exhause the literature, they do represent a major part of the most recent studies dealing specifically with acceleration of the attainment of the conservations. Other studies which were considered to deal only indirectly with the acceleration of the conservations and those related studies which were superceded by later investigations involving the same experimental method were not reviewed.

Although several of the studies reported some degree of success in enhancing the attainment of a particular conservation there were also some that were almost total failures. Considering the studies collectively, it appears that direct manipulative experiences by the children were more beneficial than demonstrations in accelerating conservation and, in general, a variety of manipulative experiences in combination with reinforcement were more helpful than single specific experiences. Demonstrations alone appear to be ineffective![33]

Another factor which apparently was not included in any of the studies was that of duration of training. Lovell believes that if

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[33]Edward A. Chittenden, "Piaget's Researches and Science Experiences for Young Children," National Science Teachers Association Address (Detroit, Michigan: March 18, 1967).

the training period lasted over a longer period (five months or longer), more lasting effects would be produced.[34] This suggests that a period of education which provided multiple experiences over a period of several months might prove very effective toward acceleration of the conservations.

What kinds of experiences are needed? Almy has this to say:

> " . . . it is interesting to note that most studies reported in the literature to date have worked with what seem to be the elements immediately involved in the conservation task, such as addition and subtraction or reversibility, rather than with what may well be the developmentally prior abilities of classifying and ordering. . . . Piaget's work would suggest that children who have had many opportunities to classify objects on the basis of similar properties, to order along dimensions of difference, or better, opportunities of both kinds, might arrive at a level of operational thought represented in conservation sooner than children who have not had such opportunities."[35]

Based on the results of the studies reviewed and their analyses, and on the opinions of the authorities quoted, the teaching method which would most likely be successful in accelerating the conservations would (1) be of several months' duration, and (2) provide more general experiences designed to provide a variety of different kinds of experiences in which the child experiments with objects from his environment and which provide the necessary prior abilities of classifying and ordering, and (3) supply necessary labels as needed to enhance understanding of the learner.

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[34]Lovell, op. cit., p. 152.

[35]Almy, op. cit., pp. 125-126.

The program selected to provide the "training" or experience for this study consisted of the regular first year science program of the Science Curriculum Improvement Study (SCIS) developed at the University of California at Berkeley.[36] This program was chosen because it satisfied all three criteria listed previously as those most likely to accelerate the attainment of the conservations. (1) The first year program of SCIS is designed to extend over most of the school year, and (2)

> " . . . confronts the elementary school children with firsthand experiences of natural phenomena and with intellectual challenges that will stimulate their further cognitive development."[37]

The experiences of the program are in describing, grouping on the basis of property, serial ordering, and making generalizations and predictions. Emphasis is on activities with real objects rather than pictures or words. (3) The SCIS program includes two distinctly differend kinds of lessons.

> "One kind introduces or 'invents' a new concept, while the other kind is designed to help the children discover the usefulness of the new concept. The invention lesson provides guided practice in using new labels and categories."[38]

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[36]Science Curriculum Improvement Study is a program sponsored by the National Science Foundation, directed by Dr. Robert Karplus, which is developing an inquiry-centered science program for grades K-6.

[37]Robert Karplus, One Physicist Looks at Science Education (Science Curriculum Improvement Study: Berkeley, University of California, 1963), p. 6.

[38]Willard Jacobson and Allan Kondo, op. cit., p. 31.

The SCIS Elementary Science Sourcebook, designed to help teachers implement the program, states the following as a goal of the SCIS program:

> "The SCIS program aims to nurture the ability to discover new relationships and to think imaginatively, at the same time as it facilitates the transition from preoperational to operational thought."[39]

Statement of the Problem

The problem investigated was:

Is there a significant difference in the rate of achievement of conservation as described by Piaget between children who use the first grade program of the Science Curriculum Improvement Study and those who do not have this experience? The particular conservation areas dealt with in the investigation were those of length, number, liquid amount, solid amount, weight and area. The evidence for conservation or nonconservation was based on linguistic judgment rather than conservation-in-action which Bruner says comes at a far earlier age.[40] Linguistic judgment as it is used here refers to the verbalization of a formulated mental evaluation. Conservation-in-action refers to manipulative comparisons such as demonstrating that one set containing a given number of objects is that same as another by matching them on an object-to-object basis.

Verbal conservation or linguistic judgment was chosen because

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[39] *Ibid.*, p. 31.

[40] Bruner, Oliver, and Greenfield, *op. cit.*, p. 325.

the tasks used in the testing for verbal conservation are rather standard and will not require validation.

Significance of the Study

It has already been noted that achievement of the conservations plays a very important role in developing the ability to think or use logical processes, which has been proposed as the central purpose of American education. In addition to this rather general although tremendously important acquisition, there are specific areas of the curriculum which have been shown to be dependent on conservation ability. A study conducted by Millie Almy caused her to draw these conclusions:

> " . . . the findings in our studies of a rather substantial correlation between performance in conservation tasks and progress in beginning reading suggests that, to some extent, similar abilities are involved. A program designed to nurture logical thinking should contribute positively to reading readiness."[41]

> "The correlations between progress in conservation and the various measures of mental aptitude and achievement are substantial enough to indicate that the child's ability to conserve is relevant to the tasks he encounters in the classroom."[42]

Mary Rowe, Teachers College, Columbia University, working with socially and culturally deprived children in the ghettos of New York City, has found that one of the areas of greatest difference between ghetto children and the rest of society is in the use of language, and

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[41] Almy, *op. cit.*, p. 139-140.

[42] *Ibid.*, p. 105.

that this deficiency will have a negative effect on the development of conceptual skills. It is the opinion of Dr. Rowe, based on her experiences, that language development goes much faster when a child has experiences with interesting concrete phenomena where such activities as comparison, sorting, and description are emphasized.[43] Although Dr. Rowe did not specifically attach achievement of the conservations to the language development, the activities that she suggested are the same as those previously recommended as the ones needed to accelerate the conservations.

For the reasons given above, it would certainly be of great interest to educators, psychologists and curriculum development personnel to learn whether or not an extended period of experiences such as those provided by the Science Curriculum Improvement Study course does significantly enhance the attainment of the conservations and verbal development.

Hypotheses Tested in the Study

The major hypothesis in the study was:

There is no significant difference in the rate of attainment of the conservations by pupils who take the Science Curriculum Improvement Study first grade course and pupils who do not take the course.

In addition to the general hypothesis, which will be tested by analyzing the overall test results, the following sub-hypotheses were

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[43] Mary Budd Rowe, "Science Curriculum Improvement Study in the Inner City School," SCIS Newsletter, No. 11 (Berkeley: Regents of the University of California, Winter, 1968), p. 6.

tested:

1. There is no significant difference in the rate of attainment of the conservation of number by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

2. There is no significant difference in the rate of attainment of the conservation of liquid amount by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

3. There is no significant difference in the rate of attainment of the conservation of solid amount by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

4. There is no significant difference in the rate of attainment of the conservation of weight by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

5. There is no significant difference in the rate of attainment of the conservation of length by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

6. There is no significant difference in the rate of attainment of the conservation of area by pupils who take the Science Curriculum Improvement Study first grade course and those who do not.

Because of the nature of the study and its educational implications, i.e., it is examining the possibility that the particular course of study might produce special benefits in addition to those stated specifically as goals of the program and not to determine whether it is a good or poor educational program for children, a type-one error, rejecting a true hypothesis, is not as costly as a type-two error might be. For this reason, a statistical rejection level of the hypotheses is not stated for the data relating specifically to the acceleration of the conservations. The statistical values will be used, however, as a factor in the acceptance or rejection of the hypotheses stated.

CHAPTER II

SELECTION OF THE SAMPLE AND ADMINISTRATION OF THE CONSERVATION TESTS

Selection of the Sample

Experimental and control samples each consisting of sixty first grade children were selected from elementary schools of the Norman, Oklahoma, school system. In order to, as nearly as possible, achieve equal samples, conferences were held with Lester Reed, Norman Superintendent of Schools and Hershell Morris, Norman Elementary Science Supervisor. Selection of the schools from which the samples were taken was based on the advice of these two men, who had a broad and intimate knowledge of each school's teaching staff and also the social and economic structure of the neighborhoods from which the children in each school came. The schools which were selected offered essentially the same first grade program except for science. The experimental sample was taken from three schools which used the Science Curriculum Improvement Study first grade curriculum; the control group was taken from two schools which used a traditional science program.

The experimental and control samples were selected in the following manner. Each teacher whose class was selected submitted an alphabetical class roster which listed the members of her class by sex. Every odd-numbered name on the roster was taken from each list until five boys and five girls were selected. No attempt was made to correlate chronological or mental age within or among groups of the samples during their selection. These facts were recorded only after the investigation was completed and they were then used in the analysis of the data.

Testing of the Samples

During the period January, 1967, to August, 1968, the investigator developed various tests which were designed to measure conservation. These tests were administered to scores of children in first and second grades in Cleveland Elementary School, Norman, Oklahoma, and first grade in Tyler Elementary School, Oklahoma City, Oklahoma. The purpose of this testing was to practice the personal interview technique and to discover which questions concerning conservation actually gave the child the correct understanding of what the interviewer wanted to know and to develop technique in asking these questions. Most of the tests developed by the investigator were ultimately discarded after certain weaknesses became apparent in them when they were used to test children. The six tests eventually selected for use were those used by Piaget and other investigators and are therefore reasonably standard conservation tests. All children participating in this investigation were tested by the investigator.

A pretest was given to experimental and control groups in September during the second week of the fall school term. This test consisted of conservation tests in number, liquid amount, solid amount, weight, length and area. Posttests, which were identical to the pretests, were administered in January at the end of the first semester of school. During the testing the children were not prompted as to the correctness of their responses since this might possibly enhance the training effects of the test. Also, only two categories of responses were recorded for each conservation test--conserver or non-conserver.

Description of Conservation Tests Used

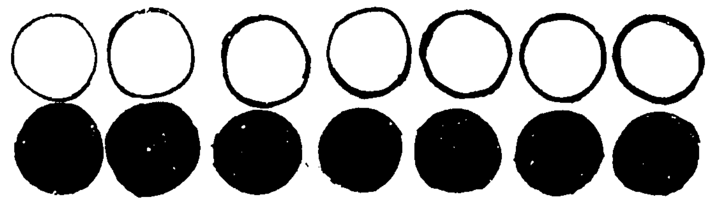
The child was seated at a table on which clay, checkers and various other materials used in the tests were placed. The tester would then say, "I would like for you to help me by answering the questions I am going to ask you about these objects. You may touch any of the objects we are talking about if you want to and I want you to tell me just what you think when I ask a question." Each child was given as much time as he wanted to think before replying to a question.

The individual tests were conducted in the following manner:

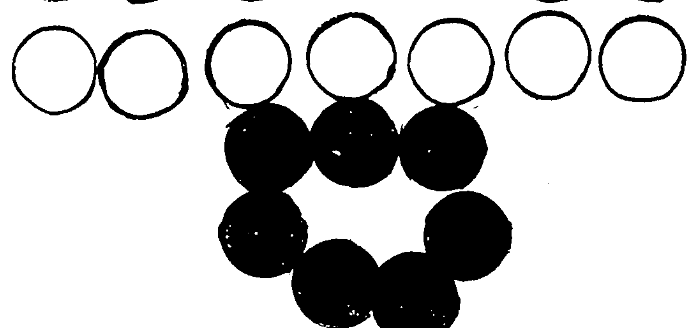
1. Conservation of Number: A stack of red and a stack of black checkers were placed in front of the child. The child was then told that the tester was going to form a row of black checkers and that each time the tester placed a checker into the row, the child was to place a red checker alongside it so the two rows would contain the same number of checkers. Seven checkers of each color were used to make each row (see arrangement A following) so that the child could count them if he desired. After completion of the row, the tester asked the child if each of the two rows contained exactly the same number of checkers. When the child agreed that each row did contain the same number of checkers, the tester would then rearrange the black

checkers to form a circle (see arrangement B following) and again ask if the numbers of black and red checkers were the same. If the child indicated that the numbers of checkers were still the same, this was taken as adequate evidence that he conserved number.

Arrangement A



Arrangement B

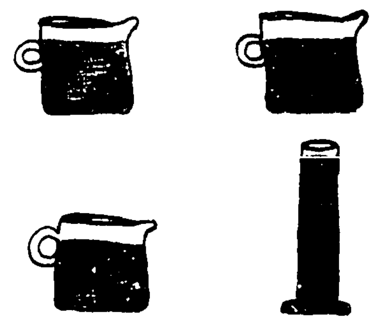


2. <u>Conservation of Liquid Amount</u>: Three glasses, two wide measuring glasses of equal size marked in one-eighth cup gradations and one tall narrow unmarked cylinder were used in this test. The two wide glasses were filled to the one cup mark with red colored water. The child was then told, "Let's pretend we are having a party and this is your kool-ade and this one is mine. Do we have the same amount to drink?" If the child asserted that each glass did contain the same amount, the test continued. If the child suggested that one glass contained more or was not certain, he was asked to add or take away liquid until he felt certain they were the same (see arrangement A following). At this point, the tester poured his glass of kool-ade into the tall narrow cylinder (see arrangement B following). He then repeated the question, "Do we each have the same amount to drink now?"

An affirmative answer was taken as evidence that the child conserved liquid amount.

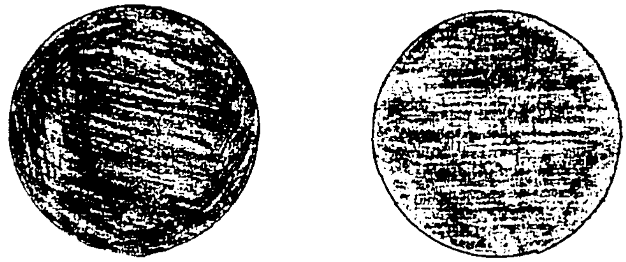
Arrangement A

Arrangement B



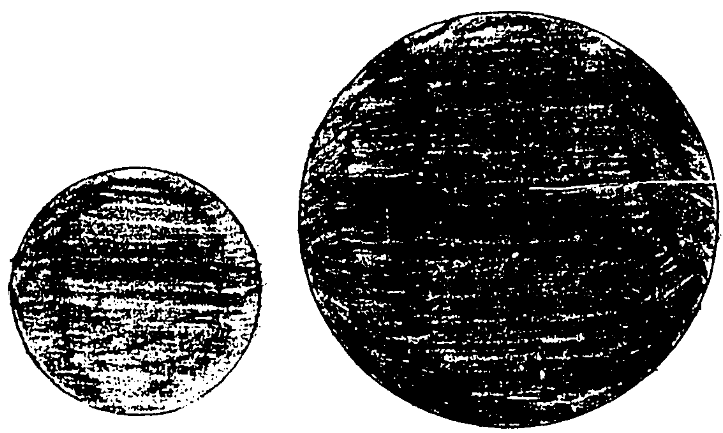
3. <u>Conservation of Solid Amount</u>: Two balls of red plasticene were placed in front of the child. The child was then told to imagine that this was something very good to eat and was told, "This is your piece to eat and this one is mine. Do we each have the same amount to eat?" If the child agreed that each ball contained the same amount, the test continued. If he did not believe the two amounts were the same, he was requested to take from one ball and add to the other until they contained the same amount to eat. When the child had decidid that each ball contained the same amount to eat, the tester would take one ball and, in full view of the child, flatten it into a pancake shape and again place it alongside the ball. Pointing to the pancake-shaped piece of plasticene, the tester would say, "This is my piece to eat and that one is yours. Do we have the same amount to eat?" An affirmative answer was considered to be adequate evidence that the child conserved solid amount.

Arrangement A



Cross sectional view Cross sectional view

Arrangement B

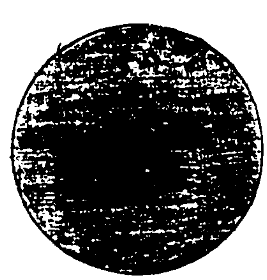


Cross sectional view Top view

Cross sectional view

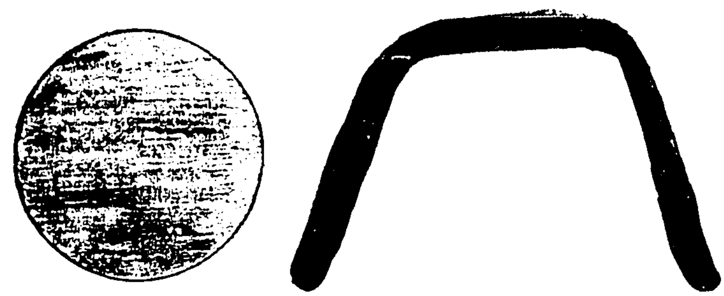
4. Conservation of Weight: Two balls of blue plasticene approximately the same size were placed in front of the child. One ball was then handed to the child with the question, "Is it pretty heavy?" When the child's attention was considered to be focused on the heaviness of the ball, the second ball of plasticene was handed to the child with this question from the tester, "Is this ball just as heavy as the other one or is one ball heavier than the other?" If the child agreed that the balls were equally heavy, the test continued. If the child asserted that one ball was heavier, he was asked to take from one ball until they were equally heavy. After the child had decided that each ball was equally heavy, the tester would take one ball and, in full view of the child, form the plasticene into a bowl. The tester then placed the bowl open side down in front of the child and beside the ball. He then asked, indicating each object in turn by placing his finger on it, "Is this one just as heavy as this one, or is one of them heavier?" The child was allowed to pick up the pieces of plasticene if he wanted to for comparison (and almost all did). If the child's reply indicated that he believed the two objects still weighed the same, this was taken as evidence that he conserved weight.

Arrangement A



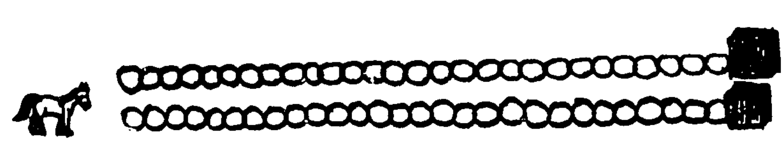
Cross sectional view

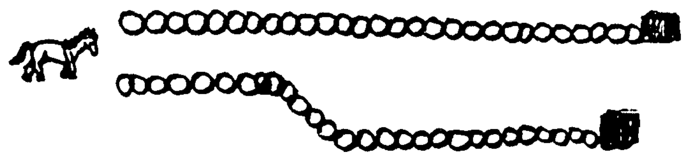
Cross sectional view

Arrangement B 

Cross sectional view   Cross sectional view

5. <u>Conservation of Length</u>: The materials for this test consisted of two identical strings of beads, a small plastic horse, and two cubes of wood. The two strings of beads were laid side by side on the table in front of the child so that the ends matched. The child's attention was called to the fact that it was just as far from the end of one string of beads as it was from the other. The child was then told, "Let's pretend that each string of beads is a road. I am going to place hay at the other end. If the horse walks down either of the roads, it would be just as far to the hay." (See arrangement A following.) When the child had agreed that the distance was the same, the tes er then bent one string of beads as shown in Arrangement B following and asked, "Now, if the horse must follow the road, would he have to walk as far to the hay on one road as on the other?" If the child stated that the horse had to travel the same distance in either case, this was taken as evidence of conservation of length.

Arrangement A 

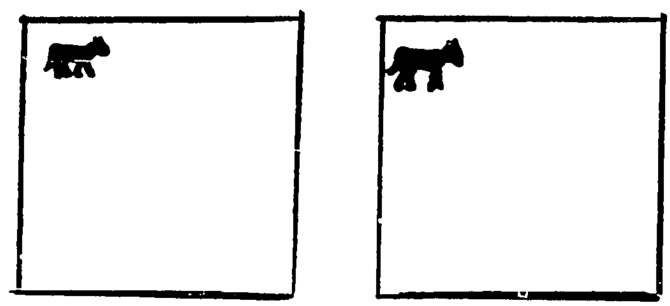


Arrangement B

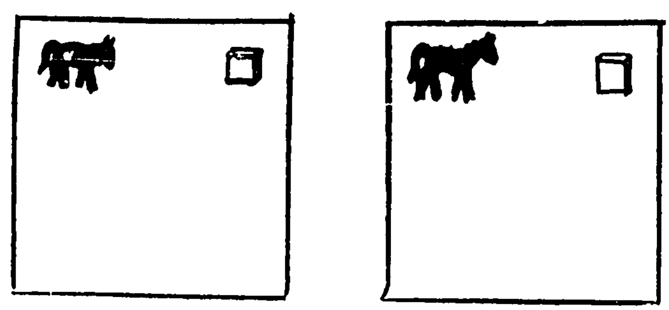
6. Conservation of Area: The materials for this test were two sheets of green poster board, each one foot square, two plastic horses, and six red cubes three-fourths of an inch on each edge. The two sheets were placed in front of the child one stacked on the other to show they were equal in size. The sheets were then separated and placed in front of the child. The tester then told the child, "Let's pretend that each of these is a patch of grass and there is just as much grass on one patch as the other." A small plastic horse was placed in the same position on each board with the comment, "Each horse may eat all of the grass in his patch if he wants to and one has just as much to eat as the other. (See arrangement A following.) Now I'm going to build a barn on each patch of grass and cover up some of it so that the horse can't get to it. (See arrangement B following.) Is there just as much grass left for one horse to eat as the other?" If an affirmative answer was given at this point the test continued. If a negative answer was given and maintained after the test was repeated to this point, as it was in two instances, the child was listed as a non-conserver. Those children who answered affirmatively were then told, "I am going to build two more barns on each patch of

grass, but I am going to build them beside the first barn on one patch of grass, and spread them out on the other patch. (See arrangement C following.) Does each horse still have the same amount of grass to eat or does one have more than the other?" An answer indicating that each horse still had the same amount of grass to eat was accepted as evidence that the child conserved area.

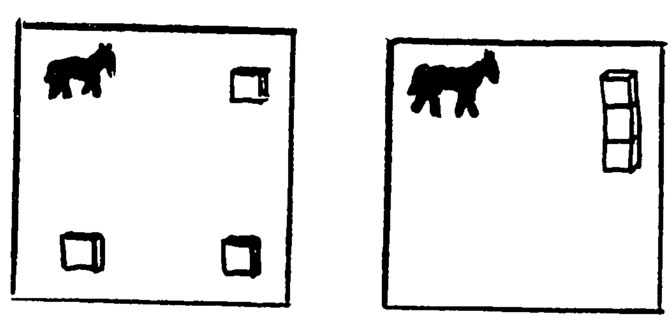
Arrangement A



Arrangement B



Arrangement C



Record of Test

A record was kept by the tester for each child during both the pretest and posttest by indicating with a check in the proper blank whether the child was a conserver or a non-conserver. A sample data sheet is shown below.

Name__________________ School__________________

Test 1 (Pretest)	Conserver	Non-conserver	Date__________
Number	____	____	Time of day
Weight	____	____	__________
Liquid Amount	____	____	Comments:
Solid Amount	____	____	
Length	____	____	
Area	____	____	

Test 2 (Posttest)	Conserver	Non-conserver	Date__________
Number	____	____	Time of day
Weight	____	____	__________
Liquid Amount	____	____	Comments:
Solid Amount	____	____	
Length	____	____	
Area	____	____	

In addition to the data collected during the tests, certain information of a personal or confidential nature was supplied by each child's teacher from school records. This information is given in the data section (Chapter III) and was used in the analysis of data section (Chapter IV). The children are designated in Tables I and II of Chapter III by numbers only since much of the data listed is of a confidential nature. A sample personal data sheet filled out by the teacher is shown below.

Name ______________________________ Number ______

Date of birth ______________________ Boy ____ Girl ____
Month Day Year

I.Q. ________ Name of I.Q. test used ________________

Date I.Q. test was given ______________ Mental age ______

Number of other children in the family ________

Older ________ Younger ________

Occupation of parents: Father ______________________

Mother ______________________

Number of months of kindergarten ________

Readiness test total score ________ Percentile ______

Name of readiness test used ______________________

Statistical Analysis

Since the data were discrete and divided easily into two-by-two contingency tables (as indicated on the following page) to yield the desired comparison of the variables, the statistical tests of significance were made with Chi Square using the following equations:

1. For calculations in which no cell contains fewer than 20, the formula $\frac{N\,(AD-BC)^2}{(A+B)(B+D)(C+D)(A+C)}$ was used.

2. For calculations in which there are cell values less than 20, the formula $\frac{N\,(AD-BC-\frac{N}{2})}{(A+B)(B+D)(C+D)(A+C)}$ was used.

Contingency Table

	Experimental sample	Control sample	
Number conserving on task	A	B	A+B
Number non-conserving on task	C	D	C+D
	A+C	B+D	N

The letters used in the equations for Chi Square have meaning relative to the contingency table as follows:

A is the cell value representing the number of children in the Experimental sample who conserved on the particular conservation task.

B is the cell value representing the number of children in the Control sample who conserved on the particular conservation task.

C is the cell value representing the number of children in the Experimental group who did not conserve on the particular conservation task.

D is the cell value representing the number of children in the Control sample who did not conserve on the particular conservation task.

A+B is the sum of the two cell values representing the total number of children who conserved on the particular conservation task.

C+D is the sum of the two cells representing the total number of children who conserved on the particular conservation task.

A+C is the sum of the two cells representing the Experimental group--those who conserved plus those who did not.

B+D is the sum of the two cells representing the Control group--those who conserved plus those who did not.

N is the sum of the Experimental and Control samples, or the total number of children involved in the comparison.

CHAPTER III

PRESENTATION AND DISCUSSION OF THE DATA

The data collected during this investigation were for the purpose of comparing the Experimental and Control samples in terms of their background and mental abilities and to determine if the experiences with the first grade science program of the Science Curriculum Improvement Study which the Experimental group experienced helped them achieve conservation skills at a faster rate than the Control group. Certain other relationships, although they do not bear directly on the primary purposes of the investigation, are of interest and can also be studied using the data. The data, therefore, with the exception of raw data in Tables I and II, are presented and discussed in two separate sections.

The data in Section A are presented and discussed in the following manner and order.

A. Raw data are given in tabular form (Tables I and II) with no discussion except for an explanation of abbreviations or terms used.

B. Cumulative data tables (Tables III, IV and V) are provided which show simple sums, differences and averages from standard tests administered by the school, background information from school records, and conservation tests administered by the investigator. Data from two of these tables are presented in graphical form to enhance the visual comparison. Each table is discussed individually.

C. Calculated numerical values of Chi Square and the level of confidence in their statistical significance are presented for each conservation area and for the total increase in conservations by the samples in Table VI.

Section B data consist of tables relating the rate of attainment of conservation to the variables of I.Q., Readiness test scores, sex, and kindergarten attendance.

Section A

The raw data given in Tables I and II below were taken from information provided by the teacher from school records and results of the conservation tests administered by the author. Table I contains information on the children from the Experimental sample; Table II contains information on the Control sample. I.Q. scores for both samples were determined using the Otis-Lennon test; Readiness scores were determined using the Metropolitan Readiness Test Form B.

The abbreviations or symbols at the top of each column which are not self-explanatory are interpreted in this way:

Pupil number is a means of identifying each child and has no other significance.

K is listed as X for those who attended a kindergarten class for two months or more (Head Start was not counted); O indicates less than two months or no kindergarten.

R refers to the sum of the scores of word meaning, listening, matching, alphabet, numbers and copying.

M.A. refers to the mental age in months of the child at the time Otis-Lennon was administered.

C.A. refers to the chronological age in months at the time of the pretest.

N, W, Li, S, Le, A refer to the six conservation tests given by the investigator. (N) number, (W) weight, (Li) liquid amount, (S) solid amount, (Le) length, and (A) area. (I) is the symbol for test 1 or pretest; (II) is the symbol for test 2 or posttest. (X) is used to designate conservation; (0) is used to designate non-conservation.

Table I
Raw Data for Control Group

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
49	F	X	86	111	94	82	0	0	0	0	0	0	0	0	0	0	0	X
48	F	X	86	111	94	82	0	0	0	0	0	0	X	0	0	0	0	X
54	F	X	57	96	70	72	0	0	0	0	0	0	0	0	X	0	0	X
51	F	X	83	84	71	83	X	0	0	0	0	0	X	0	0	0	0	X
52	F	0	70	97	80	80	0	0	0	0	0	X	X	0	0	0	0	X
56	F	X	73	105	84	77	0	0	0	0	0	0	0	0	0	0	0	0
130	F	0	40	84	60	71	0	0	0	0	0	0	X	0	0	0	0	0
131	F	X	60	89	70	77	0	0	0	0	0	0	X	0	X	X	X	X
135	F	0	68	95	77	80	0	0	0	0	0	0	0	0	0	0	0	0
132	F	X	54	93	68	72	0	0	0	0	0	0	0	0	0	0	0	0
133	F	X	59	104	80	76	X	0	0	0	0	0	X	0	0	0	0	0
136	F	X	21	73	57	78	0	0	0	0	0	0	0	0	0	0	0	0
42	F	0	65	102	82	79	0	0	0	0	0	X	0	0	0	0	0	X
45	F	X	80	102	84	81	0	0	0	0	0	0	0	0	0	0	0	X
43	F	X	83	120	104	83	X	0	X	X	0	X	X	X	X	X	0	X
44	F	X	79	120	101	80	X	0	0	0	0	0	X	X	X	X	X	0
69	F	X	78	123	94	73	0	0	0	0	0	0	X	0	0	0	0	0
73	F	X	89	107	90	80	0	0	0	0	0	X	X	0	X	X	0	X
125	F	X	58	90	65	72	0	0	0	0	0	0	X	0	0	X	0	X
68	F	X	83	107	90	80	X	0	0	0	0	0	X	0	X	X	0	X
71	F	X	51	89	67	74	0	0	0	0	0	0	X	0	0	0	0	0

Table I (cont.)

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
61	F	X	67	103	79	76	0	0	0	0	0	0	X	0	0	0	X	X
62	F	X	62	115	94	77	0	0	0	0	0	0	X	0	0	0	0	0
58	F	0	51	95	69	71	0	0	0	0	0	0	0	0	0	0	0	0
64	F	X	75	118	96	78	0	0	0	0	0	0	X	0	X	0	0	0
65	F	X	88	114	96	81	0	0	0	0	0	0	X	0	0	0	0	0
86	F	X	77	107	90	81	X	0	0	0	0	0	X	X	0	X	0	X
84	F	X	50	98	69	70	0	0	0	0	0	0	0	0	0	0	0	X
81	F	X	54	103	76	72	0	0	0	0	0	0	0	0	0	0	0	0
80	F	X	81	122	84	75	X	0	0	0	0	0	X	0	0	X	0	X
78	F	X	60	115	115	72	X	0	X	X	0	X	X	0	X	X	0	X
50	M	X	79	124	104	80	0	0	0	0	0	0	0	0	0	0	0	0
47	M	X	66	109	92	81	0	0	0	0	0	0	0	0	0	0	0	0
53	M	X	80	113	88	75	0	0	0	0	0	0	X	0	0	X	X	X
55	M	X	64	98	82	82	0	0	0	0	0	0	0	0	0	0	0	0
126	M	0	58	97	76	77	0	0	0	0	0	0	0	0	0	X	0	0
127	M	X	40	108	80	71	0	0	0	0	0	0	0	0	0	0	0	0
134	M	0	88	97	92	92	X	0	0	0	0	X	X	0	X	0	X	X
128	M	0	58	97	73	75	0	0	0	0	0	0	X	0	0	0	X	X
123	M	X	74	131	108	77	0	0	0	0	0	0	X	X	X	X	X	X
124	M	X	55	115	86	71	0	0	0	0	0	X	0	0	0	0	0	X
41	M	0	63	99	72	74	0	0	0	0	0	0	0	0	0	0	0	0
46	M	X	65	115	94	77	0	0	0	0	0	0	X	X	X	X	X	X

Table I (cont.)

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
129	M	X	81	135	108	74	0	0	0	0	0	X	X	0	X	X	0	X
70	M	0	29	98	77	78	0	0	0	0	0	0	X	0	X	X	0	X
74	M	X	80	120	101	81	X	0	X	X	0	0	X	X	X	X	0	X
67	M	X	62	111	86	76	0	0	0	0	0	0	X	0	0	0	0	0
72	M	X	25	92	67	73	0	0	0	0	0	X	0	0	0	0	0	0
75	M	0	24	83	57	82	0	0	0	0	0	X	0	0	0	0	0	X
76	M	X	74	97	80	82	0	0	0	0	0	X	X	0	0	X	0	X
59	M	X	75	109	84	75	0	0	0	0	0	0	0	0	0	0	0	X
60	M	X	76	127	104	79	X	X	0	0	0	0	X	X	X	X	0	0
57	M	X	73	121	98	77	0	0	0	0	0	0	X	0	0	0	0	0
63	M	0	45	82	64	78	0	0	0	0	0	0	0	0	0	0	0	0
66	M	[illegible]	77	117	98	81	0	0	0	0	0	0	X	0	0	0	0	X
85	M	X	82	111	86	75	X	0	X	X	0	X	X	X	X	X	X	X
83	M	X	46	105	77	71	X	0	0	0	0	0	0	0	0	0	X	X
82	M	X	46	126	96	71	0	0	0	0	0	0	X	0	X	X	X	X
79	M	X	83	124	101	78	X	0	0	0	0	0	X	0	X	X	0	X
77	M	X	80	119	90	73	X	0	X	X	0	X	X	0	X	X	0	X

Sample size = 60

Table II
Raw Data for Experimental Group

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
19	M	X	39	86	70	80	0	0	0	0	0	0	X	0	0	0	0	0
4	M	0	34	91	69	76	0	0	0	0	0	0	0	0	0	0	0	0
97	M	X	46	90	60	71	0	0	0	0	0	0	0	0	0	0	0	0
91	M	0	45	102	82	78	0	0	0	0	0	0	0	0	0	0	0	0
116	M	X	70	105	84	78	0	0	0	0	0	X	0	0	0	0	0	X
121	M	X	58	92	67	72	0	0	0	0	0	0	0	0	0	0	0	0
100	M	X	53	111	86	75	0	0	0	0	0	0	X	X	0	X	0	X
90	M	0	54	89	70	79	0	0	0	0	0	0	X	X	0	0	0	0
98	M	X	41	101	77	76	0	0	0	0	0	0	X	0	X	X	X	X
96	M	0	58	100	79	79	0	0	0	0	0	0	X	0	X	X	0	X
33	M	0	77	103	86	82	0	0	0	0	0	X	X	0	X	X	X	X
20	M	X	55	102	82	77	0	0	0	0	0	0	X	0	X	X	X	X
110	M	X	87	131	108	77	X	0	0	X	X	0	X	X	X	X	X	X
25	M	0	64	113	92	79	X	0	0	0	0	X	X	X	X	X	X	X
23	M	X	73	117	98	82	0	X	0	0	0	0	X	X	X	X	X	X
17	M	0	40	81	66	81	X	0	X	0	0	0	X	0	X	X	0	X
106	M	X	58	113	86	75	0	0	X	0	0	0	X	0	X	X	X	0
18	M	X	78	126	96	73	X	X	X	X	0	0	X	X	X	X	X	X
15	M	X	80	107	90	82	0	0	0	0	0	0	X	0	0	X	0	X
21	M	0		79	61	79	0	0	0	0	0	0	X	0	0	0	0	0
109	M	0	63	103	83	77	0	0	0	0	0	X	X	0	0	0	0	X

Table II (cont.)

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
120	M	X	83	102	84	80	X	0	0	0	0	0	X	0	0	X	X	X
29	M	X	61	115	86	73	X	0	0	0	0	0	X	0	0	0	X	0
119	M	X	61	100	76	75	0	0	0	0	0	0	X	0	0	X	X	0
2	M	X	64	107	83	76	0	0	0	0	0	0	X	0	0	0	0	0
1	M	X	65	102	82	77	0	0	0	0	0	0	X	0	0	0	0	X
103	M	X	59	117	92	75	0	0	0	0	0	0	X	0	0	0	0	X
87	M	X	34	97	76	75	X	0	0	0	0	0	X	0	0	0	0	0
89	M	X	60	101	77	76	0	0	0	0	0	0	X	0	0	0	0	0
115	M	X	43	87	63	72	0	0	0	0	0	0	X	0	0	0	X	0
118	M	0	50	101	77	76	0	0	0	0	0	0	X	0	0	0	0	0
39	F	X	63	115	94	77	0	0	0	0	0	0	X	X	0	X	X	0
95	F	X	79	115	94	78	X	0	0	0	0	0	X	X	0	X	X	0
105	F	X	58	89	72	81	0	0	0	0	0	0	X	0	0	0	0	0
102	F	0	67	108	80	73	0	0	0	0	0	0	X	0	0	0	X	0
99	F	0	48	90	68	74	0	0	0	0	0	0	X	0	0	0	0	X
88	F	0	53	86	70	80	0	0	0	0	0	0	X	0	0	0	X	X
113	F	X	73	126	84	76	0	0	0	0	0	0	X	0	0	0	0	0
35	F	X	39	103	83	79	0	0	0	0	0	0	X	0	0	0	X	0
12	F	X	46	107	86	77	X	0	0	0	0	X	X	0	0	0	X	X
114	F	X	86	103	82	82	X	0	0	0	0	0	X	0	0	0	X	X
5	F	X	71	103	83	77	0	0	0	0	0	0	0	0	0	0	0	0
92	F	X		88	69	79	0	0	0	0	0	0	0	0	0	0	0	0

Table II (cont.)

Pupil No.	Sex	K	R	I.Q.	M.A.	C.A.	I N	I W	I Li	I S	I Le	I A	II N	II W	II Li	II S	II Le	II A
117	F	O	29	84	60	77	O	O	O	O	O	O	O	O	O	O	O	O
27	F	X	41	82	64	79	O	O	O	O	O	O	O	O	O	O	O	O
112	F	X	80	105	77	71	X	X	X	O	O	O	X	X	X	X	X	O
101	F	X	75	119	90	73	X	O	O	X	O	O	X	X	X	X	X	X
111	F	O	17	69	53	77	O	O	O	O	O	O	O	X	X	O	X	X
11	F	X	83	115	90	76	O	O	O	O	O	O	X	X	X	X	X	X
93	F	X	63	107	90	82	O	O	O	O	O	O	X	X	X	X	X	X
6	F	X	61	105	77	71	O	O	O	O	O	O	X	O	X	X	O	X
3	F	X	88	125	98	75	O	O	O	X	O	O	X	O	X	X	X	X
122	F	X	85	115	94	79	O	O	O	O	O	O	X	O	X	O	X	X
104	F	O	55	103	79	75	O	O	O	O	X	O	X	O	X	O	X	O
94	F	X	48	87	68	77	O	O	O	O	O	O	X	O	X	O	O	O
16	F	O	85	139	112	74	O	O	O	O	O	O	X	O	X	X	O	O
31	F	X	69	107	90	80	O	O	O	O	O	O	X	O	X	X	X	X
37	F	X	69	115	94	79	O	O	O	O	O	O	X	O	X	X	X	X
13	F	O	27	83	63	74	O	O	O	O	O	O	X	O	X	O	O	X
14	F	X	68	128	101	75	X	O	X	X	X	X	X	O	X	X	X	X

Sample size = 60

Comparison of Experimental and Control Groups
on the Data Provided by the Teacher

Data	Experimental Group	Control Group
Average I.Q., Otis-Lennon	103.2	106.2
(Above average group) Number of children in sample with I.Q. above 111	17	21
(Average group) Number of children in sample with I.Q. between 88 and 111	33	34
(Below average group) Number of children in sample with I.Q. below 88	10	5
Number of children who attended kindergarten	42	48
Number of children in sample with readiness scores above 76 (superior)	12	21
Number of children in sample with readiness scores between 64 and 76 (high normal)	12	14
Number of children in sample with readiness scores between 45 and 63 (average)	23	19
Number of children in sample with readiness scores between 24 and 44 (low normal)	12	5
Number of children in sample with readiness scores below 24 (low)	1	1
Average score on Readiness test	59.23	65.60
Number of children with older brothers or sisters at home	37	40
Average chronological age in months at time of first test	76.83	77.00

Information tabulated in Table III suggests that although the schools were as carefully matched as possible in the opinions of officials from within the school system, the Control has a slight advantage in almost every area of comparison. The average scores on both I.Q. and Readiness tests favor the Control group. The number of children with above average I.Q. is higher and the number of children with below average I.Q. is lower in the Control group. The number of children in the superior Readiness score range for the Control group is almost twice that of the Experimental group; the number of children in the low normal range for the Experimental group is almost two and one-half times that of the Control group.

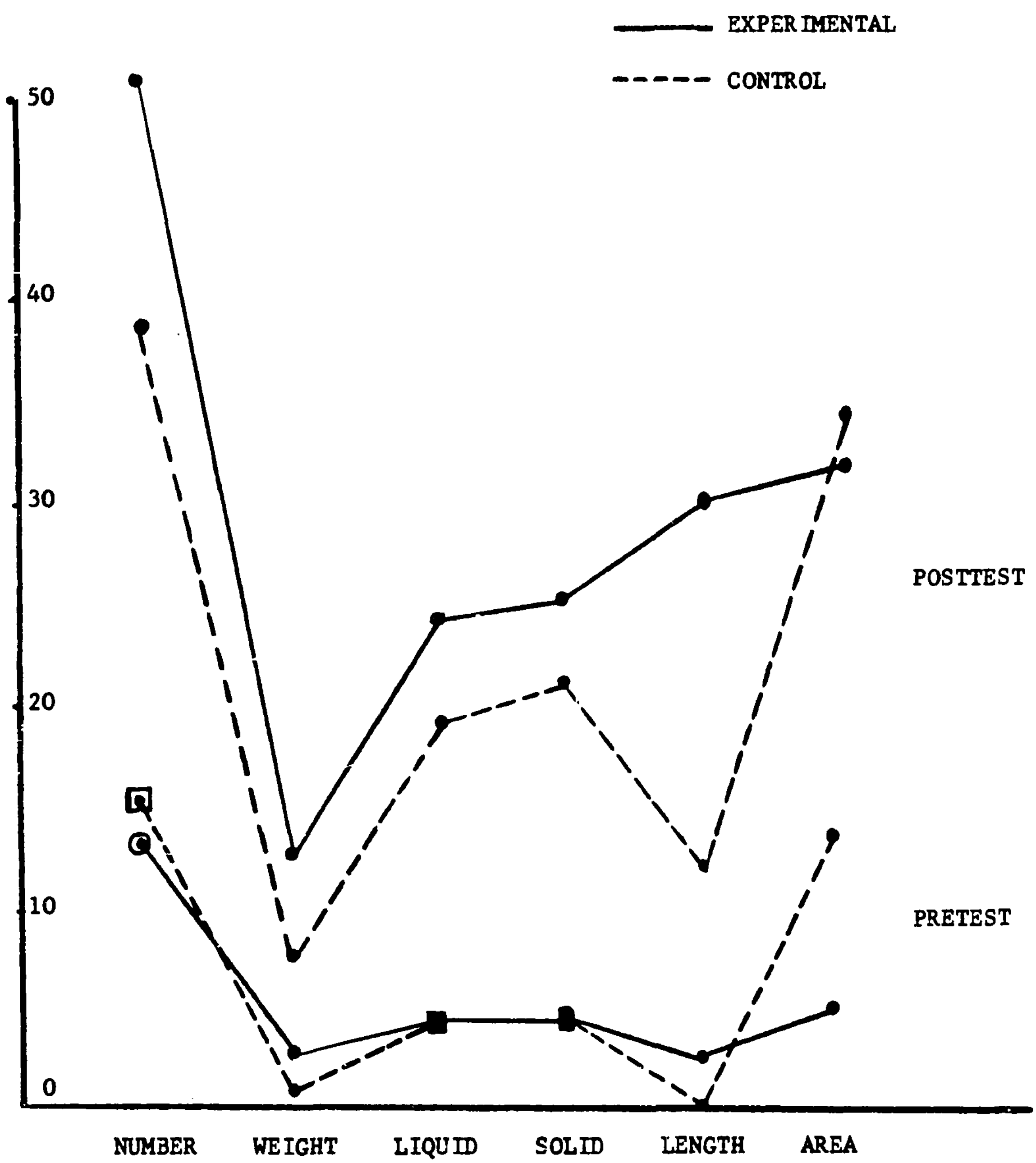
Table IV
Pretest and Posttest Totals for
Experimental and Control Groups

Conservation Area	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Number	13	50	15	37
Weight	3	13	1	8
Liquid amount	5	25	5	19
Solid amount	5	26	5	22
Length	3	30	0	11
Area	6	31	13	34
Total Conservations	35	175	39	131
Total gain in conservations		140		92

Table IV summarizes the data concerning conservation testing only in the six conservation areas used in the experiment. A visual comparison of pretest results showed very little difference in the scores on each separate conservation area with the exception of Area. On the pretest, the Control group scores were slightly higher in two areas (Area and Number), the Experimental group scores were slightly higher in two areas (Weight and Length), and the two groups scored equally on the remaining two areas. On the posttest, however, the Experimental group scored higher in every conservation except Area. These results are shown graphically in Graph I.

The total gain in conservation is the difference in the total conservations on the posttest (T_2) and pretest (T_1) or $\Sigma T_2 - \Sigma T_1$. The Experimental group shows an advantage on this comparison of 140 to 92, approximately 3 to 2, or 52 per cent.

GRAPH I: TOTAL CONSERVATIONS FOR EACH SAMPLE BY TASK



GRAPH II: NUMERICAL INCREASE IN CONSERVATIONS

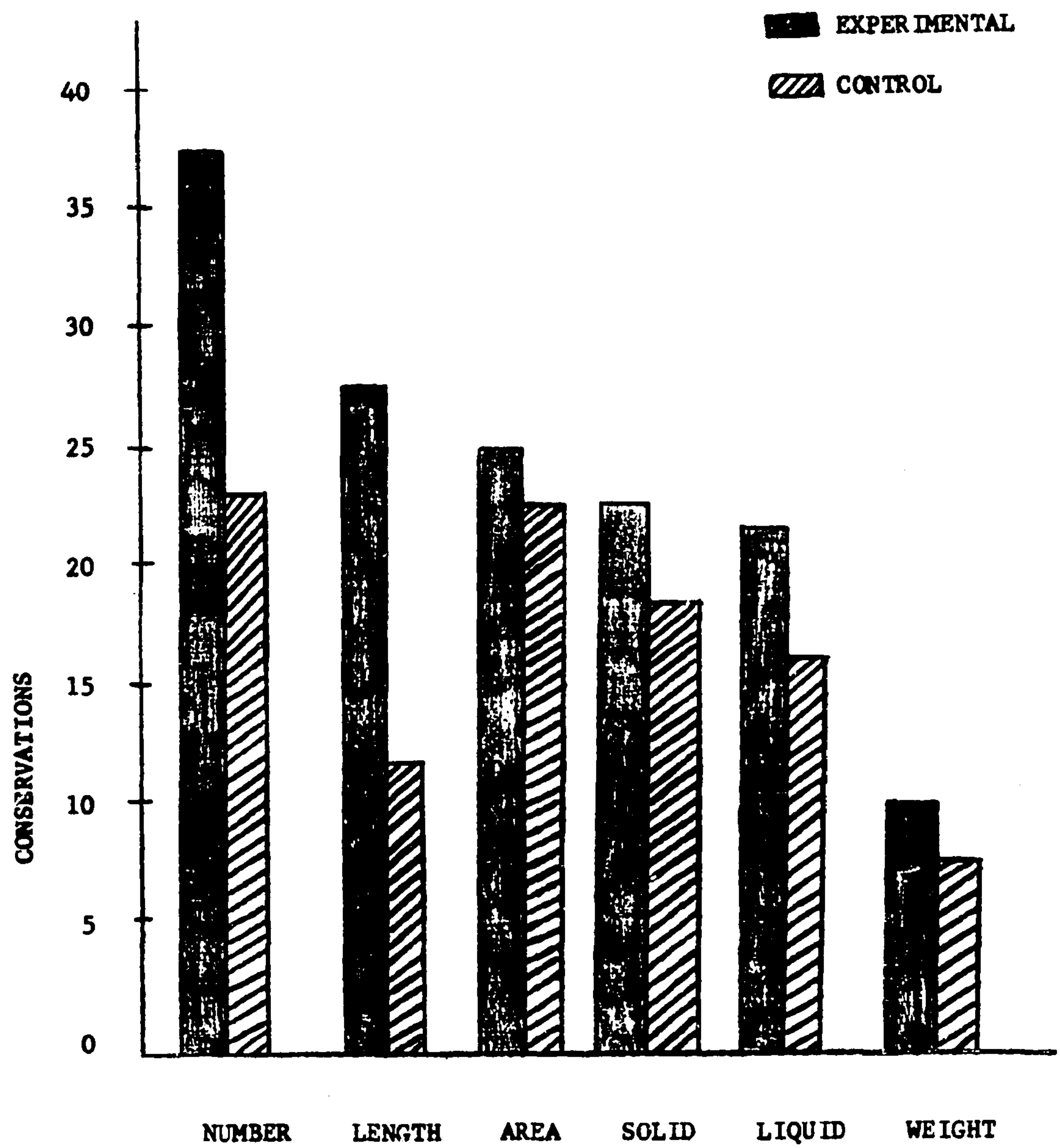


Table V

Numerical and Percentage Increase
for each Conservation Task

Conservation	Experimental Group			Control Group		
	Numerical increase	% Increase		Numerical increase	% Increase	
		Based on total in sample of 60	Based on no. of non-conservers on pre-test		Based on total sample of 60	Based on no. of non-conservers on pre-test
	(A)	(B)	(C)	(A)	(B)	(C)
Number	37	61.7	78.8(47)	22	36.7	48.9(45)
Weight	10	16.7	17.6(57)	7	11.8	11.8(59)
Liquid amount	20	33.3	36.4(55)	14	23.3	25.5(55)
Solid amount	21	35.0	38.2(55)	17	28.3	30.9(55)
Length	27	45.0	47.5(57)	11	16.7	16.7(60)
Area	25	41.7	46.3(54)	21	35.0	44.7(47)

Table V summarizes the numerical increase in conservation for each conservation task in Column A. The numerical increase in conservation is expressed as a percentage increase in two ways. In Column B, the percentage was obtained by dividing the numerical increase in conservations for each task by the total sample size (60). In Column C, the percentage increase was obtained by dividing the total numerical increase in conservation for each task by the number of children not conserving on that task on the pretest. (The number of children not conserving on each task on the pretest is given in parentheses in Column C.)

A comparison of the numerical increase in each conservation area shows the Experimental group had a larger numerical gain in <u>every</u> conservation area (see Graph II). The percentage increase calculated in both of the ways described above also favors the Experimental group in every area.

Table VI

Chi Square Values and Levels of Significance for Numerical Increase in each Conservation Area

Hypothesis	Chi Square Value	Significance Level
1. Number	8.90	.01
2. Weight	0.75	.40 (approximate)
3. Liquid Amount	1.54	.20 (approximate)
4. Solid Amount	0.643	.40 (approximate)
5. Length	11.25	.01
6. Area	.004	---
7. Total Conservations	14.25	.01

The Chi Square values in this table were computed using the numerical increase in conservations in each area for the Experimental and Control groups and the number of children who were non-conservers in each area as determined by the pretest.

Two of the individual conservation areas (Number and Length) have Chi Square values at the one percent level of significance in favor of the Experimental group. Also, the total numerical conservation increase based on the calculated possible increase (360 - sum of conservations on the pretest) had a Chi Square value with a significance at the one percent level of confidence in favor of the Experimental group.

Section B

Table VII

A Comparison of the Achievement of the Conservations and Readiness Test Scores

Division	Group	No. of Children	Total conservations Test 1	Total conservations Test 2	Difference T_2-T_1	Average increase per child	Ratio	Per cent of total increase	Significance	Chi Square
1. Total Readiness score above average (Above 64)	Experi.	24	24	87	63	2.62	1.43	45.0	.01	6.77
	Control	35	30	94	64	1.83		69.5		
2. Total Readiness score average (45-64)	Experi.	23	8	65	57	2.48	1.97	40.7	.01	11.75
	Control	19	7	31	24	1.26		26.1		
3. Total Readiness score below average (0-44)	Experi.	13	3	23	20	1.54	2.3	14.3	---	---
	Control	6	2	6	4	.67		4.4		

In Table VII, the three divisions used for comparison were developed from the categories listed in the Metropolitan Readiness Test Manual of Directions in the following manner.

Division 1 (above average) includes the Metropolitan Readiness Test Manual of Directions categories Above Average and Superior.

Division 2 (average) includes the Average category.

Division 3 (below average) includes the categories Low Normal and Low.

The rate of attainment of conservation by the Experimental group is significantly higher (.01 level of confidence) than the Control group in both Divisions 1 and 2. A value of Chi Square was not calculated for Division 3 because of the very small number of children in the Control sample. This in itself is, however, indicative of the apparent trends which appear in the table. Almost 70% of all gain in conservations by the Control group was by the Above Average group (Division 1) with almost all of the remainder of the gain in the Average group. The Experimental sample gain in conservations is more nearly balance among the three groups.

The average increase in conservation per child decreases in both Experimental and Control groups from Division 1 through Division 3. The ratio of the average increase per child of the Experimental sample and the Control sample, however, increases in magnitude.

Table VIII

Achievement of Conservation Related to I.Q. Level

Division	Group	No. of Children	Total Conservations Test 1	Total Conservations Test 2	Difference in Totals T_2-T_1	Percent of Total Conservation increases	Percent of Sample	Average Increase Per Child	Chi Square	Significance
Division 1) I.Q. range above 111 Above Average	Experi.	17	21	79	58	41.4	28.3	3.41	9.4	.01
	Control	21	22	68	46	50	35.0	2.19		
Division 2) I.Q. range 88-111 Average	Experi.	33	12	76	64	45.7	55.0	1.94	2.9	.10
	Control	34	15	60	45	48.8	56.7	1.32		
Division 3) I.Q. range below 88 Below Average	Experi.	10	2	20	18	12.8	16.7	1.8		
	Control	5	2	3	1	1.2	8.3	0.2		

Combined Samples Comparison: Above Average to Average, Chi Square is 22.2 and Significance is .01.
Average to Below Average, Chi Square is 1.89.

The I.Q. categories are essentially those listed in the Otis-Lennon test booklet with the following exceptions. (1) The superior range (above 128) and above average range (112-127) are combined to form the Above Average division, and (2) the low range (below 71) and the below average range (72-87) are combined to form the Below Average division.

A larger percentage of the total number of conservation increases occur in the Average and Above Average divisions in the Control group than in the Experimental group. The average numerical increase in conservation per child decreases toward the lower I.Q. divisions for both the Experimental and Control groups. The rate of decrease, however, is not nearly as rapid for the Experimental as it is for the Control group. For example, in the Below Average division there were only a few children in the Control group and an increase of only one conservation task was achieved.

Table IX

Influence of Kindergarten Experience on Conservations

Division	Factor	Combined Sample	Experimental	Control	Test 1	Test 2	Differences T_2-T_1	Total No. of Conservations	Chi Square	Significance Level
I	Attended Kindergarten (90)	X			X			62	3.4	.10
	No Kindergarten	X			X			12		
II	Attended Kindergarten (90)	X				X		244	6.37	.05
	No Kindergarten (30)	X				X		62		
III	Attended Kindergarten (90)	X					X	182	2.17	Below .1
	No Kindergarten (30)	X					X	50		
IV	Attended Kindergarten (42)		X				X	102	9.7	.01
	Attended Kindergarten (48)			X			X	80		
V	No Kindergarten (18)		X				X	38	6.52	.05
	No Kindergarten (12)			X			X	12		

Table IX (cont.)

Division	Factor	Combined Sample	Experimental	Control	Test 1	Test 2	Differences T_2-T_1	Total No. of Conservations	Chi Square	Significance Level
VI	Attended Kindergarten (42)		X				X	102	0.89	---
	No Kindergarten (18)		X				X	38		
VII	Attended Kindergarten (48)			X			X	80	3.75	.10
	No Kindergarten (12)			X			X	12		

In Table IX the Experimental and Control samples are combined in various ways (Divisions I through VII) to determine the influence of kindergarten experience on the attainment of conservations in the first grade. The data in the table also allow one to determine what influence the experiences provided the Experimental group had on the rate of attainment of conservations when combined with the factor of having or not having kindergarten experience.

In Divisions I, II and III, the entire Experimental and Control samples are combined (combined samples in Table X) and then re-divided on the basis of whether or not the child had kindergarten experience. The kindergarten group performed considerably better on the pretest (close to .05 level of significance), Division I of Table IX, and on the posttest (.05 level of significance), Division II of Table IX. The overall numerical increase in conservations (T_2-T_1) compared in Division III is not so pronounced (below .10 level of significance).

To obtain Divisions IV and V, the Experimental and Control samples are each divided into two groups on the basis of whether or not the child had kindergarten experience. Division IV compares the numerical increase in conservations of the children in the Experimental sample who had kindergarten experience with the numerical increase in conservations of the children in the Control group who had kindergarten experience. The Experimental group attained conservation at a significantly higher rate (.01 level of significance). Division V compares the numerical increases in conservations of those children in the Experimental and Control groups who did not have kindergarten experience. The Experimental group again scored significantly better (.05 level in the non-kindergarten group also).

Divisions VI and VII are comparisons of the numerical increase in conservation of the kindergarten and non-kindergarten groups within the Experimental and Control samples. Division VI, the comparison of the kindergarten and non-kindergarten groups of the Experimental sample, shows only a slight advantage in favor of the kindergarten group. The advantage is much more pronounced (almost .05 level of significance) in favor of the kindergarten group in Division VII which compares the kindergarten and non-kindergarten groups of the Control sample.

Table X

A Comparison of the Attainment of Conservation by Sex

Division		Samples Combined	Experi-mental	Control	Test 1 only	Test 2 only	Differ-ence T_2-T_1	No. of conser-vations	Chi Square
1	M	X			X			41	0.67
	F	X			X			33	
2	M	X				X		163	2.28
	F	X				X		143	
3	M	X					X	122	0.91
	F	X					X	110	
4	M		X		X			19	0.30
	F		X		X			16	
5	M		X			X		91	0.55
	F		X			X		84	
6	M		X				X	72	0.18
	F		X				X	68	
7	M			X	X			22	0.72
	F			X	X			17	
8	M			X		X		72	1.54
	F			X		X		59	
9	M			X			X	50	0.93
	F			X			X	42	

Number of Males = 60
Number of Females = 60

Table X compares the attainment of the conservations by sex on the basis of nine divisions. For Divisions 1, 2 and 3, all of the males of the Experimental and Control samples are combined into one group (Samples Combined) and all of the females of the Experimental and Control samples are combined into one group. These groups are then compared on the basis of pretest and posttest (Division 2) scores and on the numerical increase in conservation (T_2-T_1) (Division 3). The male groups scored somewhat higher in each of the three divisions.

Divisions 4, 5 and 6 are comparisons of the conservation scores of the females and the males of the Experimental sample only on the basis of pretest (Division 4) scores, posttest (Division 5) scores and on the numerical increase in conservation (Division 6). Again, the male groups scored higher in each division than the female groups.

Divisions 7, 8 and 9 are comparisons of the conservation scores of the females and males of the Control sample only on the basis of pretest (Division 7) scores, posttest (Division 8) scores and on the numerical increase in conservation (Division 9). The male groups in each division scored higher than the female groups.

Although there is not a single comparison of male and female groups which shows a statistically significant difference at the .05 level of confidence, the male category consistently outscored the female category.

CHAPTER IV

INTERPRETATION OF THE DATA

The tabular presentation of the data in Chapter III revealed certain patterns which were in a few cases stated in the brief discussion following the table. There are certain trends which can be revealed from a comparison of the patterns of data if the tables and graphs are used collectively. These trends will be examined in this chapter in an attempt to produce an answer to the problem stated in Chapter I; i.e., Do children who use the first grade curriculum of the Science Curriculum Improvement Study significantly accelerate their achievement of the conservations as described by Piaget over those children who have not had this experience? Further, these trends will be used to provide answers to the specific hypotheses stated in Chapter I concerning the acceleration of the attainment of the individual conservation tasks.

The results of statistical analyses are considered to be valid indicators of trends in the data. They are not, however, used in each case as the final answer to the problem or hypothesis, but only as one of the tools for evaluation. For that reason, the values of significance are given even though they are in some instances below the often-used confidence level of .05. The decision was made, and explained in Chapter I, that risking a type-one error (mistakenly rejecting a true hypothesis) was preferable to committing a type-two error.

This chapter will be divided into two sections on the same basis as Chapter III. Section A will deal with data from Section A of Chapter III and, on the basis of those data, acception or rejection of the stated hypotheses will be made; Section B will consist of an evaluation of data from Section B of Chapter III. Each section will conclude with a brief summary of the results of the analysis of that section.

SECTION A

Comparison of the Samples

Examination of the data in Table III, which compares the Experimental and Control groups relative to certain standard measurements and possible indicators of readiness or ability to learn, reveals that even though the samples cannot be shown statistically to be from different populations on the basis of average I.Q. or average Readiness scores, an overall comparison certainly favors the Control group. This favorable position of the Control group was used as one of the factors in reaching an answer to the problem of this investigation.

Conservation of Number

More subjects in both Control and Experimental samples conserved number in both the pretest and posttest (Table IV and Graph I) than any other task. The numerical and percentage increases were also higher for number (Table V) than for any other task. The increase in conservation of number by the Experimental group was 15 greater than the Control group. Statistical analysis gave a Chi Square value of 8.90 or a significance level of .01 (Table VI). On the basis of these data, the hypothesis that there is no significant difference in the rate of attainment of conservation of number by the Experimental and Control groups (Hypothesis 1, Chapter I) can be rejected in favor of the Experimental group.

Conservation of Weight

Numerical scores for the conservation of weight were, in general, the lowest for all of the tasks (Table IV). The numerical and percentage increases in conservation were also the lowest of all of the conservations tested (Table V). The Experimental group did, however, have a higher numerical increase in conservation of weight than the Control group (10:7, Table V). The Chi Square value was 0.75 which was a significance level of 0.4. Even though the Control group increased more in conservation of weight, the hypothesis that there is no significant difference in the rate of attainment of conservation of weight (Hypothesis 4, Chapter I) cannot be rejected on the basis of these data.

Conservation of Liquid Amount

The number of subjects conserving liquid amount was the same for each group in the pretest (Table IV), but the posttest results indicate a difference of 6 (third largest difference, or 1/10 the sample size) favoring the Experimental group (Table V). The Chi Square value is 1.54 which is significant at approximately the 0.2 level (Table VI). On the basis of the relatively large difference in conservation increase, and the Chi Square value, the hypothesis that there is no significant difference in the rate of attainment of conservation of liquid is rejected in favor of the Experimental group.

Conservation of Solid Amount

Although the scores on the pretest and posttest were in the middle range in size for both the Experimental and Control groups (Table IV), the numerical difference inthe increase in conservation is percentagewise the lowest of all (18% for solid amount; 43% for weight based on the difference in increases for the task compared to the numerical increase of the lower).

The Chi Square value is 0.64 and the level of significance is approximately 0.4. On the basis of these data, the hypothesis that there is no significant difference in the rate of attainment of the conservation of solid amount (Hypothesis 3, Chapter I) cannot be rejected.

Conservation of Length

The pretest scores on the conservation of length were the lowest of all (Table IV). The posttest score for the Experimental group was third highest; the posttest score for the Control group was next to the lowest. Therefore, the difference in the increase in conservation between the two groups was the largest of all (Table V shows a difference of 16).

The Chi Square value (Table VI) for length is 11.25 and the level of significance is .01. On the basis of these data, the hypothesis that there is no significant difference in the rate of attainment of the conservation of length is rejected in favor of the Experimental group.

Conservation of Area

The pretest values for the conservation of area showed the largest difference of all of the conservations (Table IV). It is also the only task in which the posttest score was higher for the Control group (Table IV; Graph I). The difference in the pretest scores was seven in favor of the Control group (Table IV), but the difference in the posttest scores was only three in favor of the Control group (Table V; Graph II). The Experimental group closed the difference to less than one-half the pretest size. Because of the large number of conservers on the posttest, this difference of four is relatively small.

The Chi Square value of .004 was shown. On the basis of this value and the other data, the hypothesis that there is no significant difference in the rate of attainment of conservation of area (Hypothesis 6, Chapter I) is accepted.

Evaluation of the Major Hypothesis

The major hypothesis of this study was that there is no significant difference in the rate of attainment of the conservations by pupils taking the first grade program of the Science Curriculum Improvement Study and pupils who do not.

The basis of determining a significant difference rests on three factors as follows:

1. The comparison of the abilities and readiness to learn of the Experimental and Control groups.
2. The general patterns and trends in the data.
3. The statistical test of significance.

The point has already been made that the Control group appears to occupy a favorable position in terms of their readiness and ability to learn (Table III). This suggests that if those abilities alone were the ones that determine the rate of attainment of conservations, the Control group should have scored higher.

The posttest scores compared by individual conservation task and/or the total conservations (Table IV) show that the Experimental group, in general, scored higher. The total gain in conservations is 48 conservations, or 52% higher than that of the Control group. This is more dramatically emphasized by the graphical presentation of the increase in total conservations by task (Graph II) which shows that the Control group had a smaller increase in <u>every</u> conservation task.

The value of Chi Square for the comparison of the overall increase in conservations between the Experimental and Control groups is 14.25 (Table VI). This value of Chi Square has a significance level of .01 (Chi Square = 6.64 for .01).

On the basis of the evaluation of these factors, the major hypothesis is rejected in favor of the Experimental group.

Summary of Section A

On the basis of the evaluation of the data in Tables III, IV, V and VI, it can be stated that some factor appeared to be operating which produced a significant acceleration of the attainment of the conservations in the individual areas of conservation of number, conservation of length, and of conservation of liquid amount, and an overall increase in the attainment of conservations in the combined areas. The only treatment difference between the educational patterns of the two groups is the experience provided by the first grade program of the Science Curriculum Improvement Study. That program, therefore, seems to be providing those experiences which not only allowed the Experimental group to overtake the Control group in overall ability to conserve, but to surpass the acquisition of conservation by the Control group.

SECTION B

Readiness Test Scores and Overall Conservation Increase

More than half of the Control sample (35 out of 60) was in the above average division (Division I). Even though those 35 pupils achieved 70 percent of the total increase in conservation by the Control group, the Experimental group scored significantly higher than the Control. The value of Chi Square for the comparison of total conservation increase in Division I is 6.77 in favor of the Experimental group. This is significant at the .01 level of confidence.

The number of pupils in Division II, the average category of Table VII, is the most nearly equal of the three divisions (23 Experimental; 19 Control). The advantage of the Experimental group is more pronounced in Division II than in Division I. The value of Chi Square for the comparison of the total conservations in Division II is 11.75 which is, of course, significant in favor of the Experimental group.

The trend toward an increased advantage on the part of the Experimental group is reflected in the ratio of the average increase of conservations per child. On the basis of these data, the Experimental group, in addition to possessing an advantage in the above average readiness group, increases this advantage in the lower readiness groups. The data also clearly indicate that the attainment of the ability to conserve is related positively to the readiness score.

I.Q. Scores and Overall Conservation Increase

Although the Experimental group achieved at a higher statistically significant level (.01 level of confidence) in the above average I.Q. range (Division I, Table VIII), the average increase in conservation per child in the three divisions provides a better basis for comparison. The average increase per child drops in the Experimental group from 3.41 in Division I to 1.94 in Division II to 1.8 in Division III. The average increase per child drops even more drastically in the Control group from 2.19 in Division I to 1.32 in Division II to 0.2 in Division III.

A comparison of the combined groups in Division I with the combined groups of Division II shows a significant difference at the .01 level in favor of the above average group. These data indicate that the rate at which the conservations are achieved is positively related to the I.Q. Also, the rate of attainment of the conservations by the Experimental groups appears to be less dependent on the I.Q. than the Control group. Since the sample size was quite small, especially in the low I.Q. region, generalizations cannot be strongly defended. There is, however, sufficient consistency in the data to suggest that the problem deserves further study.

Influence of Kindergarten Experience on the Rate of Attainment of the Conservations

Kindergarten experience appears to relate definitely to the ability to conserve. The comparison of conservation scores on both the pretest and posttest for the combined samples (Table IX, Divisions I and II) shows the kindergarten groups scoring significantly higher on both tests. The growth in conservation skills reflected by the numerical increase in conservations favors those who had kindergarten experience but the advantage is not pronounced.

The numerical increase in conservation for those children in the Experimental sample who have attended kindergarten is significantly higher (.01 level) than for the Control sample (Division IV, Table IX). Also, the numerical increase in conservation for those children in the Experimental sample who have not attended kindergarten is significantly higher (.05 level) than for the Control sample (Table IX, Division V). However, since the advantage of the Experimental sample in Division IV (those who had kindergarten) is considerably more pronounced than the advantage of the Experimental sample in Division V (those who did not attend kindergarten), the combination of kindergarten experience with the experiences of the Science Curriculum Improvement Study's first grade program is most effective.

A comparison of the results of Divisions VI and VII of Table IX indicates that kindergarten attendance is a greater factor in the growth of conservation skills for the Control group than for the Experimental group. Perhaps the experiences of the Experimental group in the Science Curriculum Improvement Study's first grade program help to compensate for not having had kindergarten experience. Additional investigation into this area might prove beneficial.

Comparison of the Rate of Achievement of Conservation by Sex

The data in Table X suggest no statistically significant differences in the rate of achievement by sex on any basis of comparison used. The fact that boys did outscore the girls on all comparisons made suggests that this is an area that might warrant further study.

Summary of Section B

The rate of attainment of conservations in the first grade is greater in the High I.Q. divisions and in higher Readiness score divisions than in the lower divisions. The Experimental group scored higher in every division and did reasonably well in the below average divisions (III) of both Readiness and I.Q. where the Control group did very poorly.

There was no significant difference in the rate of attainment of conservation when the groups were divided by sex. The boys did outscore the girls, however, on every basis of comparison made.

Kindergarten experience appears to be a factor in the rate of attainment of conservation. It appeared to be less important for the Experimental group.

CHAPTER V

CONCLUSIONS, EDUCATIONAL IMPLICATIONS AND SUGGESTIONS FOR FURTHER STUDY

Conclusions or Findings

The data of this study support the following conclusions or findings:

1. The rate of attainment of the conservation skills is significantly enhanced by the experiences made possible by the first grade program of the Science Curriculum Improvement Study.
2. A positive influence of the first grade program of the Science Curriculum Improvement Study can be shown in the above average and below average Readiness score divisions. The influence is even more pronounced in the average and below average Readiness score divisions.
3. Ability to conserve appears to be positively related to I.Q. The rate of attainment of the conservations by the Experimental sample, however, is less dependent on I.Q. than the Control sample. The treatment given the Experimental sample appears to be effective in enhancing the attainment of the conservations in the entire range of I.Q.'s usually found in

the classroom.

4. Kindergarten experience is positively related to the acquisition of conservation. The experiences made possible by the first grade program of the Science Curriculum Improvement Study appear to compensate for not having kindergarten.

Educational Implications

The suggestion was made in Chapter 1 that the ability to use logic in problem solving is contingent on the acquisition of the thought processes essential to conservation. A child does not possess the ability to structure information for storage and efficient retrieval without the ability to use logic. Since achievement in all formal school activities presupposes the ability to store and retrieve information, it is imperative that every child be provided opportunities which are designed to develop and continuously refine this ability. The experiences made possible by the first grade program of the Science Curriculum Improvement Study have been shown to accelerate the attainment of conservation skills and, therefore, could be used to initiate such a program of opportunities in first grade or perhaps in kindergarten. A program of this nature appears to take on more importance for children who have been deprived of the usual play activities and experiences of childhood and for those who are not as academically or intellectually endowed.

Since the acceleration of the acquisition of the conservation skills was achieved through educational experiences which were a part of "normal" curriculum rather than a "training" exercise designed specifically to learn a particular conservation skill, it can be assumed that the acceleration was produced because of the richer experiential educational environment. The children, then apparently had prerequisite maturation and simply lacked the experiences needed to actuate the thought processes essential to conservation and logical thought. The experiences provided in the first grade program of the Science Curriculum Improvement Study are the type needed to initiate the movement toward the stated goal of the Educational Policies Commission, i.e., " . . . the development of the ability to think."[44]

Another very important implication of the findings of this study is in the area of beginning reading. The ability to conserve was found by Millie Almy to be substantially correlated with progress in beginning reading.[45] Perhaps a more educationally fruitful approach to the teaching of reading in the first grade might be to precede the initiation of reading with not only the usual readiness activities but also a period of six to eight weeks of activities such as those given the Experimental sample of this study.

Suggestions for Further Study

Findings in the data and educational implications resulting from them suggest a need for study in some areas. Three of these have been

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[44]Educational Policies Commision, op. cit., p. 14.

[45]Almy, op. cit., p. 105.

suggested already at appropriate places in the text and will be listed here in summary.

1. The relationship between I.Q. and rate of attainment of conservations needs to be explored in depth.
2. The fact that the boys in both samples outscored the girls on every basis of comparison used with regard to conservation appears to warrant further study to examine sex related differences in attainment of conservation. Perhaps certain experiences are more fruitful in the acceleration of conservation in one sex moreso than another.
3. A study needs to be conducted to determine to what extent enriched experiences such as those provided the Experimental group in this study can compensate for lack of kindergarten experiences or other preschool experiences.

Ideas for further study that needs to be done also arise from the educational implications of this study.

1. Since progress in beginning reading is substantially correlated with ability to conserve, studies must be conducted in this area to find the optimum coordination between programs which accelerate and enhance the attainment of conservation and the initiation of the reading program.
2. A study needs to be conducted to see what benefits to reading readiness and progress in reading might accrue from the introduction of educational experiences such as those of the

first grade program of the Science Curriculum Improvement Study in kindergarten.

3. Would the acceleration of the conservations be further accelerated by a more concentrated program of experiences of the type provided the Experimental group?

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APPENDIX A

APPENDIX A

AN OVERVIEW OF THE FIRST GRADE PROGRAM OF THE
SCIENCE CURRICULUM IMPROVEMENT STUDY

The first grade program of SCIS consists of a physical science unit, Material Objects, and a life science unit, Organisms. These units may be initiated at the same time in the fall, or, as is the usual case, the physical science unit may be introduced first and the life science unit later--perhaps as much as one semester later.

The following is a brief overview of each of the units taken from the teachers guide for the unit. After the overview of each unit, the method of teaching used in the program is described.

Material Objects[46]

The concept that matter exists and has properties is one of the first abstractions the child is able to understand and deal with. Thus, after the introductory work in kindergarten, the first SCIS unit presented to the child is Material Objects. In it he learns to apply this basic concept.

Material Objects introduces the child to the fundamental concepts

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[46]This overview is taken from the Teacher's Guide for Material Objects, pp. ix-x.

of objects and their properties. It leads him to manipulate, describe, compare, and change the form of samples of metals, woods, plastics, granular materials, liquids, gases, etc.

The main objective of the unit is to teach the child to recognize material objects in his own environment. The objects themselves are to be distinguished from their properties. In the first two chapters the child learns to understand and use the word <u>object</u> as a term for referring to a piece of matter. The range of objects used is as broad as conveniently possible. The pupil observes and manipulates rigid, well-defined objects such as rocks and twigs, wood dust, samples of liquid such as glycerin in a jar, living organisms, and samples of gas such as air in a balloon.

For contrast, one can consider what would not be objects in this sense. All abstractions such as love and hate, time and space, beauty and color, hunger and thirst, are examples of things that are not material objects. The word <u>thing</u>, which can be used to refer to abstractions, has too broad a meaning to be useful in a science program which tries to communicate a concept of matter. The contrast between <u>objects</u> and <u>nonobjects</u> is introduced in later units; in this unit, the child becomes acquainted with the objects in his environment and merely distinguishes the objects from their properties.

The first chapter uses familiar objects in the classroom, home, and playground to introduce the concepts of <u>object</u> and <u>property</u>. The new ideas are then applied to other objects, to plants and animals and their parts, and to collections of buttons and wooden blocks that can be sorted according to a number of properties such as shape, color, texture and size.

In Chapter Two, the child's comparison of similarly shaped pieces of aluminum, brass, pine, walnut, vinyl, and polystyrene leads to the introduction of the concept of material. This concept is then applied in additional work with other metals and various kinds of wood, as well as with rocks, liquids, and gases.

In Chapter Three, comparison signs ($>$ and $<$) and serial ordering introduce a semiquantitative aspect to the child's comparison of objects.

Chapter Four allows the child to carry out experiments in which he collects evidence about the material of which lump sugar and rock candy are composed, tests whether objects float or sink in water, and uses air to displace water from submerged containers. These experiments give the child opportunities to apply what he has learned about material objects and their properties; the experiments also provide an informal introduction to the concept of systems, which is the subject of a later physical science unit in the SCIS program.

While dealing with material objects in this unit, the child will develop various attitudes, abilities, and skills, including habits of careful observation, a vocabulary that is useful in describing objects, methods of recording observations and experiences, and the ability to discriminate fine differences and to recognize broad similarities.

Hopefully each child will have many and varied experiences in:

1. manipulating and observing different kinds of objects;
2. describing the properties of observed objects;
3. comparing and sorting objects, with close attention to their properties;
4. developing the concept of material--the "stuff" that makes up an object;
5. applying certain mathematical concepts to concrete situations;
6. acting upon and experimenting with objects in the solid, liquid, and gaseous phases;
7. using certain tools such as a magnifier, a mortar and pestle, and a medicine dropper;
8. keeping a record of observations;
9. working with other children as part of a team.

Frequent use of the question "What is your evidence?" can help the children in many ways. Whenever a child makes and reports an observation, draws an inference, or states a conclusion, the teacher should ask this question or a similar one. The child's answers will help the teacher analyze and evaluate his ability to observe and/or manipulate objects and to use his observations in making decisions. In addition, as different children report varying evidence while observing and manipulating similar objects, the teacher will have excellent opportunities for promoting pupil-to-pupil discussions about the evidence. With the teacher's guidance, these discussions can lead the children to decide that they need to obtain further evidence to settle the controversies. Situations such as these will increase the child's interest and involvement in the concrete operations which are at the core of this unit.

Organisms[47]

Organisms, the first-year life science program, is centered on a classroom model of an ecosystem--an aquarium. Some of the basic processes, interactions, and conditions that are characteristic of ecosytems and of life are discovered as the children observe events in the aquarium, as they raise and investigate certain questions, and as the teacher initiates the activities.

Three natural events can be expected to occur in the aquaria:
birth of guppies and the appearance of snail eggs;
growth of guppies and young snails;
death and decay of organisms.

Three questions are investigated by the children:
What is on the bottom of the aquarium? (sand)
What makes the water green? (algae)
What is the black material on the sand? (detritus)

When the children compare the unknown material on the bottom of the aquarium with sand, sugar, and salt, the teacher introduces the

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[47]This overview of Organisms is taken from the Teacher's Guide for Organisms, p. 7.

children to fresh water and salt water. The children may refer to a saltwater aquarium in the classroom or to a local zoo as different kinds of places where organisms can live. On this basis, the teacher introduces the concept of habitat to the children to specify the place in an ecosystem where an organism lives.

The investigation of algae and its dependence on light forms the primary experimental activity of this unit. The children study feeding and defecation when Daphnia eat algae. The food web (feeding-relations among organisms in a community) is introduced to the children when Daphnia are in turn eaten by guppies.

The children discover that detritus originates from feces and from dead plants and animals. The contribution of detritus to soil fertility is inferred by the children as they compare the growth of seedlings in detritus and seedlings in sand.

Two activities are initiated by the teacher:

the planting of different kinds of seeds, so that the children can observe plant growth;

the presentation of aquaria with different kinds of plants and animals, to introduce the children to the concept of diversity of organisms.

This unit introduces the children to many of the concepts pertaining to ecosystems that will be developed and elaborated upon in later units. Some concepts are treated briefly during the first year, while other concepts are given fuller treatment; but all of them will be considered again as ecosystems are further studied in the units that follow.

Method of Teaching[48]

The fundamental concepts of the physical and life science are introduced by the "exploration, investigation and discovery" method of teaching. The general strategy is to first let the children explore preselected science materials. In the physical science units these may be simple objects or systems, while in the life science units they may be aquaria or other small ecosystems. The children are encouraged to explore, to discuss what they observe, and to ask questions. Then, to help the children achieve a deeper understanding, the teacher will suggest a new concept for the interpretation of what is occurring; this is called the invention. The children are then given additional equipment and materials so that they may see how the concept applies in other situations. Their investigations lead them to discover new applications of the concept. Sometimes the teacher will invite proposals of further experiments to test children's ideas; and individual children or the entire class will carry out the suggested experiments.

The atmosphere in an SCIS classroom is relaxed and yet controlled. The SCIS teacher has two functions: to be an observer who listens to the children and notices how well they are progressing in their investigations, and to be a guide who leads the children to see the relationship of their findings to the key concepts of the course. The teacher is not thought of as a pivot around which the class re-

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[48]This description of the teaching method used in the SCIS first grade program is taken from the Teacher's Guide for Organisms, p. 2.

volves and is not expected to summarize each lesson or to tie up loose ends into a neat package.

Since the teacher integrates the demonstrations, the student manuals, and the science equipment with the children's activities, the teacher's guide might be thought of as a blueprint for the course. The guide explains the objectives and structure of each part of the program, the concepts to be introduced by the teacher, opportunities for investigations to be carried out by children with equipment provided in the kit, and the role of the student manual. Each activity in the guide is carefully described to give the teacher the feeling of being "at home." Nevertheless, teachers should feel free to incorporate their own ideas into each lesson and adapt the activities to the capabilities, interests, and needs of the pupils.

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